SAFETY OF MEDICAL DEVICE USERS: A STUDY OF PHYSIOTHERAPISTS' PRACTICES, PROCEDURES AND RISK PERCEPTION

A thesis submitted for the degree of Doctor of Philosophy

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ABSTRACT

Aims: To study practices and procedures with respect to electrotherapy in physiotherapy departments and to study physiotherapists' perception of health risk, health consequences and protection of health from different risks including electromagnetic field emissions from electrotherapy devices.

Methods: This cross-sectional study was conducted in three phases from June 2002 to December 2003. The first phase was an audit of the practices and procedures regarding electrotherapy in National Health Service physiotherapy departments (N = 46 including 7 departments in pilot study) located in 12 counties in the southeast and southwest of England including Greater London. The second phase comprised one observational visit to each of the same physiotherapy departments to characterise their occupational environment. The third phase was a questionnaire survey of 584 physiotherapists working in these departments. Variables concerned perception of health risk, health consequences and protection of health associated with different risk factors.

Results: In the first two phases, the recruitment rate of the departments was 80.7% (46 out of 57) and response rate of those recruited was 100% (n=46). The response rate for the last phase of the study was 66.8% (390 out of 584). Results of the practices and procedures audit show that ultrasound was the most common form of electrotherapy while microwave diathermy was neither available nor used in these departments. Pulsed shortwave diathermy was used 4-5 days per week while continuous shortwave diathermy was used rarely. Electrotherapy was provided to up to 50% of patients per week in the departments. The observational visits to the departments revealed that there were metallic objects within close proximity of diathermy equipment and wooden treatment couches for treatment with PSWD and CSWD were rare. The risk perception survey showed that physiotherapists generally perceived a moderate health risk and health consequences (harm) from exposure to EMF emissions from electrotherapy devices. Protection from EMFs in physiotherapy departments was generally perceived as 'usually' possible.

Conclusions: Physiotherapy departments report safe electrotherapy practices. Use of diathermy devices that use RF EMFs is declining. The key predictors of physiotherapists' perception of health risk were perception of health consequences and vice versa. Gender was a significant predictor of the perception of health risks and health consequences. The main predictor of perception of protection against risk was the knowledge of environmental and health issues. Latent dimensions of perceptions of health risk, health consequences and protection from risk were identified and confirmed and their predictors were determined.

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DECLARATIONS

I declare that the research presented in this PhD thesis is my own work. I have collected and analysed the data presented in this thesis.

I have written this thesis. I have duly cited all material taken from other sources reported in this thesis.

I have published / presented / submitted / planned following publications from the data presented in this thesis.

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

A&E	Accident and emergency
AC	Alternating current
ACTH	Adrenocorticotrophic hormone
AGFI	Adjusted goodness of fit index
AIC	Akaike information criterion
AM	Amplitude modulation
AMOS	Analysis of Moment Structures
ANSI	American National Standards Institute
ATP	Adenosine triphosphate
AVE	Average variance extracted
BMI	Body Mass Index
BSE	Bovine Spongiform Encephalopathy
CAIC	Consistent Akaike information criterion
CALIS	Covariance Analysis of Linear Structural Equations
cAMP	Cyclic adenosine monophosphatase
CDMA	Code Division Multiple Access
CFA	Confirmatory factor analysis
CFCs	Chlorofluorocarbons
CFI	Comparative fit index
CI	Confidence interval
CJD	Creutzfeldt–Jakob disease
CMIN	Minimum Chi square
CML	Chronic Myeloid leukaemia
CNS	Central nervous system
CSP	Chartered Society of Physiotherapy
CSWD	Continuous shortwave diathermy
CXR	Chest X-ray
D	Disturbance
D^2	Mahalanobis distance
DC	Direct current
DF	Degree of freedom
DNA	Deoxyribonucleic acid
DV	Dependent variable
E	Error

EC	European Commission / European Community
ECG	Electrocardiogram
EEG	Electroencephalogram
EFA	Exploratory factor analysis
E-field	Electric field
EHI	Environment and health issues
ELF	Extremely low frequency
EMFs	Electromagnetic fields
EMHS	Electromagnetic hypersensitive
EMI	Electromagnetic interference
EPA	Electrophysical agent
EPSRC	Engineering and Physical Sciences Research Council
EQS	Structural Equation Modeling Software
FA	Factor analysis
GFI	Goodness of fit index
GHz	Gigahertz
GSM	Global System for Mobile Communication
h^2	Communality
HaCaT	Human keratinocytes
HC	Health consequences
H-field	Magnetic field
HL-60	Human promyelocytic leukaemic cell line
HSE	Health and Safety Executive
Hz	hertz
ICNIRP	International Commission for Non Ionising Radiation Protection
IV	Independent variable
IFI	Incremental fit index
IR	Ionising radiation
IRPA	International Radiation Protection Association
IUDs	Intra uterine devices
kg	kilogram
KMO	Kaiser-Meyer-Olkin
K-S	Kolmogorov-Smirnov
kV	kilovolt
Laser	Light Amplification by Stimulated Emission of Radiation
LISREL	Linear Structural Relations
LM	Lagrange multiplier

m	meter
MATCH	Multidisciplinary Assessment of Technology Centre for Healthcare
MDT	Medical device technologies
MF	Magnetic field
MHz	Megahertz
MMW	Millimetre wave
MR	Multiple regression
MREC	Multicentre Research Ethics Committee
MRI	Magnetic resonance imaging
MRR	Meta-relative risk
MSA	Measure of sampling adequacy
mT	milli Tesla
MWD	Microwave diathermy
NFI	Normid fit index
NHL	Non-Hodgkin's lymphoma
NHS	National Health Service
NNFI	Non-Normid fit index
NRPB	National Radiological Protection Board
OR	Odds ratio
P&P	Practices and procedures
PAR	Protection against risk
PGFI	Parsimony Goodness of fit index
Ph+	Philadelphia chromosome positive
POV	Proportion of variance
P-P	Probability-Probability
PSWD	Pulsed shortwave diathermy
Q-Q	Quantile-Quantile
R^2	Squared correlation
RF	Radiofrequency
RFID	Radiofrequency identification
RHA	Regional Health Authority
RMR	Root mean square residual
RMS	Root mean squared
RMSEA	Root mean square error of approximation
RP	Risk perception
SAR	Specific absorption rate
SAS	Statistical Analysis Software

SD	Standard deviation
SE	Standard error
SEM	Structural equation modelling
SMCs	Squared multiple correlations
SPSS	Statistical Package for Social Sciences
SRMR	Standardised root mean square residual
S-W	Shapiro-Wilk
SW	Shortwave
SWD	Shortwave diathermy
TENS	Transcutaneous electrical nerve stimulation
TLI	Tucker-Lewis coefficient index
TPA	Tetradecanoylphorbol13-acetate
TV	Television
µT	Micro Tesla
UV	Ultraviolet
WBCs	White blood cells
WHO	World Health Organisation
ZPRED	Z predicted
ZRESID	Z residual
χ^2	Chi square

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1 INTRODUCTION

The non-ionising radiation in power frequency and radiofrequency ranges has been recognised as possibly carcinogenic to humans (IARC, 2002, 2011). Human exposure to non-ionising radiation can occur from different sources such as shortwave and microwave diathermy devices. Physiotherapists - a group of healthcare workers use these devices in their clinical practice. A number of studies have measured strengths of radiofrequency electromagnetic fields from shortwave and microwave diathermy devices and found them higher than the permissible limits for occupational exposure (Tuschl et al., 1999; Shields et al., 2004b; Macca et al., 2008). In addition, several epidemiological studies have reported adverse health effects and pregnancy outcomes associated with physiotherapists' exposure to radiofrequency electromagnetic fields from shortwave and microwave diathermy devices (Taskinen et al., 1990; Larsen et al., 1991; Lerman et al., 2001; Israel et al., 2007; Vangelova et al., 2007). This has raised concerns among the regulators such as the Health and Safety Executive about physiotherapists' occupational and health safety. In addition, it is possible that physiotherapists' perceptions about their own health and safety in their workplace have been affected.

This PhD thesis therefore addresses physiotherapists' occupational health and safety issues that might be associated with their exposure to radiofrequency electromagnetic fields (RF-EMFs) arising from therapeutic diathermy devices, used in clinical practice. This research study therefore investigates physiotherapists' frequency of exposure to diathermy devices by studying the availability and use of such devices, physiotherapists' practices and procedures in the safe use of electrotherapy and the physical features of the physiotherapists' workplace that might affect their health and safety. At the same time, physiotherapists' risk perception from exposure to radiofrequency electromagnetic fields in physiotherapy departments is studied.

This chapter therefore introduces a number of relevant topics in the following order. The first section defines health risk and risk factors. The second section describes medical devices and users. The third section reports on medical devices used by physiotherapists and the fourth section describes electromagnetic radiation and sources. The fifth section reports on the regulatory framework for limiting occupational exposure to EMFs while the sixth section introduces the Health and Safety Executive sponsored study of physiotherapists' exposure to EMFs. The seventh section provides an overview of adverse health effects including reproductive outcomes associated with physiotherapists' exposure to RF-EMFs in their workplaces. The eighth section describes the need for a study from physiotherapists' health and safety perspectives and the ninth section presents the overall research questions, aims and objectives of this PhD research. The tenth section outlines the layout of this PhD thesis and the last (eleventh) section summarises this chapter.

1.1 Health risk and risk factors

1.1.1 Health risk

The term "risk" can be defined differently depending on the perspective from which it is defined. For example, moral philosophers who define 'risk' in various contexts i.e. through ordinary language analysis and normative ethics, wherein risk is defined as "the possibility that some harm will occur"; the Bayesian decision theory defines risk as "the probability of an undesirable outcome"; quantitative risk assessment defines risk as "the probability that some consequences will occur"; risk-benefit analysis defines risk as "the monetary value assigned to some probable negative outcome such as loss of life" while in insurance risk is defined as " the chance of loss, often financial loss" (Shrader-Frechette, 1998). From the ecological toxicology perspective, Rodier and Mauriello (1993) have defined risk as "the likelihood of some adverse effect" while they have defined ecological risk as "the combination of a level of impact on an endpoint with the probability of an occurrence." According to North (1995), risk can be broadly defined as "the probability of occurrence of an adverse outcome and the severity of the consequences if the outcome does occur". Rational evaluation of the above-mentioned perspectives with respect to defining the term risk reveals that risk means an undesired and unintended happening that could be referred to as a harm, consequence, or loss, or an adverse or negative outcome. In addition, risk can be defined from the World Health Organisation's perspective as "the probability of an occurrence and the magnitude of the consequences of any given hazard" where hazards are any "natural processes or phenomena (for example geological, hydro meteorological and biological) or human activity (for example environmental degradation and technological hazards) that can cause injury to or loss of life, property damage, social and economic disruption or environmental degradation (World Health Organisation, 2008). Thus, a hazard is anything that can cause harm while the risk is the likelihood of harm caused by the hazardous agent (Health and Safety Executive, 2006). Hazardous agents or risk factors are described in the next section.

1.1.2 Risk Factors

A risk factor is defined as an entity that increases the probability of disease or injury incidence or death (Global Burden of Disease Study Consortium, 2010).

The risk factors however may not be causal to the disease or injury (Kirch, 2008, p.1265). Risk factors can be broadly divided into three categories i.e. chemical, physical and biological agents (Baker, 2008, p.16). Thus, there can be several risk factors, which may be related to the individual's personal and/or work environment (Lopez et al., 2006, p. 243-244). For example, excessive exposure to electromagnetic radiation (EMR) (a physical agent) may be associated with a health risk. Exposure to EMR can occur from different sources such as the electrical equipment at work for example therapeutic diathermy devices used in physiotherapy practice (NRPB, 1998).

The following section describes medical devices including their classifications.

1.2 Medical Devices and Users

In this thesis, a medical device is defined by the researcher as 'a device that is used for the treatment, therapy and care of a patient or a person with a disability or an impairment'. This working definition is derived from the researcher's published classification of medical device users (Shah and Robinson, 2008). There are several types of medical devices which range from very simple (such as a syringe) to very complex equipment (such as a magnetic resonance imaging (MRI) device). Medical devices have been systematically defined and classified by different countries as well as regional and international organisations (Health Canada, 1985; Australian Government, 1989; Therapeutic Goods Administration, 1989; European Community, 1990, 1993, 1994; HMSO, 1994, 1995; Food and Drug Administration, 1997; European Community, 1998; Health Canada, 1998; HMSO, 2000; Department of Health, 2001; European Community, 2001; Industry Canada, 2001; Swissmedic, 2001a, 2001b; Australian Government, 2002; HMSO, 2002; Department of Health, 2003; World Health Organisation, 2003). Given the many classifications, the Global Harmonization Task Force (2006) has proposed a new classification of medical devices to harmonise medical device classification globally. Thus, there are several classification systems for medical devices (World Health Organisation, 2003). Irrespective of the classifying agency, the classifications are usually based on the degree of risk associated with the device (Canadian Agency for Drugs and Technologies in Health, 2007), shown in Table 1.1.

Table 1.1 Medical device classes and levels of risks

		Level of Risk			
Classifying Organisation		*Low*	*Medium*	*High*	*Highest*
European Community	CLASSES	I	IIa	IIb	III
US Food and Drug Administration		I	-	II	III
Health Canada		I	II	III	IV
Global Harmonization Task Force		A (Low)	B (Low -Moderate)	C (Moderate - High)	D (High)

Source: Created by the researcher from literature mentioned in this section

The risk from a medical device can be to the patient, the device user (operator) and/or someone else who may be exposed to the risk from the device (Davey et al., 2005). For example, in electrotherapy such as therapeutic diathermy, the physiotherapist uses the diathermy device, the patient receives the electrotherapy, and other patients or staff in the close vicinity might become exposed to stray electromagnetic field emissions arising from the operating diathermy device. There is therefore a need for avoidance, elimination and minimisation of such undesired risks. However, there is in addition a need for the identification of those people who might become exposed to medical devices to a greater extent with a potential for risks to their health. Among the three categories of people mentioned above, the users (operators) of the devices are more likely to be exposed to risks because they are exposed to the devices more frequently. However the users of medical devices are diverse (Figure 1.1) such as healthcare professionals who use a range of medical devices for patients' benefits as well as patients, and their lay carers, who also use medical devices for self-testing or home care (Shah and Robinson, 2008).

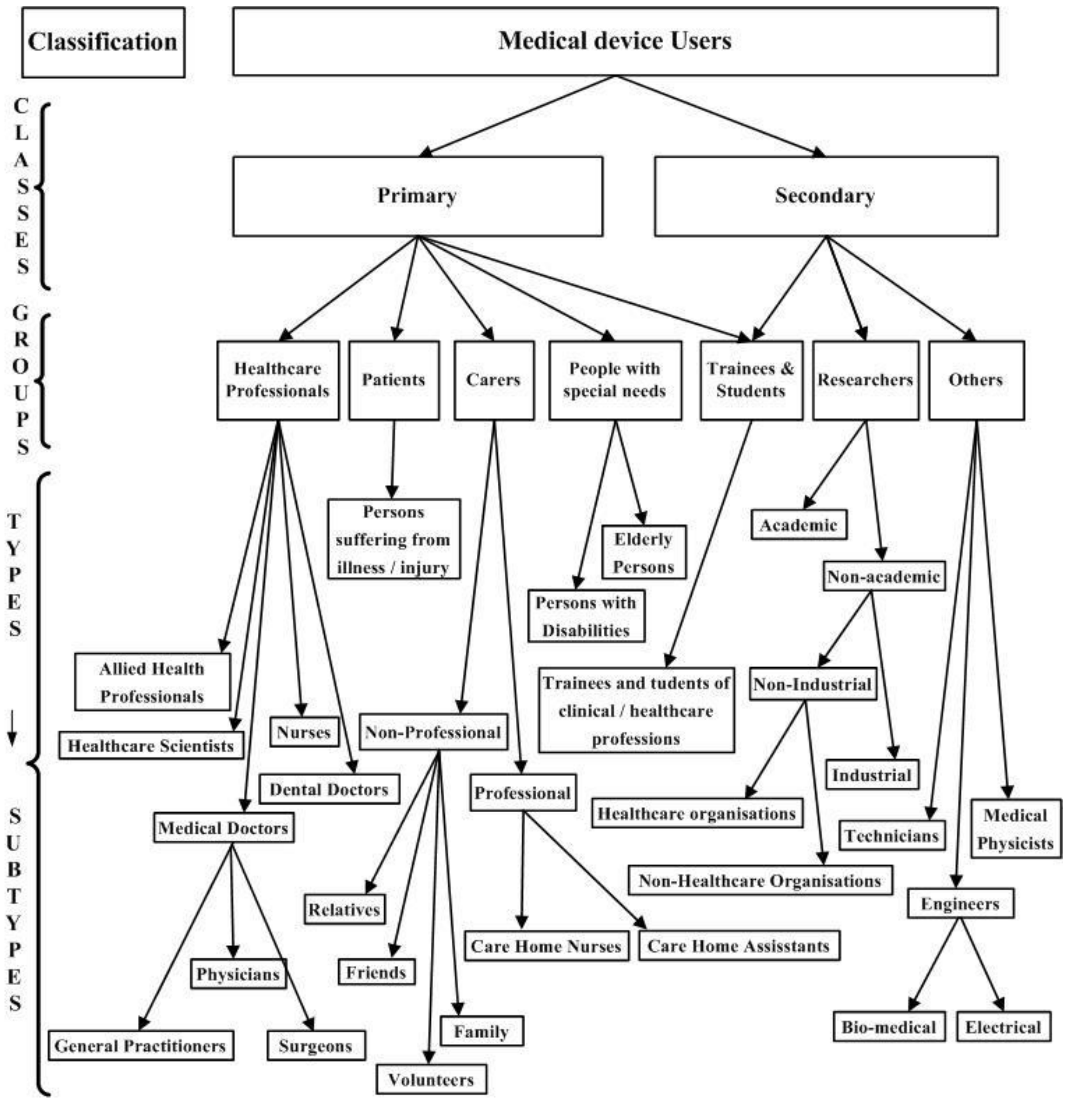

Figure 1.1. Classification of medical device users
[Adapted from the researcher's published work (Shah and Robinson, 2008)]

Healthcare professionals use medical devices more regularly and for longer durations than other users; therefore, it is assumed that they are likely to be exposed to medical device related health risks. The next section describes medical devices used by physiotherapists in their clinical practice.

1.3 Medical Devices used by Physiotherapists

Physiotherapists are allied health professionals who provide physiotherapy services to patients (Chartered Society of Physiotherapy, 2002a; Porter, 2008). A component of physiotherapy practice is electrotherapy, which is provided using different electrophysical agents (EPAs) (Watson, 2000, 2008), administered by physiotherapists by means of different types of devices. For example, acoustic energy used in therapeutic ultrasound, electric current used in interferential, transcutaneous electrical nerve stimulation (TENS) and H-wave, light energy used in laser and radiofrequency electromagnetic energy used in shortwave diathermy (SWD) and microwave diathermy (MWD) (Chipchase et al., 2008; Watson, 2008). It is beyond the scope of this thesis to explain the mechanism of application of each of these EPAs and provide in depth description of the resulting therapeutic effects. However, it would suffice to mention that these EPAs are used for different therapeutic purposes. For example, CSWD and MWD are used for heating the tissues to enhance the healing process in musculoskeletal injury; ultrasound, PSWD and laser are used for bio-stimulation of tissues, and interferential and TENS are used for electrical stimulation of muscular nerves for alleviating pain in musculoskeletal injuries (Fox and Sharp, 2007). In addition, the frequency of use of these EPAs varies. For example, therapeutic ultrasound is used more commonly while MWD and H-wave are used rarely (Chipchase et al., 2009).

Physiotherapists therefore use a variety of electrotherapy devices, which are different from each other not only in that they use different types of the energy but also their application mechanisms are different and their mode of releasing the energy is different. For example, SWD and MWD devices use non-ionising radiation in the radiofrequency shortwave and microwave ranges, respectively (Goats, 1989a, b, 1990; Giombini et al., 2007; Al-Mandeel and Watson, 2008), as described below.

In the UK, SWD devices operate at 27.12 MHz and MWD devices operate at 2450 MHz (2.45 GHz) frequency (Scott, 2002; Baxter et al., 2006; Leitgeb et al., 2010). It should also be noted that MWD devices also operate at different frequencies (Giombini et al., 2007) such as 433.92 MHz (Leitgeb et al., 2010) and 915 MHz (Martin et al., 1991; Lerman et al., 1996). It is also pointed out that SWD is used either in pulsed (PSWD) or in continuous (CSWD) mode (Belanger, 2002; Bazin et al., 2008; Leitgeb et al., 2010). SWD and MWD devices are used to provide heating for therapeutic purposes. According to the US Food and Drug Administration classification of medical devices, SWD and MWD devices are classified as class II (High risk) devices on the basis of risk associated with these devices when used for deep heating due to the use of non-ionising energy in the radiofrequency range (Center for Devices and Radiological Health, 2007). The next section describes electromagnetic radiation.

1.4 Electromagnetic Radiation and Sources

The electromagnetic radiation spectrum is divided into ionizing radiation and non-ionising radiation (NRPB, 1998). Ionising radiation is radiation greater than 300 GHz (ICNIRP, 1998). Non-ionising radiation includes electromagnetic radiation ≤ 300 GHz (ICNIRP, 1998), which is divided into extremely low frequency (ELF) radiation ≤ 300 hertz (Hz) and radiofrequency (RF) radiation 300 Hz - 300 GHz (gigahertz) (Kheifets et al., 2010). RF radiation includes shortwave 300 Hz - 300 MHz (megahertz) and microwave energy (300 MHz – 300 GHz) (ICNIRP, 1998). The term electromagnetic fields generally refers to electric (E), magnetic (H) and electromagnetic fields (EMFs), which are generated by electric current (ICNIRP, 1998). An electric field is generated by the presence of electric current (voltage) while a magnetic field is created by the flow of electric current (EMF RAPID Program, 1996; ICNIRP, 1998; Low and Reed, 2000, p. 180). Electric and magnetic fields can be either static (fixed) or time varying and the latter are commonly known as EMFs (ICNIRP, 1994, 1998). The static electric and magnetic fields do not change with the time and they are produced by direct electrical current (DC) while the time varying EMFs are produced by alternating current (AC) and their strength and direction changes with time (NRPB, 1998; World Health Organisation, 1999, 2010). Electric and magnetic fields move at right angles to each other and at right angles to the direction of their travel and when the electric field changes, the magnetic field also changes, which in turn changes the electric field again and the cycle continues (Low and Reed, 2000, p. 182).

Electric and magnetic fields can penetrate a material and be absorbed or reflected to a varying degree depending on the nature of the material (Low and Reed, 2000, p. 193-194). E-fields can be shielded and their strength weakened by materials that conduct electricity such as buildings, trees and humans while H-fields pass through most conducting materials and hence are difficult to weaken or shield (EMF RAPID Program, 1996). The strength of the E-field decreases as the square of the distance from its source increases but the strength of H-field has an inverse relationship with the actual distance from its source i.e. when the distance from the source increases the strength of H-field decreases and vice versa (EMF RAPID Program, 1996, p. 178; Low and Reed, 2000). The strength of the E-field is measured in volts per meter ($V\ m^{-1}$) (ICNIRP, 1998). The strength of the magnetic field is explained as either magnetic field strength (H) or the magnetic flux density (β) (Low and Reed, 2000, p. 181), which are measured in ampere per meter ($A\ m^{-1}$) and Tesla (T), respectively (ICNIRP, 1998).

Exposure of biological systems to RF radiation is generally expressed in different terms such as the source frequency (e.g. 2.45 GHz in the case of MWD), frequency modulation i.e. continuous wave or pulsed wave (e.g. CSWD and PSWD respectively), strengths of incident electric-field and magnetic-field as well as incident power density (when suitable), type and zone of exposure (e.g. near field or far field), and the duration of exposure (ICNIRP, 2009). Therefore, exposure to time varying EMFs can occur from different sources such as the electrical equipment in the home and at work (NRPB, 1998). The physiotherapy workplace is one of the occupational environments where there is possible exposure to radiofrequency electromagnetic radiation (RF-EMR) during electrotherapy. In electrotherapy, several forms of non-ionising radiation such as thermal, acoustic, electrical and electromagnetic energy are applied using different types of medical devices for example, use of therapeutic diathermy devices for electrotherapy with RF-EMR (Chipchase et al., 2008). There are two types of therapeutic diathermy i.e. shortwave diathermy (SWD), which operates at the frequency of 27.12 MHz and microwave diathermy (MWD) that can operate at different frequencies such as 433.92 MHz and 2.45 GHz (Low and Reed, 2000, p. 185; Leitgeb et al., 2010). It can be noted that the electromagnetic spectrum runs from left to right and is arranged from low to high frequency and long to shortwave length; there is therefore an inverse relationship between the frequency and wavelength of the radiation spectrum (Lee, 2010). As such, radiofrequency radiation energy released from SWD has a wavelength of 11.06 m and the radiation from MWD has a wavelength of 12.245 cm (0.12 m) (Low and Reed, 2000, p. 185). Therefore, physiotherapists and patients present within the above-mentioned distances for therapeutic diathermy devices may be exposed to RF EMFs arising from the diathermy devices. The reduction of excessive, and unintended, exposure to EMFs is essential to protect from associated health risks (World Health Organisation, 1993).

The next section describes the regulatory framework used to ensure a limit to exposure and the management of health and safety in the workplace with a special focus on occupational exposure to RF EMFs and physiotherapists.

1.5 Regulatory Framework for Limiting Occupational Exposure to EMFs

Workers can be exposed to various hazards such as radiation in the workplace that can lead to adverse health effects (Kirch, 2008, p.1023). Management of workplace (occupational) health and safety thus requires the reduction or elimination of hazards created by equipment and work processes (Kirch, 2008, p.648). If elimination of the hazard is not possible then controlling hazards to reduce the risk to a minimum is required (Kirch, 2008, p.648). Workers can also be protected from hazards using administrative controls, safe work procedures and practices, safety training and personal protective equipment (Kirch, 2008, p.648). In this regard, there are number of regulations and safety guidelines to protect and ensure the health and safety at the workplace. A review of the regulatory framework for limiting occupational exposure to RF EMFs with particular focus on physiotherapists is therefore presented in the following section.

1.5.1 Legislation

1.5.1.1 European Commission's legislation

The European Commission (EC) has issued a directive for limiting occupational exposure to EMFs within the member countries of the European Union (EU). The directive can be described as follows.

1.5.1.1.1 EC Directive 2004/40/EC

The EC Directive 2004/40/EC is aimed at protecting the health and safety of workers from the risks associated with their exposure to physical agents (electromagnetic fields and waves) in the workplace (European Community, 2004). Before this directive, there were EC recommendations regarding the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (European Community, 1999), which were non-binding on the member states. However, compliance with the EC Directive 2004/40/EC is binding. The directive provides an 'exposure level' for protection from acute exposure effects on central nervous system tissues in the head and trunk of the human body. It also provides an 'action level' with exposure limit values for protection based on the International Commission on Non-ionising Radiation Protection (ICNIRP) guidelines on limiting exposure to non-ionising radiation (described later in this section).

1.5.1.2 Legislation in the UK

In the UK, the regulatory jurisdiction pertaining to control of EMF exposure rests with the Health and Safety Executive (HSE). The relevant legislation in the UK can be described as follows.

1.5.1.2.1 Health and Safety at Work etc. Act 1974

Health and safety at the workplace including exposure to EMFs come under the jurisdiction of the Health and Safety at Work etc. Act 1974 (HMSO, 1974). General duties and rights of employees and employers to ensure health and safety at workplace are described in sections 2 and 7 of the Act. Section 2 of this Act explains general duties of employers to their employees and it states that employers shall ensure health and safety of all their employees at work (HMSO, 1974). Section 7 of the Act states that all employees have to take care of themselves and others while at work and cooperate with their employers in ensuring health and safety at their workplace (HMSO, 1974).

1.5.1.2.2 Management of Health and Safety at Work Regulations 1999

EMF exposure in the workplace is also controlled through risk assessment under the Management of Health and Safety at Work (MHSW) Regulations 1999 (HMSO, 1999). Under section 3 of these regulations, employers are required to undertake assessment of risks to employees' health and safety at the workplace and undertake necessary measures to prevent risks to the employees (HMSO, 1999). Section 14 of these regulations require all employees to ensure their own health and safety while at work and to handle any equipment, device or substance according to the formal instructions of use as well as to inform the employer and other fellow workers with respect to any health and safety issues arising from the use of such devices or substances.(HMSO, 1999).

Occupational exposure to EMFs is controlled by the Health and Safety Executive (HSE) (Health and Safety Executive, 2003) by means of assessing compliance with sections 2 and 7 of the Health and Safety at Work etc. Act 1974 (HMSO, 1974) and risk assessment under regulation 3 of the MHSW Regulations 1999 (HMSO, 1999) and with reference to the NRPB guidelines on restriction to EMF exposure (NRPB, 2004). In addition to the above mentioned legal instruments, there are guidelines to limit exposure to EMFs at the workplace, which are described below.

1.5.2 Guidelines

1.5.2.1 ICNIRP and NRPB guidelines for limiting EMF exposure

The guidelines for limiting exposure to the time varying electric, magnetic and EMFs include the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines of 1998 (ICNIRP, 1998). These ICNIRP guidelines cover the frequency range of 0 Hz to 300 GHz of the electromagnetic spectrum and are aimed at preventing adverse effects on the health of both the general public and workers. It is reiterated that the ICNIRP guidelines are non-binding and the member states have to frame their own guidelines in the light of the ICNIRP guidelines or adopt these guidelines. In this regard, in the UK, the National Radiological Protection Board (NRPB) has issued guidelines such as the restrictions on human exposure to static and time varying electromagnetic fields and radiation (NRPB, 1993), which were superseded in 1999 by the NRPB advice (NRPB, 1999) on the ICNIRP guidelines 1998. The NRPB 1999 advice was however superseded in 2004, when the NRPB issued another advice on limiting exposure to electromagnetic fields up to 300 GHz (NRPB, 2004), which recommended adoption of the ICNIRP guidelines 1998 in the UK.

The ICNIRP guidelines of 1998 provide two sets of limits i.e. “Basic Restrictions” and “Reference Levels” for protection against exposure to EMFs (ICNIRP, 1998). ‘Basic restrictions’ relate to the internal (dose) quantities whereas the ‘Reference levels’ relate to the external quantities, field strengths and the power densities (Mann, 2002). The limits under basic restrictions have been established on the basis of health effects and they must not be exceeded while the limits under reference levels have been provided for determining exposure levels as to whether the basic limits have been exceeded (ICNIRP, 1998). In addition, it is noteworthy that when restriction levels are exceeded then it does not mean that the basic restrictions have been surpassed; however, there will be a need to check compliance with the basic restrictions (ICNIRP, 1998). The values of limits of both basic restrictions and reference levels have been suggested for different bands of electromagnetic frequencies. The limits for frequencies at which therapeutic diathermy devices operate are described in the following section.

1.5.2.2 Limits of occupational exposure to time varying EMFs for frequencies used in therapeutic diathermy devices

Limits to occupational exposure to EMFs imposed under basic restrictions and reference levels recommended by the ICNIRP guidelines for frequencies used in therapeutic diathermy devices are described as follows.

1.5.2.2.1 Basic restrictions

The limits of basic restrictions for occupational (workers’) exposure to EMF recommended in the ICNIRP guidelines are presented in (Table. 1.2).

Table 1.2 Basic restrictions recommended by ICNIRP for limiting occupational exposure to time varying E and H fields in frequency range used in therapeutic diathermy devices

Frequency	*Whole body average SAR*	*Localised SAR (head and trunk)*	*Localised SAR (limbs)*
10 MHz – 10 GHz	0.4 W/kg*	10 W/kg*	20 W/kg*

* Averaged over any 6 minute period, Source: adapted from (ICNIRP, 1998)

1.5.2.2.2 Reference levels

The reference levels recommended by the ICNIRP (1998) for limiting occupational exposure to frequencies used for physiotherapy diathermy are given in Table 1.3.

Table 1.3 Reference levels recommended by the ICNIRP for limiting occupational exposure to time varying E and H fields in frequency range used in therapeutic diathermy devices

Frequency(f)	*Electric field (E) strength**	*Magnetic field (H) strength**	*Magnetic flux (B) density**	*Equivalent plane wave power (Seq) density**
10 MHz – 400 MHz	61 V/m	0.16 A/m	0.2 μT	10 W/m2
400 MHz – 2000 MHz	3f 1/2 V/m	0.008 f 1/2 A/m	0.01 f 1/2 μT	40 W/m2
2 GHz – 300 GHz	137 V/m	0.36 A/m	0.45 μT	50 W/m2

* Averaged over any 6 minute period, Source: adapted from (ICNIRP, 1998)

In the UK, protection from occupational exposure to RF-EMFs is covered under the NRPB advice (NRPB, 2004) for the adoption of the ICNIRP guidelines of 1998 (ICNIRP, 1998). Occupational exposure limits to time varying E and H fields for electromagnetic frequencies used for shortwave and microwave diathermy devices and applicable to occupationally exposed workers (physiotherapists) have been derived by the researcher from the corresponding limits given in reference levels (Table 1.3) recommended in the ICNIRP Guidelines 1998 (ICNIRP, 1998). These derived exposure levels are given in Table 1.4.

Table 1.4 Occupational exposure limits for electromagnetic frequencies associated with therapeutic shortwave and microwave diathermy devices

Diathermy modality	*Frequency (f)*	*Electric field (V/m)*	*Magnetic field (A/m)*	*Power density (W/m2)*
SWD	27.12 MHz	61	0.16	10
MWD	433.92 MHz	62.5	0.17	10.8
MWD	915 MHz	90.7	0.24	22.8
MWD	2.45 GHz	137	0.36	50

SWD = shortwave diathermy, MWD = microwave diathermy

Source: Researcher's own calculation based on the ICNIRP Guideline 1998

The guidelines by the ICNIRP (ICNIRP, 1998) and the NRPB (NRPB, 1999) have however recognised that investigation (reference) levels may be exceeded in certain occupational settings such as that close to physiotherapy diathermy equipment. In addition to the above-mentioned guidelines, the physiotherapists' professional society has also issued guidelines, which are described below.

1.5.2.3 Chartered Society of Physiotherapy's Guidelines

The Chartered Society of Physiotherapy in the UK has issued a number of guidelines and advice regarding the health and safety of physiotherapists in the safe use of electrotherapy. These include health and safety - safe practice with electrotherapy (shortwave therapies) 1997 (Chartered Society of Physiotherapy, 1997d); health and safety - risk assessment policy statement and guidance (Chartered Society of Physiotherapy, 1997c, 1998); health and safety - reproductive and post-birth health hazards in physiotherapy (Chartered Society of Physiotherapy, 1998); rules of professional conduct (Chartered Society of Physiotherapy, 2002c); core standards of physiotherapy practice 2005 (Chartered Society of Physiotherapy, 2005); and the 2006 guidance for the clinical use of EPAs (Baxter et al., 2006).

A detailed description of these guidelines is beyond the scope of this thesis; however, these guidelines provide advice to ensure health and safety in using electrotherapy devices. For example, the minimum safe distance of 1 m from the operating SWD device and position of physiotherapist i.e. standing behind the console of the device, while operating a SWD device, and risk assessment for using some electrotherapy devices such as MWD by female physiotherapists who are pregnant (Chartered Society of Physiotherapy, 1997a, b). Under the above-mentioned legislation and guidelines, it is the responsibility of physiotherapists and their employers to comply with the health and safety guidelines specific to their workplace.

1.5.3 Health and Safety Executive's roll in health and safety at work

The Health and Safety Executive has a statutory duty to ensure health and safety, minimise the occupational risk and prevent death and illness of workers (including physiotherapists) at their workplaces by assessing their exposure to potential health risks associated with their work practices (Health and Safety Executive, 2009). The HSE undertakes this duty mainly by means of the health and safety inspection visits undertaken by its safety inspectors to the work premises (Health and Safety Executive, 1998). In addition, the HSE commissions case studies in different workplace sectors (such as the health and social care services industry) and on specific occupational health and safety issues (such as exposure to radiation – both ionising and non-ionising) (Health and Safety Executive, No date). One such case study funded by the HSE, and described below, facilitated the PhD study reported in this thesis.

1.6 HSE Funded Study

The Health and Safety Executive funded the study of the assessment of physiotherapists' exposure to electromagnetic fields in physiotherapy departments, which was approved under the HSE Grant No. R47.022. The aim of the study was "assessment of EMF exposures of physiotherapists working in hospital departments" (Health and Safety Executive, 2002b). This project started in June 2002 and finished in December 2003. The objectives of the study were: estimation of physiotherapists' exposure to electric and magnetic (EM) fields at the workplace by a questionnaire tool, development of a predictive model for estimating EM fields and exposures related to specific practices, measurement of radiofrequency EM fields in the physiotherapy departments where the predictive model suggested higher EM levels, and investigation of the feasibility of producing personal dosimeters capable of logging to radiofrequency EMFs (Health and Safety Executive, 2002b).

1.6.1 Researcher's roll in the HSE study

This researcher was employed on the HSE study as research fellow on a full-time basis and Dr Alexandra Farrow was the principal investigator of the HSE study as well as the line manager and the PhD study supervisor of the researcher. The role of the researcher on the HSE study included conducting a literature review on physiotherapists' exposure to electromagnetic fields at their workplace, contacting and recruiting of NHS physiotherapy departments, arranging and conducting visits to these departments for measurement of electric and magnetic fields, assisting the medical physicist hired for measuring intensities of EMFs from diathermy devices in selected departments, development, validation and application of a questionnaire tool, collection, compilation and analyses of data, and writing quarterly progress reports and the project final report for the HSE. In addition, writing papers for academic journals and presenting research findings at national and international conferences were included in the duties of the researcher.

The above-mentioned study was funded by the HSE as a result of research reporting on health and safety issues, particularly the adverse pregnancy outcomes, associated with physiotherapists' exposure to RF-EMF emissions from therapeutic diathermy equipment.

The next section provides an overview of the potential health risks associated with physiotherapists' occupational exposure to RF-EMFs from therapeutic diathermy devices as reported in the literature. This was part of the evidence supporting a need for a study of physiotherapists' exposure to EMFs.

1.7 Physiotherapists' Exposure to EMFs and Associated Health Risks

1.7.1 EMFs in physiotherapy departments

Several researchers have measured emissions of stray RF E- and H-fields from SWD and MWD devices at higher than permissible levels for occupational exposure at the designated safe distance of 1 m (Martin et al., 1990b; Martin et al., 1991; Tzima and Martin, 1994; Lerman et al., 1996; Li and Feng, 1999; Tuschl et al., 1999; Grandolfo and Spinelli, 2002; Hrnjak and Zivkoviae, 2002; Shields et al., 2004b; Macca et al., 2008), and sometimes extending even up to 2 m distance (Grandolfo and Spinelli, 2002; Hrnjak and Zivkoviae, 2002; Shields et al., 2004b), from the operating diathermy equipment. In addition, studies sponsored by the National Radiological Protection Board (NRPB) have also mentioned that electric and magnetic fields from SWD and MWD equipment could exceed ICNIRP reference levels for occupational exposure under certain exposure conditions such as operator’s position, for example <1 m distance, from diathermy devices (Allen et al., 1994; Cooper, 2002). Emission of higher levels of RF E- and H- fields from operating diathermy devices can be a health risk not only to the physiotherapists but also for patients and other people (staff, other patients or other people such as patients’ family members or visitors) in the vicinity of these devices (Benetazzo et al., 2003).

1.7.2 Health risks associated with physiotherapists’ exposure to EMFs

A number of studies have reported statistically significant association between physiotherapists’ occupational exposure to RF-EMFs arising during the use of SWD and MWD devices and some adverse health effects and pregnancy outcomes. For example, adverse reproductive outcomes including spontaneous abortion associated with exposure to MWD (Ouellet-Hellstrom and Stewart, 1993), delayed time to pregnancy (>6 months) (Taskinen et al., 1990), stillbirth (Kallen et al., 1992), congenital malformations (Kurppa et al., 1983; Logue et al., 1985; Taskinen et al., 1990), low birth weight (<2500 g) (Lerman et al., 2001) and alteration of the gender ratio i.e. low ratio of male to female offspring (Larsen et al., 1991) associated with exposure to SWD. In addition, physiotherapists’ exposure to RF EMFs from SWD and MWD has been associated with the high rates of excessive excretion of stress hormones i.e. adrenaline, cortisol and noradrenaline (Vangelova et al., 2007) and high total cholesterol and low density lipoprotein cholesterol; hence a risk of being dyslipidemic, a cardiovascular risk factor, have been reported (Israel et al., 2007). An earlier study had reported a statistically significant association between long term exposure to SWD and ischaemic heart disease (IHD) in male physiotherapists (Hamburger et al., 1983). While the prevalence rates of IHD in physiotherapists were lower than in the general population, the authors noted that physiotherapists usually being of higher socioeconomic status, with better access to healthcare and generally being healthier than the general population might have been expected to have a lower incidence of IHD (Hamburger et al., 1983). These health risks and adverse pregnancy outcomes have been associated with physiotherapists' exposure to higher than the recommended occupational exposure levels of RF E and H fields arising from operating SWD and MWD devices.

From the physiotherapists' health and safety perspective there is therefore a need for an integrated study as explained in the following section.

1.8 Need for physiotherapists' health and safety study

Apart from clinical studies on electrotherapy, a review of published literature on the use of EPAs in physiotherapy conducted by the researcher, and reported in chapter two, revealed that published studies have focused on three main issues in relation to physiotherapists use of EPAs and their occupational exposure to RF EMFs during electrotherapy. First, investigation of the availability and use of electrotherapy equipment in physiotherapy practices. Second, the study of adverse health mainly the reproductive outcomes among physiotherapists exposed to SWD and MWD devices. Third, measurement of intensities of stray RF E and H field emissions from operating MWD and SWD equipment. There is however a lack of research focusing on physiotherapists' health and safety especially integrating the following issues. The frequency of physiotherapists' exposure to SWD and MWD electrotherapy modalities, the physical environment in which physiotherapists work and provide electrotherapy with SWD and MWD, physiotherapists' strategies to avoid unintended exposure to RF EMFs arising during SWD and MWD use, and physiotherapists' perceptions of health risk and the possibility of self-protection from RF EMFs at their workplace.

Therefore, it is important to establish the frequency of physiotherapists' exposure to SWD and MWD devices, which would depend on the availability and use of the devices. There is therefore a need to study the availability and frequency of use of these devices in physiotherapy departments (Shah et al., 2007). In addition, there is a need to study physiotherapists' practices and procedure in the use of SWD and MWD devices from the occupational health and safety perspective. In addition to the regulatory framework for using electrophysical agents, physiotherapists' practices and procedures in relation to the safe use of SWD and MWD will also depend on their perception of the levels of health risks and health consequences associated with such risks from these devices and physiotherapists' ability to protect themselves from these risks. Therefore, a study of physiotherapists' perception of health risk in general and in relation to their exposure to EMFs in their working environment is required. To investigate the issues mentioned above, a research study was carried out, which is the basis of this PhD thesis.

The research questions addressed and study aims and objectives are described as follows.

1.9 Research Questions, Aims and Objectives of this PhD study

1.9.1 Research questions

This research study from physiotherapists' occupational health and safety perspective has attempted to answer the following questions.

Q1. What is the current level of availability and frequency of use of nine different types of electrophysical agents in NHS physiotherapy departments?

Q2. What are NHS physiotherapists' practices and procedures with respect to the safe use of electrophysical agents, particularly shortwave and microwave diathermies?

Q3. What are physical features in the physiotherapy workplace particularly in treatment rooms / cubicles used for treatment with therapeutic diathermy modalities that may have potential to impact on health and safety of physiotherapists?

Q4. What are levels and predictors of NHS physiotherapists' perception of risk, health consequences and protection from exposure to RF EMFs in NHS physiotherapy departments?

The aims and objectives of this study were as follows.

1.9.2 Aims

The aims of this research study were:

A. Investigation of physiotherapists' frequency of use of EPAs in the NHS physiotherapy departments and clinics
B. Study of physiotherapists' practices and procedures in the safe use of electrotherapy devices
C. Study of physiotherapy departments' physical features from the physiotherapists' occupational health and safety perspective

D. Study of physiotherapists' rankings and predictors of perception of health risk, health consequences and protection against health risk from exposure to RF EMFs in their workplace

1.9.3 Objectives

The objectives of this PhD study were:

a) To develop and apply a questionnaire tool:

   i. To examine the availability and frequency of use of the major types of electrotherapy devices in NHS physiotherapy departments

   ii. To audit physiotherapists' practices and procedures in the safe use of electrophysical agents with a special focus on PSWD, CSWD and MWD modalities.

b) To identify specific physical features of physiotherapists' work environment workplace particularly in treatment rooms / cubicles used for treatment with therapeutic diathermy modalities in a sample of NHS hospitals and clinics that may raise safety issues for physiotherapists

c) To adapt and apply a health risk perception questionnaire:

   i. To ascertain physiotherapists' self-reported current lifestyle and health status, and knowledge and awareness of environmental and health issues

   ii. To study physiotherapists' perception of risk, health consequences and protection from EMFs in physiotherapy departments and other known hazards

   iii. To develop predictive models and identify predictors of physiotherapists' perception of health risk, health consequences and protection from various occupational, social, and environmental risks

The relationships between the aims and the objectives of this study were as follows. The objectives (a)i-ii were designed to meet the aims A and B respectively, the objective (b) fulfilled the aim C and the objectives (c) i-iii were aimed to realise the aim D.

It is also important to mention that data for this PhD research were collected in three phases. The first phase comprised an audit of physiotherapy departments and clinics using a survey questionnaire, which provided the data for the aims A and B (i.e. objectives ai-ii and b). The second phase included observational visits using a diary tool that enabled data collection for the aim C (i.e. objective b). The last (third) phase involved the risk perception questionnaire survey of NHS physiotherapists' exposure to EMFs in physiotherapy departments, which collected data for the aim D (i.e. objectives ci-iii).

The next section outlines the structure of this thesis.

1.10 Thesis Layout

This thesis is divided into six chapters. The first chapter introduces this research study and the thesis layout. The second chapter reviews the relevant published literature. The third chapter describes the methodology used in this research study. The fourth chapter presents results and findings of this PhD research while the fifth chapter provides the discussion of the findings of this study in relation to published literature. The final chapter provides conclusions of the study and suggests recommendations for future research.

1.11 Summary

There are numerous types of medical devices, which have been properly defined and systematically classified on the basis of their use as well as the potential risk involved in their usage. Risk from medical devices can be low, medium, high or very high. The potential risk from medical devices may involve their users who are diverse such as healthcare professionals, patients and carers. Physiotherapists – a category of healthcare professionals are exposed to various types of electrotherapy devices such as PSWD, CSWD and MWD, which are classified as Class II devices based on the moderate-high level of risk to their users. The literature suggests that physiotherapists may be exposed to different health risks associated with their exposure to RF-EMFs arising from the use of PSWD, CSWD and MWD devices. To ensure the health and safety of workers, including physiotherapists, at the workplace, there is a variety of legislation such as the EC Directive 2004/40/EC (European Community, 2004), Health and Safety at Work Act 1974 (HMSO, 1974) and the Management of Health and Safety at Work Regulations 1999 (HMSO, 1999). In addition, there are numerous professional guidelines to protect the health and safety of physiotherapists for example health and safety - safe practice with electrotherapy (shortwave therapies) 1997 (Chartered Society of Physiotherapy, 1997d), health and safety – risk assessment policy statement and guidance 1998 (Chartered Society of Physiotherapy, 1998) and 2006 guidance for the clinical use of electrophysical agents (EPAs) (Baxter et al., 2006) issued by the Chartered Society of Physiotherapy in the UK for safe use of EPAs (Bazin et al., 2008). However, a number of studies have reported that RF-EMF emissions from therapeutic diathermy devices are higher than the permissible occupational limits at the safe distance of 1 m from the diathermy equipment (Stuchly et al., 1982; Martin et al., 1990a; Martin et al., 1991; Tzima and Martin, 1994; Lerman et al., 1996; Li and Feng, 1999; Tuschl et al., 1999; Grandolfo and Spinelli, 2002; Hrnjak and Zivkoviae, 2002; Shields et al., 2004b; Macca et al., 2008), which sometimes extend up to 2 m distance from the devices (Grandolfo and Spinelli, 2002; Hrnjak and Zivkoviae, 2002; Shields et al., 2004b). In addition, several studies have reported the association between physiotherapists' occupational exposure to RF-EMFs from SWD and MDW and a number of adverse pregnancy outcomes such as spontaneous abortion, stillbirth, congenital malformations and altered gender ratio (Kurppa et al., 1983; Logue et al., 1985; Taskinen et al., 1990; Larsen et al., 1991; Ouellet-Hellstrom and Stewart, 1993). In addition, excessive excretion of adrenaline, cortisol and noradrenaline hormones in physiotherapists occupationally exposed to RF-EMFs as well as high total cholesterol and low density lipoprotein cholesterol have been reported. Moreover, the IARC has recently classified RF-EMFs as a possible carcinogen to humans group B (IARC, 2011). It is therefore important to study physiotherapists' health and safety by integrating physiotherapists' frequency of exposure to SWD and MWD devices, physiotherapists' practices in the use of SWD and MWD, physiotherapists' workplace environment, and physiotherapists' perception of health risk from their exposure to RF EMFs during electrotherapy with SWD and MWD.

The researcher has therefore conducted such an integrated research study which is reported in this PhD. This study has investigated the availability and frequency of use of electrotherapy devices, physiotherapists' practices and procedures in the use of different electrotherapy devices as well the physical features of physiotherapists' workplace. In addition, the researcher has surveyed physiotherapists' perception of health risk, health consequences and level of protection from potential health risks from exposure to RF EMFs in physiotherapy departments compared to other known health risk factors.

The next chapter presents a review of published literature relevant to this research study.

2 LITERATURE REVIEW

This chapter presents a review of published literature relevant to physiotherapists' health and safety issues in the context of their exposure to EMFs from electrotherapy devices and in particular from shortwave and microwave diathermy devices. The first section of this chapter describes the process of the literature review and outlines the literature search parameters used for conducting this review. The second section of the review reports on the availability, use, non-use and non-availability of nine electrotherapy modalities. These are ultrasound, PSWD, CSWD, MWD, TENS, interferential, biofeedback, laser and H-wave. The third section presents a review of studies reporting on the measurement of electric and magnetic field emissions from shortwave and microwave diathermy devices in physiotherapy departments. It is pertinent to mention that given the focus of this study on physiotherapists' exposure to EMFs from shortwave and microwave diathermy devices; the literature review on electromagnetic fields covers the radiofrequency spectrum of non-ionising radiation. The devices being considered operate / use shortwave and microwave energy, which is within the radiofrequency range. The fourth section presents a review of literature on adverse health effects reported to be associated with physiotherapists' exposure to radiofrequency EMFs from shortwave and microwave diathermy usage. The fifth section defines risk perception, describes the main theories and the predictors of risk perception and presents a review of literature on physiotherapists' risk perception from exposure to RF EMFs in physiotherapy departments. The final section summarises the main findings of the literature review, identifies research gaps and presents the research questions that will be addressed in the present PhD study.

2.1 The Process of Literature Review

2.1.1 Aims and objectives

The aim of the literature review was to provide evidence from published research to underpin and rationalise this research study. The objective was to identify the relevant literature.

2.1.2 Stages of the literature review

The literature review presented in this chapter reviewed literature published from January 2000 to June 2010. Review of literature was conducted in two stages. The first stage began in October 2002 when this PhD research started and covered literature published from 1990 to 2002. The second stage was completed in June 2010, which covered literature published between January 1990 and June 2010. The methodology for the literature review was as follows:

2.1.2.1 Inclusion criteria

The following inclusion criteria were applied to the literature search.

Language: English

Publication dates: January 1990 to June 2010

Study type: Empirical primary research studies

Study populations: Humans

2.1.2.2 Exclusion criteria

Discursive, hypothetical and review articles and studies published in languages other than English were excluded.

2.1.2.3 Subject areas of literature review

Literature review was conducted in four subject areas that were related to physiotherapists' exposure to radiofrequency electromagnetic fields. The first topic of literature review was the availability, use, non-use and non-availability of the above- mentioned nine electrotherapy modalities in physiotherapy departments. The second was the measurement of EMF emissions from PSWD, CSWD and MWD devices in physiotherapy departments. The third was adverse health effects and pregnancy outcomes associated with physiotherapists' exposure to radiofrequency EMFs from devices of three types of therapeutic diathermy mentioned earlier. The fourth was physiotherapists' health risk perception from occupational exposure to radiofrequency electromagnetic fields in physiotherapy departments.

2.1.2.4 Keywords

A separate list of key words was prepared for searching the relevant literature on each of the above-mentioned four subject areas. The keywords that were common were electrophysical agents, electrotherapeutic devices, electrotherapy, microwave diathermy, physiotherapy, physical therapy, physiotherapist, physical therapist, shortwave diathermy, and therapeutic diathermy. For literature searches on the availability and use of electrotherapy equipment, additional keywords were devices, equipment, survey, use and availability. Extra keywords for literature searches on the measurement of EMF emissions from PSWD, CSWD and MWD devices included allied health personnel, departments, electric and magnetic fields, electromagnetic, electromagnetic fields, EMF, exposure, measurement, non ionizing, non-ionising, occupational, operator, radiation and radiofrequency. Similarly, the keywords used for literature on adverse health effects and reproductive outcomes in physiotherapists operating SWD and MWD devices were all the common keywords mentioned above and all the keywords, except the 'measurement', used for searches on the EMF measurements as well as the following keywords. Abortion, adverse outcome, birth weight, congenital malformation, gender ratio, health risk, hyperthermia, occupational health, outcome measures, pregnancy outcomes, radio waves, reproductive outcomes, and spontaneous abortion. The keywords used for literature searches on physiotherapists' risk perception from occupational exposure to EMF included determinant, perception, health risk, model, modelling, modelling, predictor,

risk, survey, workplace as well as all the aforementioned common keywords and the keywords used for searches on the EMF measurements in physiotherapy departments.

Using these keywords and applying the 'AND' and 'OR' Boolean search operators, literature searches were conducted through the following databases.

2.1.2.5 Databases searched

Literature searches were conducted through a number of online bibliographic databases. Databases that were commonly searched for literature on all four subjects areas included Medline/OvidSP, PubMed Central, CINAHL/ EBSCOhost, ScienceDirect, Scopus, and ISI Web of Knowledge. In addition,

OSH UPDATE and OSHROM databases were searched for literature on EMF measurements from diathermy devices and adverse health effects and pregnancy outcomes associated with physiotherapists' exposure to EMFs. For literature on risk perception, additional databases searched were PsychINFO, PsycInfo, Springer and Wiley Online Library.

2.1.2.6 The process of short listing of articles

The process of short listing and identifying the relevant articles comprised three steps. The first step included reading the title of each article. The second step comprised reading the abstracts of the shortlisted articles arising from the first step. The third step included obtaining full text copies of articles identified in the second step and then reading them thoroughly. If the articles were found to be relevant to the aims of this research then they were retained otherwise they were discarded. Finally, data on the key findings and conclusions were extracted from the reviewed studies, which are presented in this chapter.

A flow chart showing the number of total papers found, dropped out and selected for full review was developed for each subject area of the literature review and such flow charts are presented at the beginning of each section presenting the literature review for each of the four subject areas.

Adopting the literature review process described above, the research literature was reviewed in afore mentioned four subject areas. The findings of the literature review on first subject area, electrotherapy equipment availability and usage, are presented in the following section.

2.2 Review of Literature on Availability, Use, Non-use and Non-availability of Electrotherapy Devices

Electrotherapy, which is the main component of physiotherapy practice (Watson, 2000, 2008), is provided using different electrophysical agents (EPAs). These are therapeutic ultrasound, shortwave diathermy (used in pulsed (PSWD) and continuous (CSWD) modes), microwave diathermy (MWD), interferential, transcutaneous electrical nerve stimulation (TENS), biofeedback, laser (Watson, 2008), and H-wave (Blum et al., 2008; 2009). Some of the electrotherapy modalities used in the past are becoming less popular (Watson, 2008); hence, there is variation in the availability and use of these modalities. It is therefore important to review the literature to assess the degree to which such electrotherapy modalities are available and used, available but not used, and not available at all in physiotherapy departments. In this regard, a review of relevant literature is presented in this section.

Literature searches were conducted using the literature review process and literature search parameters, keywords and databases described in the section 2.1. The process of excluding and including the studies in shown in Figure 2.1, which led to the identification of 22 relevant studies for full review. The data abstracted from these 22 studies included the publication year and location of the study, aims and objectives, study design, data collection tool, sample size, response rate and the key findings. Table 2.1 presents data extracted from these 22 studies with respect to the above-mentioned variables alongside the researcher's (reviewer's) comments / remarks.

Figure 2.1. Number of included and excluded studies on the availability and use of electrotherapy devices in physiotherapy departments

Table 2.1 Studies included in literature review on the availability and usage of electrophysical agents in physiotherapy departments

Authors (year)	Lindsay et al. (1990)	Location: Brisbane, Australia
Aims/objectives	Survey of ownership, frequency of use and factors affecting the pattern of use of electrotherapeutic modalities	
Participants; sample size	Private physiotherapy practices; N =105	
Design; (response rate)	Questionnaire survey; (70%)	
Findings	Physiotherapists aged <31 years more likely to use TENS than those ≥31 years (p <.05). US owned by 100%; TENS 92%; interferential 85%; SWD66%; MWD33%; biofeedback 24%; PSWD 20%; laser, 17% of clinics. Frequency of use for those owning equipment was US by 93%; interferential 90%; MWD 79%; SWD 68%; laser 58%; TENS 21% and biofeedback 18%. Main reasons for TENS use was 'effectiveness and portability'; for SWD was 'effectiveness'. Major reasons for non-use of SWD were cost and safety. Non-use of PSWD was mainly due to cost. Main reasons for frequent use of MWD were 'effectiveness' and 'ease of application' with safety as the main concern for non-use. Non-ownership of laser was due to cost, unfamiliarity and questionable effects, and for biofeedback was due to a lack of need. This study reported a weekly patient load of up to 350 patients / week with the majority of practices having 71-105 patients/week.	
Researcher's comments	Issues of safety, whether for the physiotherapist, the patient or both were not clear. No report on the number of devices available in each practice. This small study included only private clinics in Brisbane and findings cannot therefore be generalised, but a regional trend of electrotherapy is suggested.	
Authors (year)	Baxter et al. (1991)	Location: Northern Ireland (UK)
Aims/objectives	To evaluate use of therapeutic laser	
Participants; sample size	Physiotherapists; N =148	
Design; (response rate)	Postal Questionnaire Survey (conducted in two stages); (63%, n=116)	
Findings	Therapeutic Laser was used mainly for burns but also for rheumatoid arthritis and various types of ulcer and shingles (Herpes zoster). A lack of information especially about the parameters of optimal treatment with laser was reported.	

Researcher's comments	No information presented on the number of devices per department. Research design and selection of the sample were not clear. This was a regional study and therefore not generalizable but suggested a regional trend of laser usage in physiotherapy.	
Authors (year)	Taylor and Humphry (1991)	Location: USA
Aims/objectives	Use of electrophysical agent modalities	
Participants; sample size	Physiotherapists (specialist in physical disabilities); N=997 (randomly selected)	
Design; (response rate)	Postal Questionnaire Survey; (63%, n=629)	
Findings	Figures on availability of devices not reported. Hot and cold packs were most commonly used: 89% used for neuromuscular electrical stimulation (NMES), 88% for TENS, 86% for US. Use of several times / week equal for NMES and US but lower for TENS. Non-use was highest for US (14%) followed by TENS (13%) and NMES (11%). Non-use of any electrotherapy modality was reported by 23% of physiotherapists. Most common mode of receiving training for US, NMES and TENS was 'on job training'. No training was received by 11% for US, 9% for TENS and 7% for NMES.	
Researcher's comments	Limited scope of the study on use of EPAs because participants were from one specialist group of physiotherapists in physical disabilities practice. Not known whether this survey covered both public and private practices. No precise data given on overall availability of PSWD, CSWD, MWD, biofeedback, laser, or H-wave, thus providing limited knowledge on EPAs as a whole.	
Authors (year)	McMeeken and Stillman (1993)	Location: Victoria, Australia
Aims/objectives	Use of therapeutic laser	
Participants; sample size	Physiotherapists; N = 122	
Design; (response rate)	Questionnaire Survey; (31%, n=38)	
Findings	The maximum number of laser equipment was 3 devices per practice. The value of using laser was questioned and a lack of information about laser use and effectiveness was reported.	
Researcher's comments	Mainly addressed clinical efficacy of therapeutic laser; hence, less relevant. Did not inform on frequency of use. As a regional Australian study, it cannot be representative of Australia as a whole. Moreover, sampling strategy was not random as compiled with information from	

	laser manufacturers/suppliers and other sources such as healthcare professionals.	
Authors (year)	Kitchen (1995)	Location: UK (6 health regions)
Aims/objectives	Use of PSWD, CSWD, ultrasound and laser in clinical practice	
Participants; sample size	Physiotherapists (NHS and private); N = 10	
Design; (response rate)	Face to face interviews; (100%, n=10)	
Findings	PSWD, CSWD and US devices were available to all participants (n=10) while laser equipment was available to 40% (n=4) of participants. Personal experience and availability were the two main reasons for selection of modalities. Doubts about the efficacy of electrotherapy agents were reported..	
Researcher's comments	Exploratory study with a small sample (n=10) over six health regions; location of the health regions was not described. Mainly referred to use of CSWD, PSWD, US and laser for management of soft-tissue problems and the factors affecting the selection of the modality. Hence, this study has less value for assessing the availability and use / non-use of EPAs. In addition, reported the occurrence of a number of adverse reactions due to these modalities; however, it was not clear whether patients or physiotherapists experienced them	
Authors (year)	Lindsay et al. (1995)	Location: Alberta, Canada
Aims/objectives	To survey all private practitioners registered within the Province of Alberta regarding modality usage	
Participants; sample size	Physiotherapists, N = all private practitioners registered within the Province of Alberta	
Design; (response rate)	Questionnaire Survey; (41%, n=208)	
Findings	Electrotherapy was a common treatment mode. US, TENS and interferential were most frequently used. Frequent use of TENS was greater amongst older physiotherapists and clinic owners ($p < 0.05$). Similar to 1990 results by same researchers carried out in Australia (Lindsay et al., 1990). Male physiotherapists' use of biofeedback was greater than female physiotherapists ($p < 0.05$).	
Researcher's comments	No precise sample size reported. Reported availability of PSWD and CSWD equipment as 'high' but did not report exact number of devices per department. There was no report on the non-use of modalities. Moreover, this study covered only private physiotherapists in the region of Alberta; hence, the findings not representative of physiotherapists in both public and private sectors across Canada.	

Authors (year)	Pope et al. (1995)	Location: England
Aims/objectives	To study ownership and use of electrotherapy equipment	
Participants; sample size	Senior physiotherapists in 139 hospitals in 14 regional health Authorities (RHAs), random sampling	
Design; (response rate)	Questionnaire Survey; (84%, n=116 hospitals),	
Findings	More than one reply from each hospital: total replies = 213. The order of highest ownership was for US (n=212) > PSWD (n=209), TENS (n=209) > interferential (n=207) > CSWD (n=196), laser (n=196) > MWD (n=178) > biofeedback (n=176) and H-wave (n=173). Use with ownership was US (100%) > interferential (99%), TENS (99%), PSWD (97%) = H-wave (97%) > biofeedback (94%), laser (93%), CSWD (65%), MWD (64%). Non-use despite ownership was MWD (36%) > CSWD (35%), laser (7%), biofeedback (6%), PSWD (3%) = H-wave (3%), TENS = (1%) and interferential (0.5%). Reasons for non-use despite ownership for US were not reported. Most common reasons for not purchasing CSWD, MWD, laser, H-wave and biofeedback equipment were unfamiliarity with the modalities, lack of clinical evidence and high cost.	
Researcher's comments	No exact sample size of physiotherapists reported. Report of final response rate was not clear as to whether response rate was based on hospitals or physiotherapists. Figures on ownership and use /non-use were not clearly reported. No explanation of unfamiliarity with some modalities. Some of the hospitals provided more than one response.	
Authors (year)	Kitchen and Partridge (1996)	Location: England
Aims/objectives	Survey of availability and frequency of use US, SWD and laser for treating of soft tissue lesions (Part-1)	
Participants; sample size	Physiotherapists, N = 111 (in 14 NHS outpatient departments, one each in 14 health services regions), stratified random sampling	
Design; (response rate)	Postal Questionnaire Survey; (89%, n=99). Responses analysed = 98	
Findings	Availability of equipment of US (pulsed and continuous) was 100%, PSWD was 98%, CSWD was 85% and laser 33%. Frequency of use more than once per week: pulsed US was 76%, continuous US 56%, PSWD 76%, CSWD 16% and laser 32%. Overall, laser was used by 97% of (i.e. 32 out of 33) physiotherapists with access to it. The study revealed physiotherapists' preference for the use of non-thermal modalities (PSWD) over thermal modalities (CSWD) in treating a variety of soft tissue lesions at the NHS outpatients departments.	

Researcher's comments	A very high response rate was achieved but the participants were only those physiotherapists who used electrotherapy and not every physiotherapist working in a participating department; hence, the findings might be less representative. Moreover, the focus of this study was on the types of soft tissue lesions and not on the types of electrotherapy modalities.	
Authors (year)	Seymour and Kerr (1996)	Location: Trent region, England
Aims/objectives	Survey of community based physiotherapists	
Participants; sample size	Physiotherapists (community based in Trent RHA); N = 150	
Design; (response rate)	Postal Questionnaire Survey; (65%, n=97)	
Findings	Of respondents, 92% were female, 54% were aged 31-40. The workload for 57% physiotherapists was 6-10 patients/day. Use of electrotherapy modalities by physiotherapists was 73% for US, 44% for TENS, 30% for interferential and 3% for PSWD. 97% of physiotherapists received in-service training, usually once each month.	
Researcher's comments	No report on how many participants had access to electrotherapy equipment and how many did not use the equipment despite availability. A local study representing the area covered by a health authority in the north of England. Only public sector community physiotherapists were involved providing limited information of physiotherapists' practices within the wider geographical boundaries of the Trent RHA.	
Authors (year)	Kitchen and Partridge (1997)	Location: England
Aims/objectives	Study of use of US, SWD and laser for management of soft tissue lesions (Part-2)	
Participants; sample size	Physiotherapists; N = 111 (in 14 NHS outpatient departments, one each in 14 health services regions) stratified random sampling	
Design; (response rate)	Postal Questionnaire Survey; (89%, n=99). Responses analysed= 98	
Findings	The pattern of availability and use of US, PSWD, CSWD and laser was the same as reported in the aforementioned study by Kitchen and Partridge (1996), which was part-1 of this study. In addition, this article reported a number of factors affecting selection of electrotherapy modalities for treating different types of soft tissue lesions. Description of these lesions and factors is out of the scope of this review; hence not reported here.	
Researcher's comments	This was Part II of Kitchen and Partridge (1996) study; hence, the researcher's comments are the same as those reported above in Kitchen	

	and Partridge (1996).	
Authors (year)	Robertson and Spurritt (1998)	Location: Australia (Tasmania and Victoria)
Aims/objectives	Study of the availability and use of electrophysical modalities	
Participants; sample size	Physiotherapy facilities (general hospitals, private practices, community clinics and rehabilitation centres); N =206	
Design; (response rate)	Postal Questionnaire Survey; (78%, n = 160)	
Findings	Availability of EPA: US 96%, TENS 86%, interferential 77% and SWD 52%, which included 36% for CSWD and 30% for combined PSWD and CSWD. Biofeedback was available in 32%, laser in 12% and MWD in 7% of facilities. Use of modalities was 100% for US and laser, 96% for TENS, 86% for CSWD, 75% for MWD, 70% for combined PSWD and CSWD and 66% for interferential. Frequency of use of 'at least daily' was 81% for US, 83% for MWD, 70% for laser, 53% for interferential, 51% for combined SWD, 43% for CSWD. Most common frequency of use of 'at least monthly' was for TENS in 50% of facilities. Three most common reasons for using US, TENS and interferential were: known effects, ease of application and availability. Availability of alternative method and safety were two of the most common reasons for non-use.	
Researcher's comments	Study targeted facilities with placements for physiotherapy students but no clear sampling method was reported. This sampling strategy may bias reporting the availability/use of electrotherapy modalities compared to other facilities without placements. There was no report of the number of devices for each modality at each facility. Nevertheless, this study had a high response rate and most of the electrotherapy modalities were covered.	
Authors (year)	Partridge and Kitchen (1999)	Location: England and Wales
Aims/objectives	Adverse health effects of electrotherapy in patients (phase I) and adverse health in patients with neurological conditions (phase II)	
Participants; sample size	Physiotherapy departments in NHS hospitals; N = Phase I = 200; Phase II= 145	
Design; (response rate)	Postal Questionnaire Survey: (Phase I: 74%, n=148); Phase II: 80%, n =116)	
Findings:	Phase I did not report availability or use of EPAs. Adverse health effects due to use of modalities reported for patients and not relevant here. Phase II found 52% of physiotherapists working in neurology were in senior 1 grade. 70% did not use electrotherapy in neurological	

	conditions. Use of electrotherapy during previous year was reported by 58% for TENS, by 55% for US, by 14% for interferential, by 8% for SWD and by 7% for laser. Remaining participants did not use these modalities.	
Researcher's comments	Study focus on adverse health effects in patients; hence, less relevant from the physiotherapists' safety perspective. Provided some data on the use of EPAs such as use of SWD but no details of PSWD and CWD given. Study provided little information on electrotherapy modalities overall.	
Authors (year)	Cooney et al. (2000)	Location: Republic of Ireland
Aims/objectives	Study of availability and use of electrotherapy modalities in public and private physiotherapy practices	
Participants; sample size	Physiotherapists; N = 120 (public = 40 and private =80)	
Design; (response rate)	Postal Questionnaire Survey; (Total =72%, n=86; public sector = 88%, n=35; private practitioners = 64%, n=51)	
Findings:	Availability of: interferential was 98%, TENS 97%, US 95%, PSWD 39%, laser 38%, CSWD 37%, MWD 6%, biofeedback 3% and H-wave 2%. Availability of CSWD, PSWD, MWD, TENS, laser and biofeedback equipment was higher in public sector practices while US, interferential and H-wave equipment was higher in private practices. Interferential, TENS and US were used by 100% of facilities. Frequency of use of '2-3days/ week' was 95% for interferential, 90% for US, 59% for laser, 53% for PSWD, 15% for TENS and 10% for CSWD while MWD was used least. Non-use was higher in the public sector. 41% wished to purchase laser, 18% to purchase PSWD, 11% TENS and 8% wished to purchase US. There was no desire to purchase MWD or H-wave due to these being superseded by other modalities. Cost was the main consideration for not buying PSWD, CSWD and laser in private practices.	
Researcher's comments	The sample size was small, particularly for public sector physiotherapists thus limiting the generalizability of findings. The reasons for selection and non-use of the surveyed modalities were not reported. None of the modalities were reported to have ceased to be used. Altough, the study provided sufficient information on purchase of equipment, it was difficult to know the exact status of device ownership.	
Authors (year)	Shields et al. (2001)	Location: Republic of Ireland
Aims/objectives	Survey of the availability, age, use, non-use and intention to purchase PSWD and CSWD	

Participants; sample size	Physiotherapy facilities; N =240 (82 hospital departments and 158 private practices)	
Design; (response rate)	Postal Questionnaire Survey; (Total = 96%, n=231; hospital departments = 95%, n=78; private practices = 97%, n=153)	
Findings	Availability of SWD: 65% in hospital departments (CSWD and PSWD in 54%) and 12% in private practices (CSWD in 5%, PSWD in 4%). Non-use despite availability was 12% of hospital departments and 33% of private clinics. The number of available devices was 1-3 devices/department; one device/department in 51% of hospital departments and 92% of private practices. SWD devices were <10 years old in 43% of hospital departments and 46% of private practices. Among 35% of hospital departments and 89% of private practices with no SWD devices, reasons for non-purchase included nature of the patients, lack of space, cost, lack of evidence for clinical efficacy and safety concerns. In hospitals, SWD servicing and quality control testing were carried out in 53% and 49% respectively, most commonly every six months by external contractors. In private clinics, servicing (58%) and quality control testing (50%) were carried out generally less than once a year by an external contractor.	
Researcher's comments	A high response rate; hence, results were most representative and more generalizable. However, only SWD was covered. No details on safety issues (neither for patients nor physiotherapists) were reported. However, the issue of evidence on clinical effectiveness of SWD (both PSWD and CSWD) was raised.	
Authors (year)	Shields et al. (2002b)	Location: Republic of Ireland
Aims/objectives	Study of safety issues and clinical effectiveness of PSWD and CSWSD	
Participants; sample size	Senior physiotherapists; N= 116 (in 41 hospital departments)	
Design; (response rate)	Postal Questionnaire Survey; (75%, n =87), Responses analysed = 83	
Findings	Approx. 65% of participants were senior 1grade physiotherapists, with mean time since qualification of 12 years. Equipment availability: interferential 100%, TENS and US 99%, PSWD 94%, CSWD 93% and laser 63%. 'Frequent or often' use was reported by 91% for US, 73% for interferential, 58% for TENS, 76% for laser, 45% for PSWD and 21% for CSWD. Non-use despite availability was 44% for CSWD, 12% for PSWD, 12 % for laser and 1% for interferential. No respondent reported non-use for US and TENS. The mean period for using PSWD and CSWD was 10 (±6) and 14 (±9) years respectively. PSWD and CSWD were not used in 10% (n=9) of departments. The	

	majority used capacitive method and air space drums during SWD. Measures for physiotherapists' safety included keeping a distance of 3m between SWD equipment and metallic objects, no use of other modalities within the same vicinity, a separate room for SWD treatment, notification of SWD use to other physiotherapists particularly pregnant colleagues and advice to therapists to leave the room during the treatment. However, taking no measures for physiotherapists' safety were reported by 30% of respondents.	
Researcher's comments	Reported total response rate was 75% (n=87); however, only 83 responses were analysed; hence, the effective response rate of this study was 72%. This reduced response rate was not reported. Reporting of electrotherapy equipment availability was given in percentages with no actual number of departments. It was therefore difficult for the researcher / reviewer to ascertain whether the total completed / returned surveys or the total analysed surveys were included. No information on the frequency of use of electrotherapy by a physiotherapist per day or per week. The study largely addressed operator safety issues, and provided discussion on safety issues and raised concerns regarding a lack of adherence to physiotherapists' safety guidelines.	
Authors (year)	Warden and McMeeken (2002)	Location: Victoria, Australia
Aims/objectives	To assess the availability, frequency of use and dose of ultrasound in treating sports injuries	
Participants; sample size	Physiotherapists (in sports injuries); N = 355	
Design; (response rate)	Postal Questionnaire Survey; (48%, n=171)	
Findings	There were 60% male respondents (n=102). Median experience (10 years) and workload of 15 patients / day. US devices were available to all respondents. The most common pattern of use was 'at least daily' (84%, n=143). Treatment with US = 25% of total patients; 4 patients / day (median figures). The main factors in deciding dose of US were training during graduate degree (83%) and experience (76%). Of respondents, 72% reported a lack of research evidence for US therapy.	
Researcher's comments	The response rate was comparatively low and only sports physiotherapists were selected suggesting a source of bias in favour of champions for providing US therapy for sports injury. Therefore, the findings cannot be representative of US usage in physiotherapy practice in Australia as a whole.	
Authors (year)	Chipchase and Trinkle (2003)	Location: Southern Australia

Aims/objectives	To determine the frequency and trends of use and effectiveness of US	
Participants; sample size	Physiotherapists (special interest in musculoskeletal); N = 380 (public and private)	
Design; (response rate)	Postal Questionnaire Survey; (55%, n=210)	
Findings	There were 63% (n=131) female respondents; mean age of sample and experience were 37 (±10) and 15 (±9) years, respectively. Of respondents, 70% worked in the private sector and 98% had access to at least one US device. 70% used US once/day and an average of 33% (±2) of treatments involved US therapy. The four most frequently used EPAs were US, interferential, CSWD and TENS. Healing of tissues and thermal effects were two main reasons for using US.	
Researcher's comments	The response rate was moderate. The study involved both private and public sector physiotherapists but the breakdown was not reported. The frequency of use was calculated by the number of patients/week treated with US, not by the actual number of sessions of US therapy. This study involved only physiotherapists interested in musculoskeletal injuries. No details given about the number of respondents who were actually working in musculoskeletal physiotherapy. The findings may not be representative of all physiotherapists working in Southern Australia.	
Authors (year)	Al Mandeel and Watson (2006)	Location: Northern England
Aims/objectives	Use of PSWD	
Participants; sample size	Patient records; N = 1750 patient files in 8 hospitals	
Design; (response rate)	Audit; (response rate = Not applicable)	
Findings	Total number of patients treated with PSWD = 192. Treatments with PSWD = mean 11% (range 8%-13%). Treatment time = mean 12 (range 5-20) minutes/session. Frequency of PSWD use: 1/week = 76%, 2x/week = 20%, 3x/week = 5%.	
Researcher's comments	This clinical audit determined PSWD use through patients' case notes, finding only a small per cent of patients were treated with PSWD; no information as to whether PSWD equipment was available but not used or not available. This audit provided valuable information on duration of PSWD treatment although information was incomplete in the majority of patient files.	
Authors (year)	Tabasam and Johnson (2006)	Location: England (North)

Aims/objectives	Use of interferential for pain management	
Participants; sample size	Physiotherapists; N = all physiotherapists in 4 hospitals	
Design; (response rate)	Postal Questionnaire Survey, (Not stated)	
Findings	Interferential use by 91% (n=57). Frequency of use: 63% (n=36), used for pain relief: 61% (n=35) of which 71% treated less than 25% of total clinic patients. Average treatment time with interferential = 11-20 min.	
Researcher's comments	This small regional study involved physiotherapists from only 4 hospitals. Neither the actual sample size nor the response rate reported. It was the only study that focused on interferential use but only in pain management. The findings on interferential use very specific and did not represent overall pattern of use of this modality. No details about non-availability and non-use given.	
Authors (year)	Wong et al. (2007)	Location: USA (Northeast and Mid-Atlantic regions)
Aims/objectives	Use of therapeutic ultrasound	
Participants; sample size	Physiotherapists (orthopaedic specialists); N = 457	
Design; (response rate)	Postal Questionnaire Survey,; (45.3%, n=207)	
Findings	60% of physiotherapists reported likely to use US for ≥25% of patients and 40% reported unlikely to use US for ≤10% of patients. 50% reported US as clinically important, 35% reported as not important and 15% would not use US.	
Researcher's comments	Response rate was moderate and this study involved physiotherapists from only one specialist group. Therefore the findings cannot represent US usage by all physiotherapists in the survey regions in the USA. Moreover, the usage was reported only for pain, (soft) tissue inflammation, healing, swelling and scar remodelling. The clinical importance was also studied with respect to the conditions above, but there was no information about the overall effectiveness of US in physiotherapy practice. Therefore, findings cannot be generalised to overall physiotherapy practice.	
Authors (year)	Chipchase et al. (2009)	Location: Australia
Aims/objectives	Availability and usage of EPAs	
Participants; sample size	Physiotherapists; N = 12893	

Design; (response rate)	Postal Questionnaire Survey; (27%, n = 3538)	
Findings	Availability of equipment: US= 90%, TENS = 82%, interferential = 72%, biofeedback = 52%, laser = 32%, CSWD = 12%, PSWD = 11%, MWD = 2%. Daily use: US = 37%, interferential =24%, biofeedback =8%, laser =5%, CSWD =2%, PSWD= 1% and MWD =0.2%. Non-use: MWD =99%, PSWD = 96%, CSWD =95%, laser =81%, biofeedback = 58%, TENS = 30%, interferential = 24% and US = 22%.	
Researcher's comments	Sampling of participants was limited to those physiotherapists who had consented to release of their contact details. The response rate was therefore very low. Thus, there were major limitations to the generalizability of findings applicable to Australia as a whole. The study did not cover all modalities, e.g. H-wave was not surveyed. No reasons were stated for non-use despite availability of equipment and no implications were discussed for widespread non-use of available equipment.	
Authors (year)	Scudds et al. (2009)	Location: UK and Hong Kong (HK)
Aims/objectives	Use and effectiveness of TENS compared to other EPAs in pain treatment	
Participants; sample size	Physiotherapists; N =1200 (600 each from the UK and HK), random sampling	
Design; (response rate)	Postal Questionnaire Survey; (Overall 34.7%, n=416; UK =35%, n=211; HK =34%, n=205)	
Findings	Usage of electrotherapy modalities for pain management was TENS 98%, US 86%, interferential 78%, SWD 50% and laser 48% in HK and TENS 79%, US 72%, interferential 64%, SWD =24% and laser 22% in the UK.	
Researcher's comments	Sample was randomly selected but response rate was low. The generalizability of findings is limited due to participants comprising <1% of the total registered physiotherapists in the UK and only 9% of those in Hong Kong. The data on the use of EPAs was presented only in graphical format: the researcher / reviewer determined the % of use by viewing the graph. No breakdown of SWD into separate use of PSWD and CSWD. Authors' emphasis was on differences rather than similarities between practices in the two countries. The study determined use of selected EPAs for only one medical issue i.e. pain.	

The types of electrotherapy modalities that were studied in 22 studies included in this literature review are shown in Table 2.2.

Table 2.2 Types of electrotherapy modalities reported in reviewed studies

Study / Reference	*Year*	*US**	*PSWD*	*CSWD*	*Laser*	*IFT**	*TENS*	*BFD**	*MWD*	*H-wave*
Lindsay et al.	1990	✓	✓	✓	✓	✓	✓	✓	✓	
Baxter et al.	1991				✓					
Taylor and Humphry	1991	✓				✓	✓			
McMeeken and Stillman	1993				✓					
Kitchen	1995	✓	✓	✓	✓					
Lindsay et al.	1995	✓	✓	✓		✓	✓	✓		
Pope et al.	1995	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kitchen and Partridge	1996	✓	✓	✓	✓					
Seymour and Kerr	1996	✓	✓			✓	✓			
Kitchen and Partridge	(1997)	✓	✓	✓	✓					
Robertson and Spurritt	1998	✓	✓	✓	✓	✓	✓	✓	✓	
Partridge and Kitchen	1999	✓	✓	✓	✓	✓	✓			
Cooney et al.	2000	✓	✓	✓	✓	✓	✓	✓	✓	✓
Shields et al.	2001		✓	✓						
Shields et al.	2002		✓	✓						
Warden and McMeeken	2002	✓								
Chipchase and Trinkle	2003	✓								
Al Mandeel and Watson	2006		✓							
Tabasam and Johnson	2006					✓				
Wong et al.	2007	✓								
Chipchase et al.	2009	✓	✓	✓	✓	✓	✓	✓	✓	
Scudds et al.	2009	✓	✓	✓	✓	✓	✓			

*US = ultrasound, IFT =interferential, BFD= Biofeedback

The findings showed that some studies were about only one electortherapy modality such as therapueitc ultrasound studied by Warden and McMeekan (2002), Chipchase and Trinkle (2003) and Wong et al. (2007), PSWD by Al Mandeel and Watson (2006), interferential by Tabasam and Johndon (2006) and laser by Baxter et al. (1991) and McMeekan and Stillman (1993). Shields et al. (2001, 2002) studied two shortwave modalities i.e. PSWD and CSWD. Two studies (Pope et al., 1995; Cooney et al., 2000) investigated nine electrotherapy modalities, which were US, PSWD, CSWD, MWD, TENS, interferential, biofeedback, laser and H-wave (Table 2.2).

2.2.1 Findings of literature review on availabilty and use of electrotherapy modalities

Findings of this literature review regarding the vialability and non-availability as well as use and non-use despite availability of above-mentioned nine electrotherapy modalities are presented, in the order of most commonly to less commonly studied modalities, as follows.

2.2.1.1 Ultrasound

Ultrasound was the most commonly studied modality in the reviewed literature. This modality was reported in 16 studies (72.7%) out of 22 studies included in this review. Four studies (Taylor and Humphry, 1991; Warden and McMeeken, 2002, Chipchase and Trinkle, 2003; Wong et al., 2007) investigated only this modality while 12 other studies investigated this modality along with other modalities (Table 2.2). However, all studies did not reported statistics on the the ‘availability’, ‘use’, ‘non-use despite availability’ and ‘non-availability’ of this electrotherapy modality. For example, study by Taylor and Humphry (1991) and Syemour and Kerr (1996) did not report data on the availability and non-availability whereas Kitchen (1995) did not report data on ‘use’ and ‘non-use despite availability’. In addition, Scudds et al. (2009) did not report statistic on all these four variables and provided data on only use of ultrasound in comparison to other EPAs for pain management. Moreover, Pope et al. (1995) reported the number of physiotherapists (n=212) who had access to ultrasound equipment. This reviewer (researcher) therefore determined the availability of ultrasound by dividing the number of physiotherapists (n=212) having access to ultrasound equipment with the total respondents (n=213) in the study. Data on the availability and use of ultrasound extracted from the reviewed studies is presented in Figure 2.2, which shows that the availability of this modality has been very high between 1990 and 2009; however, the availability of ultrasound has started declining recently. The use of ultrasound has been high i.e. between 70% and 100% but fitting of a linear trend line shows a slight declining trend in the use of this modality. Non-use despite availability of this modality is low but it shows an increasing trend in the recent years. Similarly, non-availability of this modality has been very low since 1990 but it has rose to 10% in 2009 (Figure 2.2).

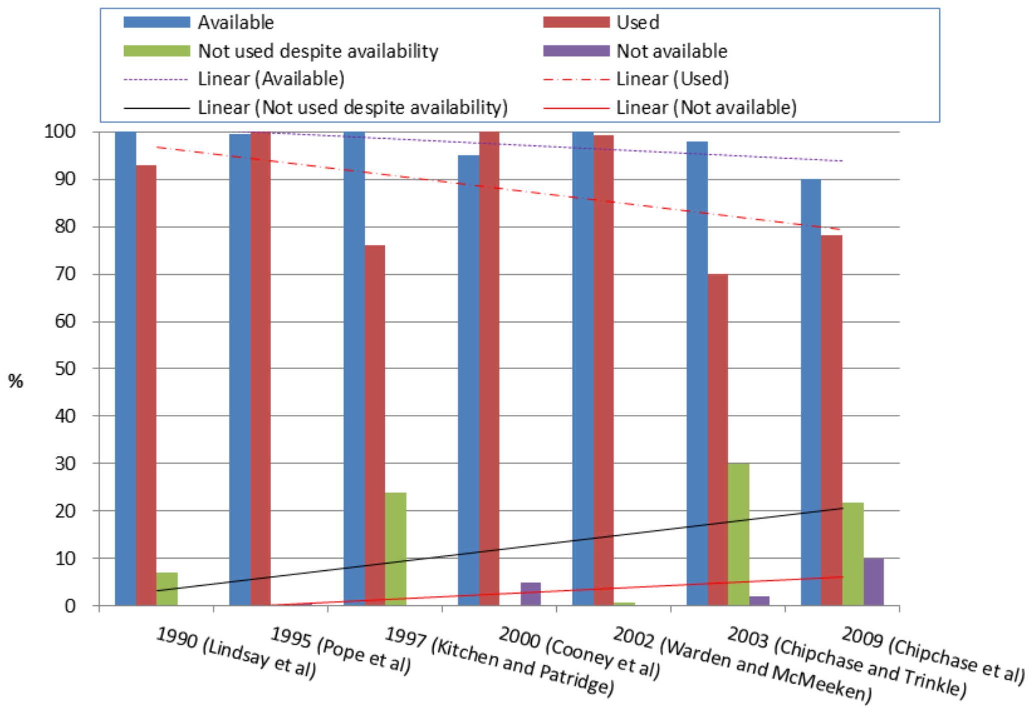

Figure 2.2 Availability, use, non-use and non-availability of ultrasound

2.2.1.2 Pulsed shortwave diathermy

Pulsed shortwave diathermy (PSWD) was also one of the most commonly studied electrotherapy modalities in the reviewed literature. This modality was investigated in 15 studies (68.2%) out of 22 studies included in this literature review. Study of only PSWD was conducted by Al Mandeel and Watson (2006), two studies by Shields et al. (2001, 2002) investigated PSWD modality along with continuous shortwave diathermy (CSWD) while in the remaining studies (n=12) PSWD was studied in conjunction with other modalities (Table 2.2). A few of these studies did not report data on all or some of the four variables i.e. ‘availability’, ‘use’, ‘non-use despite availability ’and‘ non-availability’ for this modality. For example, study by Lindsay (1995) and Syemour and Kerr (1996) did not report extractable data on four variables mentioned-above. Kitchen (1995) reported data only on the availability of this modality. Scudds et al. (2009) reported data on the use but for combined shortwave diathermy (SWD); hence, it was not possible to extract data for only PSWD from their study. In addition, Pope et al. (1995) reported only the number of physiotherapists (n=209) having access to PSWD equipment. Therefore, this reviewer (researcher) calculated the availability of PSWD by dividing the number of physiotherapists (n=209) having access to PSWD devices with the total respondents (n=213) in the study by Pope et al. (1995).

Data on the availability and use of PSWD extracted from the reviewed studies is presented in Figure 2.3, which reveals that the availability of this modality was highly variable with highest (>90%) availability during 1995, 1997 and 2002 while the lowest availability (11%) was reported in 2009. The highest (97%) use of PSWD was reported in 1995 (Pope et al., 1995); however, the use of this modality started declining afterwards. In 2002, the use of PSWD was 45% (Shields et al., 2002) and in 2009, the use of this modality was less than 1% reported (Chipchase et al., 2009). Fitting of linear trend lines across the abstracted data on the availability and use of PSWD revealed considerable declining trends in the availability and use of this modality (Figure 2.3).

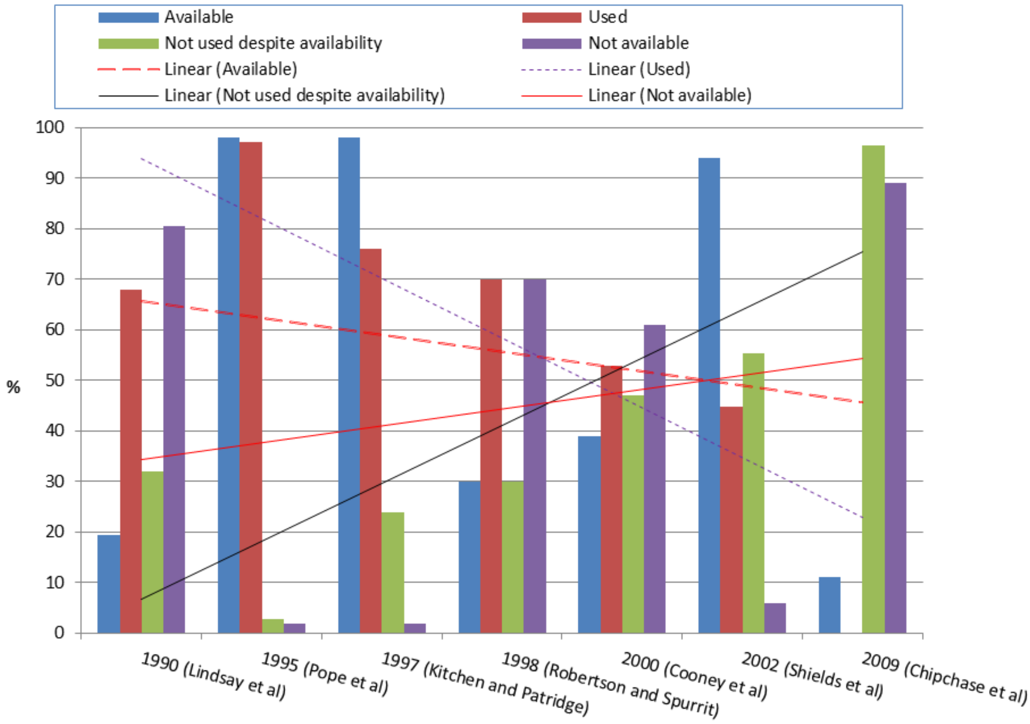

Figure 2.3 Availability, use, non-use and non-availability of PSWD)

The non-use despite availability of PSWD varied from 3% in 1995 (Pope et al., 1995), 55% in 2002 (Shields et al., 2002) to 96% in 2009 (Chipchase et al., 2009). The non-availability of this modality was fluctuating. In 1991, it was 81% (Lindsay, 1991), in 1995 it was 2% (Pope et al., 1995; Kitchen and Partridge, 1997), in 2006 it increased to 6% (Shields et al., 2002) and in 2009 it reached to 89% (Chipchase et al., 2009).

Linear trend lines fitted across the non-use despite availability and the non-availability data for this modality show a rising trend for both of these parameters of PSWD (Figure 2.3). It is however important to point out that at the time of start of this PhD study in October 2002, PSWD was highly available (94%) and commonly used (44.5%) as reported by Shields et al. (2002), which suggested that PSWD was the one of most commonly available and commonly used electrotherapy modality in 2002.

2.2.1.3 Continuous shortwave diathermy

Continuous shortwave diathermy (CSWD) was another most commonly studied electrotherapy modalities in the reviewed literature. CSWD was not studied as a single modality in any of the studies included in this review. However, CSWD was studied in conjunction with other modalities (Table 2.2). This modality was investigated in 13 studies (59.1%) out of 22 studies. This showed that the number of studies that studied CSWD modality was lower than the number of studies that investigated ultrasound and PSWD (Table 2.2). A few studies did not provide data on the availability, use, non-use despite availability and non-availability of this modality. For example, a study by Lindsay (1995) did not report extractable data on all above-mentioned four variables about the CSWD. Kitchen (1995) did not report data on use and non-use of CSWD despite equipment availability. Scudds et al. (2009) reported data on the use of combined shortwave diathermy; therefore, extraction of data for only CSWD was not possible from their study. As mentioned earlier, Pope et al. (1995) reported only the number of physiotherapists (n=196) having access to CSWD equipment. This reviewer (researcher) therefore calculated the availability of CSWD by dividing the number of physiotherapists (n=196) having access to PSWD devices with the total number of respondents (n=213) in the study by Pope et al. (1995). This showed that the availability of CSWD was 84.8% in the study conducted by Pope et al. (1995). Data on the availability and use of CSWD extracted from the reviewed studies is presented in Figure 2.4, which shows that the availability of this modality was very high i.e. about 85% during 1995 (Pope et al., 1995) and 93% in 2002 (Shields et al., 2002) while the lowest availability (12%) was reported in 2009 (Chipchase et al., 2009).

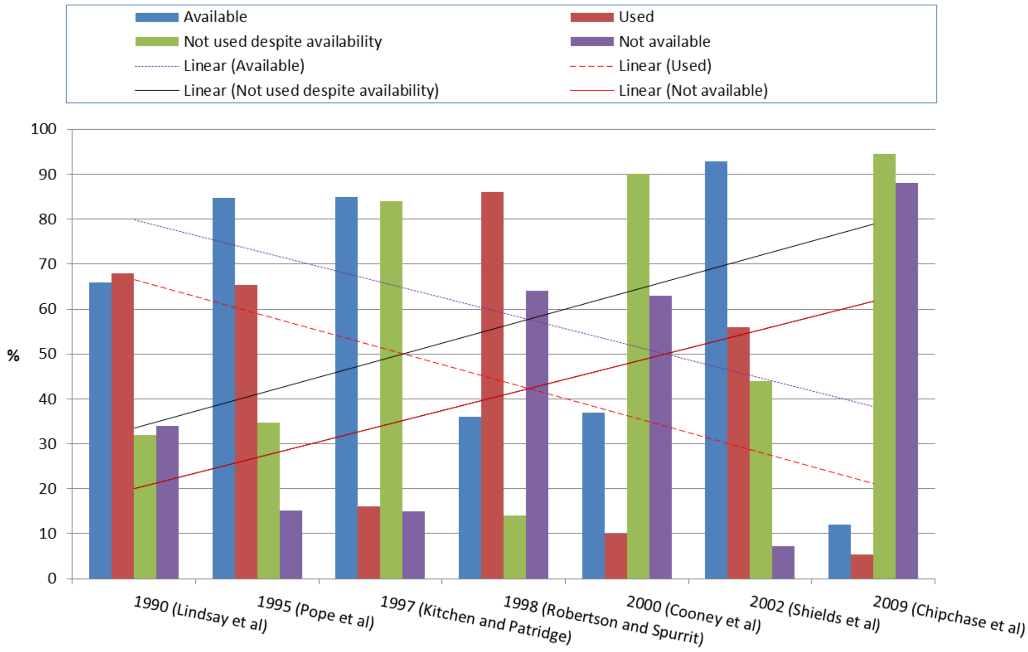

Figure 2.4 Availability, use, non-use and non-availability of CSWD

The use of CSWD was highly fluctuating between 1990 and 2009. The highest use (86%) of CSWD was reported in 1998 by Robertson and Spurritt (1998), which declined to 56% in 2002 (Shields et al., 2002) and reached to the lowest level (5%) in 2009 (Chipchase et al., 2009). Fitting of linear trend lines across the data on the availability and use of CSWD revealed considerable declining trends in both the availability and the use of this modality. Non-use despite availability of this modality varied from 14% in 1998 (Robertson and Spurritt, 1998) to 44% in 2002 (Shields et al., 2002) to 95% in 2009 (Chipchase et al., 2009). Non-availability of CSWD was lowest (7%) in 2002 (Shileds et al., 2002) but it increased to 88% in 2009 (Chipchase et al., 2009). Linear trend lines fitted across the non-use despite availability and the non-availability data for CSWD show a rising trend for both these parameters for this modality (Figure 2.4). It is important to state that at the time of start of this PhD study in 2002, CSWD was highly available (93%) and commonly used (56%) electrotherapy modality, as reported by Shields et al. (2002). These findings confirmed that CSWD was the one of most commonly available and commonly used electrotherapy modalities in 2002.

2.2.1.4 Laser

Therapeutic laser was also one of the most commonly studied modalities in the reviewed literature. This modality was investigated in 12 studies (54.5%) out of 22 studies included in this literature review. Two studies (Baxter et al., 1991; McMeeken and Stillman, 1993) investigated only laser while remaining 10 studies investigated laser along with other electrotherapy modalities (Table 2.2). Nevertheless, the data for laser on all or some of the four variables (i.e. availability, use, non-use despite availability and non-availability) were not provided in some of these studies. For example, studies by Baxter et al. (1991) and McMeeken and Stillman (1993) did not report extractable data on all of the above four parameters about laser. A study by Kitchen (1995) reported data only on the availability of this modality but she did not report data on other three parameters mentioned above. Partridge and Kitchen (1999) reported data only about the use and non-use of laser but they did not report data on the availability and non-availability. As reported earlier, Pope et al. (1995) did not report overall availability of this modality but they provided the total number of physiotherapists who had access to laser equipment. This reviewer (researcher) therefore determined the availability of laser by dividing the total number of physiotherapists (n=196)) having access to equipment of this modality with the total number of respondents (n=213) in the study. This revealed that the availability of laser was 84.8% in the study by Pope et al. (1995). Data on the availability, use, non-use despite equipment availability and non-availability of laser extracted from the reviewed studies is presented in Figure 2.5, which shows that the availability of this modality was highest (92%) in 1995 (Pope et al., 1995). However, it declined in the subsequent years. Therefore, the availability of this modality shows an overall declining trend (Figure 2.5).

The use of laser increased from 58% in 1990 (Lindsay et al., 1990) to 100% in 1998 (Robertson and Spurritt, 1998). However, it decreased to 59% in 2000 (Cooney et al., 2000) and reached to the lowest level of 19% in 2009 (Chipchase et al., 2009). Therefore, the use of laser overall showed a steady trend from 1990 to 2000; however, when data for 2009 (Chipchase et al., 2009) was included it showed a moderate declining trend.

Non-use of laser despite availability of equipment was high i.e. 42% in 1990 (Lindsay et al., 19990) but it declined to 0% in 1998 (Robertson and Spurrit, 1998). However, in 2000, it increased gain and reached to 41% (Cooney et al., 2000) and in 2009; it almost doubled (81%) (Chipchase et al., 2009). Consequently, the data for the non-use despite laser equipment availability shows an increasing trend (Figure 2.5). Total non-availability of laser has been considerably high (averagely 63%) from 1990 to 2009 except in 1995 when it was the lowest (8%) reported in the study by Pope et al. (1995). Overall, the data extracted from the reviewed studies revealed an increasing trend of non-availability of laser equipment (Figure 2.5).

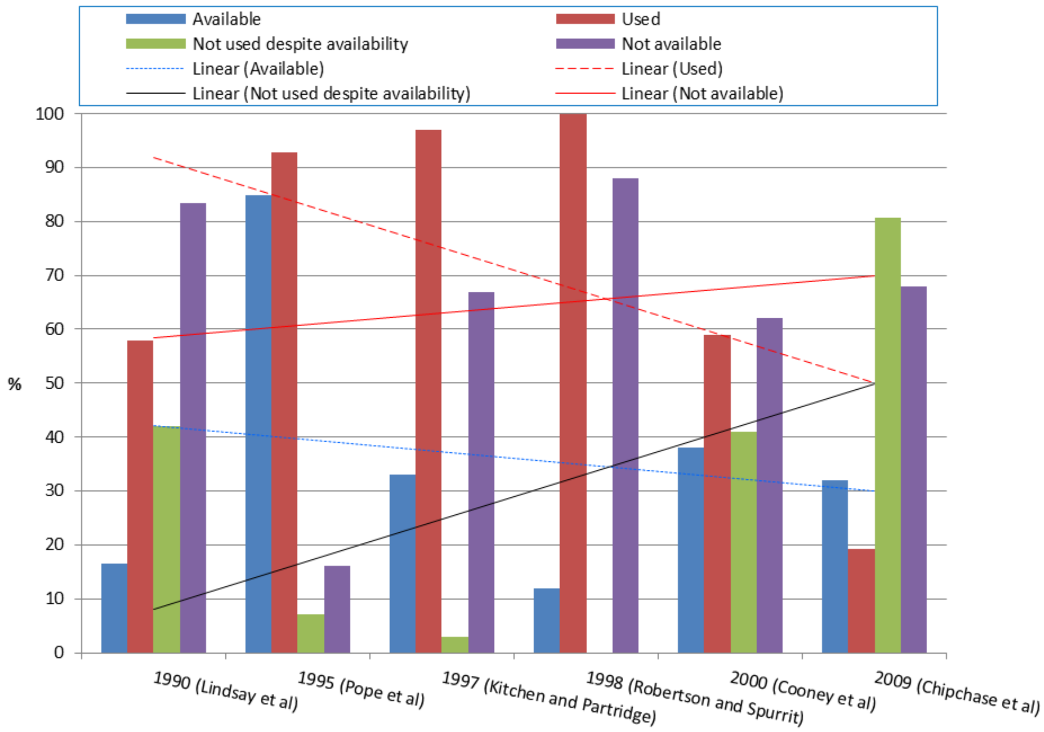

Figure 2.5 Availability, use, non-use and non-availability of laser

2.2.1.5 Interferential

This literature review revealed that interferential modality was also one of the commonly studied electrotherapy modalities. This modality was investigated in eleven (50%) studies out of 22 studies included in this literature review (Table 2.2). A study by Tabasam and Johnson (2006) studied only this modality while remaining ten studies studied interferential along with other modalities (Table 2.2). It is important to point out that Tabasam and Johnson (2006) studied treatment with interferential by auditing / reviewing patients' case files and they did not report statistics on the availability, use, non-use and non-availability of equipment of this modality in physiotherapy departments. In addition, Taylor and Humphry (1991) and Seymour and Kerr (1996) reported data on the use and non-use of interferential but they did not report data on the overall availability and non-availability of this modality. Two more studies (Lindsay et al., 1995; Partridge and Kitchen, 1999) also did not report extractable data about this modality. Moreover, Pope et al. (1995) reported the total number of physiotherapists having access to interferential equipment but they did not report data about the overall availability of equipment of this modality. As mentioned earlier, the researcher (reviewer) determined the equipment availability of this modality by dividing the number of physiotherapists (n=207) having access to interferential equipment by the total number of respondents (n=213) in the study by Pope et al. (1995), which revealed that interferential equipment availability was 97.2% in the study by Pope et al. (1995).

Data on the availability, use, non-use and non-availability of interferential extracted from the reviewed studies are presented in Figure 2.6, which shows slightly declining trends of the availability and use of interferential modality (These trends lines have become superimposed on each other due to the nature of data). Although the use of this modality increased from 98% in 1990 to 100% in 2000, it declined by about 25% in 2009 compared to 2000 (Figure 2.6).

The use of this modality was however 67% in 1998 (Robertson and Spurritt, 1998). The non-use of interferential was highest (about 36%) in 1998 (Robertson and Spurritt, 1998) while the study by Cooney et al. in 2000 reported non-use of this modality as zero. However, the non-use of interferential again increased to 24% in 2009 (Chipchase et al., 2009). Similarly, the non-availability of interferential equipment was slightly high (15%) in 1990, it decreased to 2% in 2000 but it increased again and reached to 28% in 2009. Therefore, the non-availability of interferential equipment revealed an overall increasing trend (Figure 2.6).

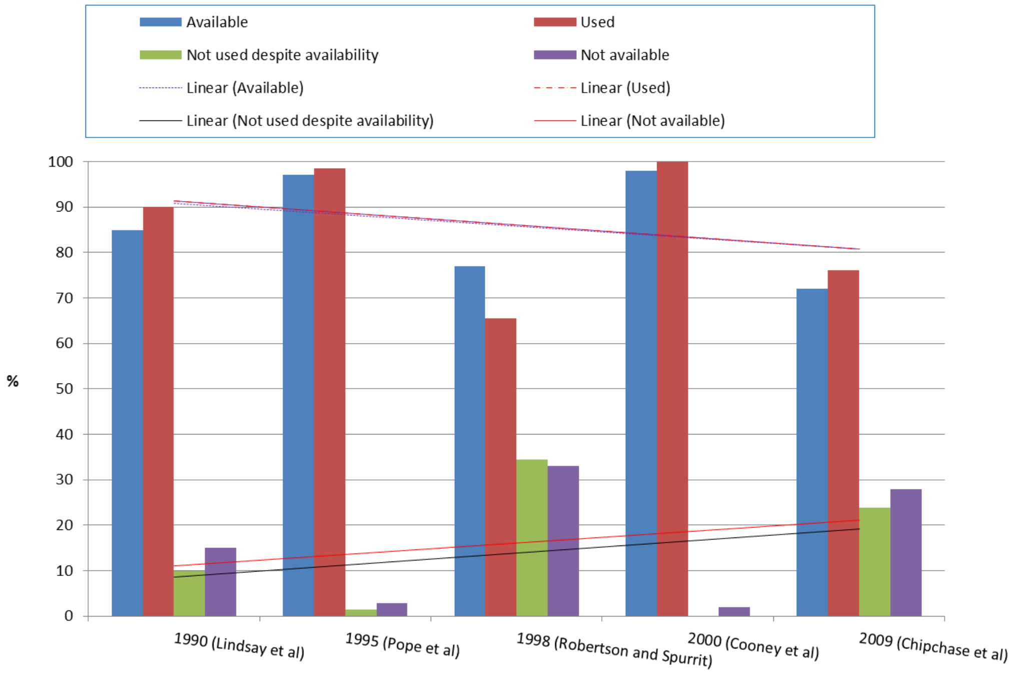

Figure 2.6 Availability, use, non-use and non-availability of interferential

2.2.1.6 Transcutaneous electrical nerve stimulation

Transcutaneous electrical nerve stimulation (TENS) was one of the commonly studied electrotherapy modalities in the reviewed literature. This modality was studied in ten (45.5%) studies out of 22 studies that were included in this review (Table 2.2). Taylor and Humphry (1991) studied only TENS while other nine studies investigated TENS along with other modalities (Table 2.2). Three studies (Taylor and Humphry, 1991; Seymour and Kerr, 1996 and Partridge and Kitchen, 1999) reported data on the use and non-use of TENS but they did not report data on the overall availability and non-availability of this modality. A study by Lindsay et al. (1995) did not report extractable data about this modality. As pointed out earlier, Pope et al. (1995) did not report overall availability of TENS but reported the total number of physiotherapists having access to TENS equipment. The researcher (reviewer) determined the availability of this modality by dividing the number of physiotherapists (n=209) having access to TENS equipment by the total number of respondents (n=213) in the study by Pope et al. (1995). This showed that the availability of TENS was 98.1% in the study by Pope et al. (1995). Figure 2.7 presents the statistics on the availability, use, non-use and non-availability of TENS extracted from the reviewed studies, which shows that the availability of TENS equipment presents slightly declining trend.

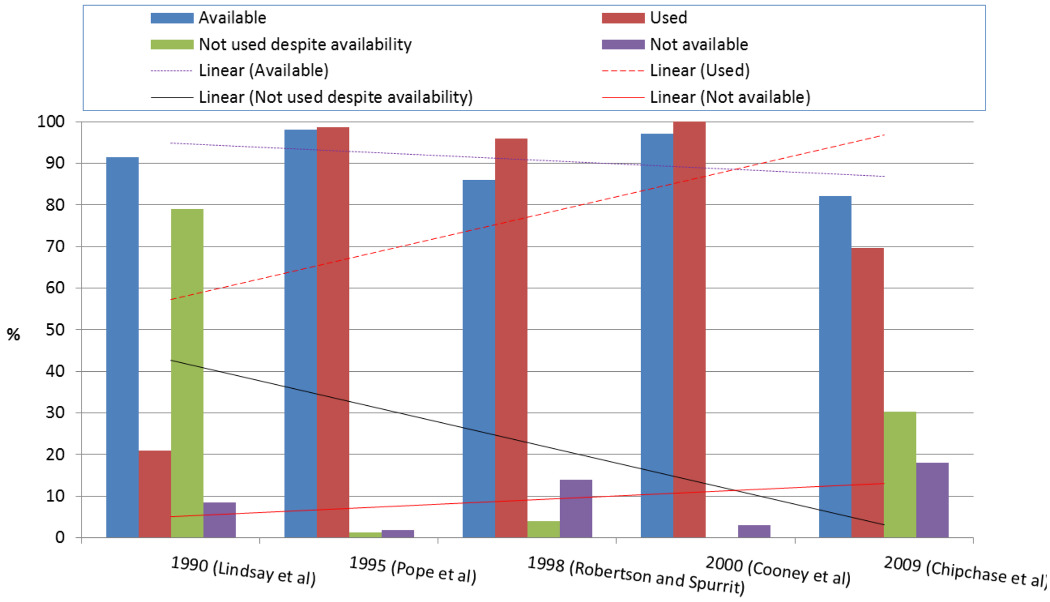

Figure 2.7 Availability, use, non-use and non-availability of TENS

The use of this modality shows an increasing trend from 1990 to 2000; however, the use of this modality has decreased by about 30% in 2009 compared to 2000 (Figure 2.7). In addition, there is a declining trend in the non-use despite equipment availability of TENS; however, the non-availability of equipment of this modality shows overall a slightly increasing trend.

2.2.1.7 Biofeedback

This literature review revealed that biofeedback modality was one of the less commonly studied electrotherapy modalities in the reviewed studied (Table 2.2.).

Biofeedback was investigated in six (27.3%) studies out of 22 studies included in this literature review (Table 2.2). In all these six studies, biofeedback was investigated in association with other modalities (Table 2.2). Lindsay et al. (1995) did not report extractable data about this modality. Two studies (Robertson and Spurritt, 1998; Cooney et al., 2000) did not report data on the availability and non-availability of biofeedback equipment; however, they presented data on the use and non-use of this modality. For the study by Pope et al. (1995), the availability of this modality was determined by the researcher (reviewer) by dividing the number of physiotherapists (n=176) having access to biofeedback equipment by the total number of respondents (n=213) in the study. This revealed that the availability of biofeedback equipment was 82.6% in the study by Pope et al. (1995). Data on the availability, use, non-use and non-availability of interferential extracted from the reviewed studies are presented in Table 2.3.

The availability of biofeedback fluctuated between 1990 and 2009. The highest availability of biofeedback was 83% in the study by Pope et al. (1995) while the lowest availability of this modality was 3% reported by Cooney et al. (2000); however, the availability of this modality was reported moderately high (52%) by Chipchase et al. (2009). The use of this modality was lowest (17.5%) in 1990 (Lindsay et al., 1990) and the highest (94%) in 1995 (Pope et al., 1995). However, the use of this modality decreased considerably and reached to about 43% in 2009 (Chipchase et al., 2009) compared to 1995 (Pope et al., 1995) (Table 2.3). The non-use of biofeedback was highest (83%) in 1990 (Lindsay et al., 1990) and the lowest (6%) in 1995 (Pope et al., 1995); however, it increased to 58% in 2009 (Chipchase et al., 2009). The non-availability of biofeedback equipment was lowest (17%) in 1995 (Pope et al., 1995) and the highest (98%) in 2000 (Cooney et al., 2000) but it declined to 48% in 2009 (Chipchase et al., 2009). Overall, the availability and non-availability of this modality was fluctuating.

Table 2.3 Availability, use, non-use and non-availability of Biofeedback

	Available (%)	*Used (%)*	*Not used despite availability (%)*	*Not available (%)*
1990 (Lindsay et al)	23.5	17.5	82.5	76.5
1995 (Pope et al)	82.6	94.3	5.7	17.4
1998 (Robertson and Spurrit)	32	NA	NA	68
2000 (Cooney et al)	3	NA	NA	97
2009 (Chipchase et al)	52	42.5	57.5	48

2.2.1.8 Microwave diathermy

Microwave diathermy (MWD) was also a less commonly studied electrotherapy modality in the reviewed literature. This modality was investigated in only five (22.7%) studies out of 22 studies included in this review. MWD not studied as a single modality in any of the studies included in this literature review. This modality was however studied along with other electrotherapy modalities in the reviewed studies (Table 2.2). The researcher (reviewer) determined the availability of MWD by dividing the number of physiotherapists (n=178) having access to MWD equipment by the total number of respondents (n=213) in the study by Pope et al. (1995). This revealed that the availability of MWD was 83.6% in the study by Pope et al. (1995). In addition, Cooney et al. (2002) reported use of MWD as the 'least used' and they did not report any statistics about the non-use despite availability of MWD equipment. Table 2.4 presents the statistics on the availability, use, non-use and non-availability of MWD extracted from the reviewed studies.

Table 2.4 Availability, use, non-use and non-availability of MWD

Year (Study)	*Available (%)*	*Used (%)*	*Not used despite availability (%)*	*Not available (%)*
1990 (Lindsay et al)	33	79	21	67
1995 (Pope et al)	83.6	64	36	16.4
1998 (Robertson and Spurritt)	7	75	25	93
2000 (Cooney et al)	6	Least used	Not reported	94
2009 (Chipchase et al)	2	0.6	99.4	98

The findings show that the availability of this modality was highest (84%) in 1995 (Pope et al., 1995) and it decreased considerably to 6% in 2000 (Cooney et al., 2000) and it reached to the lowest level (2%) in 2009 (Chipchase et al., 2009). The use of MWD was between 64% and 79% from 1990 to 1998; however, it declined to very low use from 2000 to 2009. Similarly, the non-availability of MWD was higher ranging from 67% in 1990 (Lindsay et al., 1990) to >90% from 1998 (Robertson and Spurritt, 1998) to 2009 (Chipchase et al., 2009); however the lowest non-use of MWD (21%) was reported by Pope et al. in 1995. The greater difference in the non-availability of MWD might be due to the differences in the location of studies. For example, Pope et al. study (1995) was conducted in England while other studies on MWD were conducted in Australia (Lindsay et al., 1990; Robertson and Spurritt, 1998; Chipchase et al., 2009) and in the Republic of Ireland (Cooney et al., 2000) as shown in Table 2.2. The data on MWD presented in Table 2.4 reveals that the availability and use of this modality is highly declining while its non-availability is greatly rising. It is however important to mention that there was no study on MWD to judge the extent of the availability, use, non-use and non-availability of this modality at that time of start of this PhD study in October 2002. Overall, the availability and use of this modality in the reviewed studies showed a highly declining trend while the non-use and non-availability of it was greatly rising. However, no study reported the cessation of use of this modality.

2.2.1.9 H-wave

H-wave was the least studied modality in the reviewed literature. This modality was investigated by only two studies (9.1%) out of 22 studies included in this literature review (Table 2.2). Data extracted from the reviewed studies on the availability, use, non-use despite equipment availability and non-availability of this modality is presented in Table 2.5.

Table 2.5 Availability, use, non-use and non-availability of H-wave

	Available	*Used*	*Not used despite availability*	*Not available*
1995 (Pope et al)	81.8	97.1	2.9	18.2
2000 (Cooney et al)	2	NA	NA	98

The findings show that the availability and use of this modality was very high in 1995 (Pope et al., 1995); however, it became highly non-available in 2000 (Cooney et al., 2000). There were however no data on the use and non-use despite availability of H-wave reported in the study by Cooney et al. (2000). It was therefore not possible to know the extent of usage of this modality after the Pope et al. study in 1995. Overall, the reviewed literature shows that the availability of H-wave is at the verge of disappearing and its non-availability in physiotherapy departments is becoming universal. A summary of these findings is given in the next section.

2.2.2 Summary of findings of literature review on electrotherapy equipment

This literature review revealed that all of these studies were conducted in only English speaking countries. The countries along with the number of studies conducted in each county, given in parenthesis, are as follows. Australia (n=6), Canada (n=1), England (n=6), England and Wales (n=1), Hong-Kong and UK (n=1), Northern Ireland (n=1), Republic of Ireland (n=3), the UK (n=1) and the USA (n=2). The identification of studies conducted in only English speaking countries could be due to the selection of the study language as only English.

The extracted data revealed that twelve (54.5%) studies were published during 1990s and ten (45.5%) studies were published in 2000s. In total, 16 studies (73%) were published between 1990 and 2002 and prior to the start of this PhD study, which started in October 2002. The remaining six studies (27%) were published after the present PhD research study was started and the data were collected for it in 2002-2003.

This literature review found that a 'cross sectional survey' design using a postal questionnaire was used in the most of reviewed studies. However, Kitchen (1995) used face-to-face interviews for their survey and Al Mandeel and Watson (2006) who conducted an audit, reviewed patients' case files / records to extract the data on the use of electrotherapy.

In the reviewed studies, research participants were physiotherapists; however, physiotherapy departments were also recruited as participants in some studies (Lindsay et al., 1990; Robertson and Spurritt, 1998; Patridge and Kitchen, 1999; Shields et al., 2001).

The sample size in these studies varied from minimum 10 participants in the study by Kitchen (1995) to a maximum of 12,893 participants in the study by Chipchase et al. (2009). A few studies did not provide the exact sample size. For example, Wong et al. (2007) did not provide any information on their sample size while Lindsay et al. (1995) reported their sample size as ‘all private practitioners registered in Alberta, Canada’.

The response rate also varied widely in the reviewed studies. The lowest response rate was 27%, which was reported by Chipchase et al. (2009) and the highest response rate was 99.3%, which was reported by Sheields et al. (2001).

This literature review found that most of these studies were conducted in a local / regional context such as a study by Linday el al. (1990) conducted in the city of Brisbane, Australia, a study by Lindsay et al. (1995) in the province of Alberta, Canada, a study by Seymour and Kerr (1996) in the Trent region, England, a study by Tabasam and Johnson (2006) in North England and a study by Wong et al. (2007) in the Northeast and mid-Atlantic regions of USA.

In addition, this review revleaed that some studies involved study of EPAs by physiotherapists specialised / interested in particular clinical conditions / specialities. For example, study by Taylor and Humphry (1991) involved physiotherapists specialised in physical disabilities, study by Seymour and Kerr (1996) invovled only community physiotherapsits, study by Warden and McMeeken (2002) involved physiotherapsits interrested in sports injuries, while Shields et al. (2002) involved only senior physiotherapsits, Chipchase and Trinkle (2003) included physiotherapsits interested in musculoskeletal field and Wong et al. (2007) invovled physiotherapists specialised in orthopaedics. Moreover, a few studies investigated the use of electrotherapy in treating particular medical conditions. For example, the use of EPAs in the management of pain was studied by Tabasam and Johnson (2006) and Scudds et al. (2009).

Most of the studies invovled physiotherapsits working in the public sector while a few studies (Lindsay et al., 1990; 1995) involved only private practitioners. Nevertheless, physiotherapsits working in both private and public sectors were involved in some studies (Kitchen, 1995; Robertson and Spurritt, 1998; Cooney et al., 2000; Shields et al., 2001; Chipchase and Trinkle, 2003). This reseacher's (reveiwer's) comments / critique on each of the reveiwed studies included in this literature review are given in Table 2.1. The researcher found that the most commonly these studies were conducted on a regional level and their sample size was small hence the findings of these have limited generalisability. In addition, reporting of the data in these studies varied very largely; therefore, it was difficult to extract the required data on the same paramters from all of these studies.

Overall, this literature review indentified that the order of availability and use, from high to low, of the EPAs reported in these studies was ultrasound followed by PSWD, CSWD, Laser, interferential, TENS, biofeedback, MWD and H-wave.

In addition, it was also important to findout that in England the last study that reported availability and use of a number of electrotherapy modalities was a study by Partridge and Kitchen published in June 1999, and submitted in July 1998, suggested that the data for this study was perhaps collected in 1997-1998. This showed that there was a gap of about five years between the start of this PhD study and the last study (i.e. Partridge and Kitchen, 1999) on availability and use of electrotherapy modalities in the NHS physiotherapy departments in England. The exact status of current use of electrotherapy modalities in general and SWD and MWD in particular in clinical practices is important to know the frequency of physiotherapists' exposure to RF-EMFs from diathermy devices. It was therefore important to fill in this gap and update the body of knowledge by studying the level of availability and use of electrotherapy modalities in physiotherapy departments in the NHS in England. Therefore, this research developed following research question.

Q. What is the current level of availability and frequency of use of nine different types of electrotherapy modalities in NHS physiotherapy departments?

The next section presents a review of literature on measurement of EMFs from shortwave and microwave diathermy devices.

2.3 Review of Literature on Measurement of EMF emissions from PSWD, CSWD and MWD devices in physiotherapy departments

This section presents a review of published literature comprising primary studies reporting the measurement of EMF emissions from PSWD, CSWD and MWD devices in physiotherapy departments.

Relevant literature was searched using the literature review process and literature search parameters described in the section 2.1. The process of excluding and including the articles in shown in Figure 2.8, which identified 12 studies reporting on the measurement of EMF emissions from PSWD, CSWD and MWD devices. The data abstracted from these studies (n=12) included the publication year and location of the study, the type, the number (sample size) and the frequency of diathermy devices studied; the type of EMFs measured; and the key findings and measured EMF intensities reported in these studies. Table 2.7 presents data extracted from these studies (n=12) with respect to these variables alongside the researcher's (reviewer's) comments.

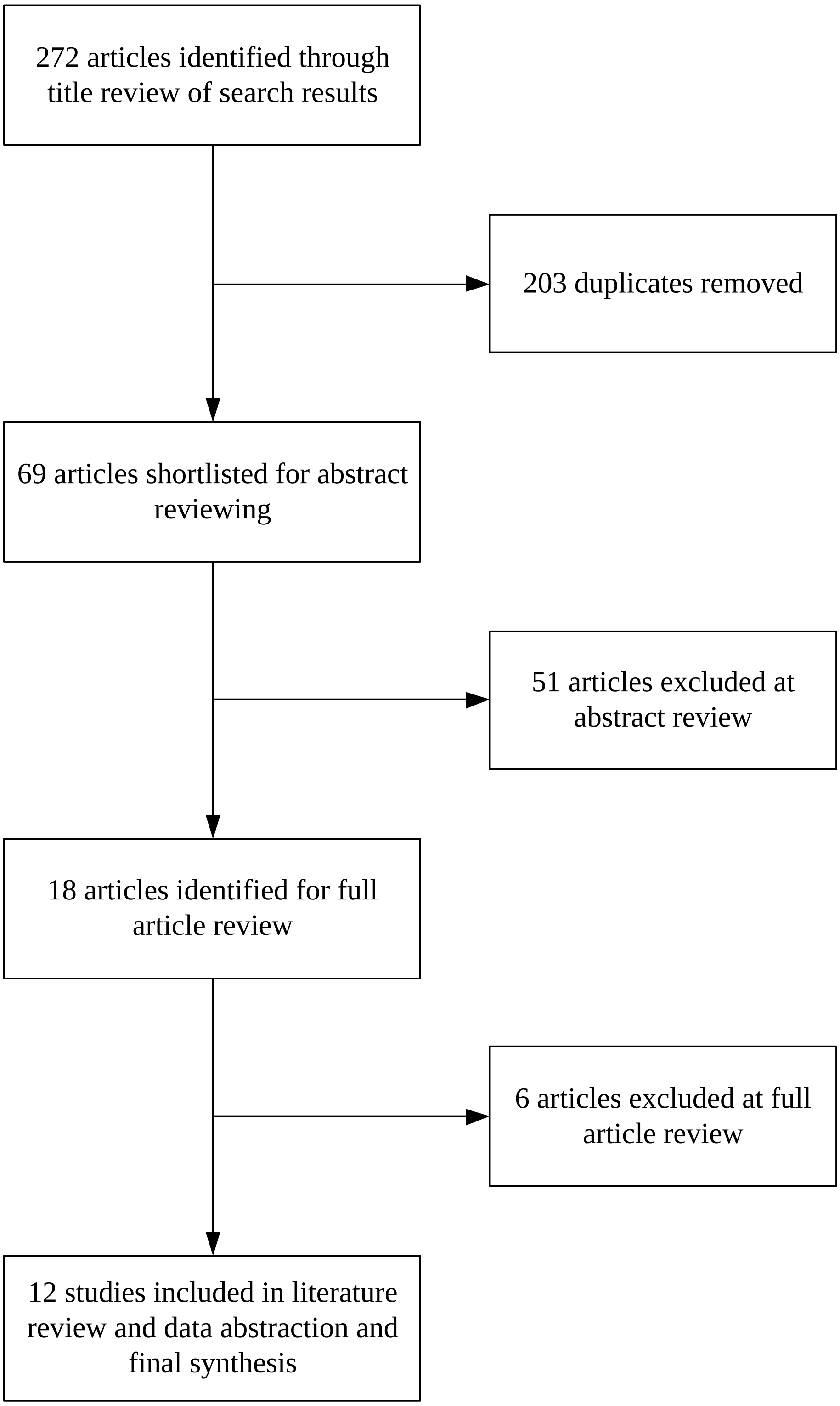

Figure 2.8 Number of included and excluded studies on measurement of EMFs from therapeutic diathermy devices

Table 2.6 Studies included in literature review on measurement of electric and magnetic fields from shortwave and microwave diathermy devices

Study / Reference	*Country*	*Diathermy modality (sample size)*	*Device Frequency*	*Fields measured*	
Martin et al. (1990)	Scotland	CSWD (n=3) PSWD (n=3) MWD (n= 2)	27.12 MHz 27.12 MHz 2.45 GHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	Field strengths higher than NRPB and IRPA/INIRC recommended levels found at 0.10 m to 1.0 m from the electrodes and cables for CSWD and up to 0.5 m for PSWD and MWD. EMFs from CSWD devices were higher than PSWD devices. Operators should stay at 1-2 m from the operating device, especially CSWD units and they should not come closer (<0.5m) to the cables and electrodes				
Researcher's comments	EMF strengths were presented as contour graphs; hence, it was difficult to know the exact strengths of E- and H- fields.				
Martin et al. (1991)	Scotland	CSWD (n=3) PSWD (n=3) MWD (n= 2)	27.12 MHz 27.12 MHz 2.45 GHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	Field strengths above the reference levels extend up to 1 m from electrodes and cables for CSWD, and up to 0.8 m from PSWD units at highest pulses and power settings with capacitive applicators while with inductive applicators higher field extended only up to 0.2 m from electrodes and cables. Capacitive applicators produce higher fields compared to inductive applicators.				
Researcher's comments	EMF strengths were reported as contour maps; hence, it was difficult to extract data on E and H fields' strengths. No details of power setting reported. EMF measurements reported in this article were published in an earlier article, described above, by the same researchers (Martin et al., 1990).				
McDowell and Lunt (1991)	England	PSWD (n=2)	27.12 MHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	Distance from the applicator: 0.3 m	0.6 m	1m		

	E field 55-80 V/m 14-22V/m 4 – 6 V/m H field 0.34-0.36 A/m 0.03 A/m Not reported NRPB safety guideline limits (i.e. E-field 61V/m and H-field 0.16A/m) exceeded only at a distance <50cm distance from the applicator even when equipment operated at maximum output.				
Researcher's comments	All materials e.g. metallic beds, radiators, racks etc. that would affect EMFs intensity were removed from the measurement area; this would not provide a true picture of the routine treatment areas in daily practice. Maximum power settings were used during EMF measurement, which again would not be representative of routine electrotherapy treatment. Only Megapulse units (one old and one new) manufactured by the same manufacturer were tested. Therefore, the findings cannot be generalised.				
Tzima and Martin (1994)	Scotland	PSWD (n= 3) CSWD (n=3) MWD (n=2)	27.12 MHz 434 MHz 2.45 GHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	Phantom simulations and common treatments settings were used. E-field strengths above the national reference levels were found at 0.8m to 1.1 m distance from capacitive electrodes for CSWD, at 0.2 to 0.8 m distance for PSWD and 0.2 to 0.1m for MWD. H fields exceeded at 0.7 to 1.1m for CSWD, at 0.2 to 0.8m for PSWD. Higher EMFs were noted at longer distance (up to 0.8m) for capacitive applicators compared to inductive applicators (up to 0.4m).				
Researcher's comments	EMF strengths were reported as contour map; therefore, it was hard to know the precise level of EMFs at particular distances. No H –fields were recorded for 2.45 GHz MWD unit.				
Lerman et al. (1996)	Israel	CSWD (n=15)	27.12 MHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	EMFs measured at 0.2 m, 0.5 m, 0.7 m and 1m distance from electrodes during patient treatment using lower levels of power settings (level 2 and 4 were used). Electric field strengths above the NRPB reference levels were measured up to 1 m from electrodes and cables. H-fields were below the recommended levels at short distance from the CSWD units. Measured EMF intensities were as follows:				

	Distance 0.2 m 0.5 m 0.7 m 1m E field $1-5*10^5$ $2-5*10^4$ $3-8*10^3$ to $4*10^4$ $1-3*10^3$ H field = intensities not reported				
Researcher's comments	Study involved only two models i.e. Curapulse 419 and Ultratherm of CSWD units. Power settings used were low compared to other studies that used maximum power settings and still found higher EMFs up to 1m from electrodes. This study did not measure EMFs from the SCWD console where the operator usually stands during treatment. In addition, no data on H-field intensities was reported but it was noted that at a short distance away from the diathermy devices the H-field intensities fell below the limits recommended for whole body exposure.				
Li and Feng (1999)	Taiwan	CSWD (n = not reported)	27.12 MHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	Measurements taken on the front and back of CSWD units at 30 cm (knee level), 1 m (waist level) and 1.5 m (hand level) above the floor and 20 cm from the electrodes. EMF strengths were as follow: Measurement from diathermy device console: Front side of diathermy / Back side of diathermy Distance 30 cm 1 m 1.5 m / 30 cm 1 m 1.5 m E-field 53.7 V/m 19.2 V/m 15. 96 V/m / 46.1 V/m 46.69 V/m 6.78 V/m H-field 0.87 A/m 0.22 A/m 0.34 A/m / 0.91 A/m 0.25 A/m 0.21 A/m Measurements from electrodes: Highest E- and H-fields were 0.34 A/m, 15.96 V/m respectively, measured at 20 cm from electrodes and 1.5 m above the ground level while E- and H-fields at 1.5 m from electrodes were nearly zero. The operator's knees may have the highest exposure level for magnetic (H) fields in the normal operating position, i.e. behind the device console; however, E-field strengths were below the recommended limits.				
Researcher's comments	Study involved only two models i.e. Curapulse 419 and Ultratherm of CSWD units. EMFs were measured at three distances that included 1 m				

	(the recommended safe distance), 0.3 m (less than the safe distance) and 1.5m (more than the safe limit). The EMF strengths were clearly reported. However, no details of the CSWD device setup during the measurements were reported. In addition, there was no information as to whether the measurements were taken during actual patient treatment or simulation using a saline filled phantom; there were no details of the number of CSWD units tested. The type of electrodes used was also not reported. Moreover, only Curapulse 419 CSWD device by one manufacturer (i.e. Enraf Nonus) was used. Hence, the findings could not be generalised for all models and makes of CSWD equipment.				
Tuschl et al. (1999)	Austria	SWD (n=7) [Number of CSWD and PSWD units = no information] MWD (n=11)	27.12 MHz 433.92 MHz and 2450 MHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	Over exposure to EMFs (greater than the Austrian limits of E = 67.9 V/m and H = 0.18 A/m) noted at six out of seven shortwave diathermy devices within working areas of therapists. EMFs measurements for SWD Distance above floor: 40 cm (legs) 85 cm (Hands) 95 cm (Genitals) 135 cm (Chest) E field 868.3 V/ m 221.4 V/m 237.8 V/m 19.4 V/m H field 1.0 A/m 0.8 A/m 0.6 A/m 0.15 A/m No overexposure was noted from microwave devices.				
Researcher's comments	No report of power settings on diathermy devices. No details of whether real patients or dummies were used. No details of SWD modes i.e. pulsed or continuous. The main aim was to investigate the effect of RF EMFs on white blood cells and immune parameters.				
Hrnjak and Zivkoviae (2002)	Yugoslavia	SWD (n=21) [No information about the mode of SWD devices]	27.12 MHz	Power density	✓
Findings	Intensities of RF EMF power density were measured during electrotherapy sessions using typical power settings of SWD units. Power				

	densities measured from CSWD units were: 30 cm 1 m 2 m 3 m Power density 0.10->200 mW/cm^2 <0.10 – 10 mW/cm^2 <0.10-4 mW/cm^2 <0.10-1 mW/cm^2 RF field intensities were higher than the occupational exposure limit of 1.22 mW/cm^2 and were measured up to 2 m distance from CSWD units.				
Researcher's comments	Power density was measured instead of E and H fields. No details as to whether measurements were carried out during continuous or pulsed mode or during both modes. No information on number of CSWD/ PSWD units tested.				
Grandolfo and Spinelli (2002)	Italy	Total devices = 15 SWD (n = not reported) [Number of CSWD and PSWD units = no information] MWD (n=not reported)	 27.12 MHz 434 MHz, 2450 MHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	Measurement taken during patient treatment as well as saline dummies using power settings suggested by physiotherapists or the maximum when there were no suggestions. EMFs were higher than the recommended levels (61V/m and 0.16 A/m for SWD; 62.4 V/m and 0.17 A/m for 434 MHz MWD, 137 V/m and 0.36 A/m for 2.45 GHz MWD units) extended up to 2 m from diathermy units.				
Researcher's comments	EMF intensities were presented in graphical form; therefore, it was not possible to know the exact levels of measured EMFs. No details of actual number of CSWD, PSWD and MWD units tested.				
Aniolczyk et al. (2004)	Poland	SWD (n=540) [Number of CSWD and PSWD units = no information] MWD (n=4)	27.12 MHz 2450 MHz	Electric (E) fields Magnetic (H) fields Power density	✓ ✓ ✓

Findings	Maximum E-fields recorded were 235V/m for SWD devices. H-fields were not reported. For MWD devices, the power density recorded was 0.2-22 W/m^2. Whole body exposures of operating therapists were found to have higher exposures than the recommended limits in 86% of the shortwave diathermy devices measured within the areas where therapists regularly operated.				
Researcher's comments	No report on the device settings, patient or dummies and occupational environment. Reported that the data source was the authors own studies as well as data obtained from EMF emission registry in the country. The number of SWD devices tested was 540 units, which is the largest sample reported so far but details of PSWD and CSWD units were not given. Compared to the large numbers of SWD units, only 4 MWD units were studied. Moreover, there was no report on the distance at which E-fields from SWD units were measured. The basic aim of the study was effectiveness of the EMF shielding material rather than the measurement of EMF emissions.				
Shields et al. (2004)	Republic of Ireland	CSWD (n=8) PSWD (n-10)] (Total SWD units =10, Combined Continuous & Pulsed = 8, only Pulsed =2)	27.12 MHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	Measurements of EMFs from PSWD and CSWD units were taken in eight directions at 1 m, 1.5 m and 2 m distance from SWD units using both capacitive and inductive electrodes. EMF measurements from CSWD with capacitive electrodes were: At .5 m: EMFs were too high and triggered the meter alarm; hence, no measurements were taken. At 1m: E-fields = 39.7-380 V/m, H-fields =0.03-0.36 A/m. At 1.5 m: E-fields = 4.6-83.2 V/m, H-fields =0.02-0.12 A/m. At 2 m: E-fields =4.8 – 39.8 V/m, H-fields =0.02-0.07 A/m. EMF measurements from PSWD with capacitive electrodes were: At .5 m: E field = 57.5-318.8 V/m, H-fields =0.87-1.729 A/m At 1m: E-fields = 8.1-106.5 V/m, H-fields = 0.01-0.11 A/m.				

Researcher's comments	Overall, this study was the best in terms of description of methods and presentation of the results. However, limitations were measurements taken at 30 sec compared to EMF exposure limits for an average of 6 min duration. Dummies (phantoms) were used instead of actual patients for convenience, safety and ethical reasons. Maximum power output settings as a worst-case scenario, were used which might not be representative of a majority of electrotherapy treatments. All metallic objects were removed before EMF measurements began, which might not be possible during actual practice hence not a true reflection of EMF intensities. No data reported on EMF measurement from PSWD at at 1.5m and 2m distances.				
Macca et al. (2008)	Italy	SWD (n=4) MWD (n=11)	27.17 MHz 2450 MHz	Electric (E) fields Magnetic (H) fields	✓ ✓
Findings	Modality Distance measured maximum E field measured maximum H field E-field EC limits H-field EC limits SWD console 1m 5.49 V/m 0.256 A/m 61 V/m 0.16 A/m MWD console 1 m 32.79 V/m 0.086 A/m 137 V/m 0.36 A/m EMF emissions (both E and H fields) measured behind the device console were higher than the occupational limits established under EC directive 2004/40/EC at 0.5 m from MWD applicators and only H fields from SWD devices were higher than the EC limits.				
Researcher's comments	EMF strengths were measured for periods shorter than the 6 minutes period suggested in the ICNIRP guidelines for estimating EMF occupational exposure. H-fields strengths were higher for SWD at 1 m distance from the device, which was not highlighted by the authors. No information about the modes of SWD equipment reported. No details as to whether measurements were taken on dummies or during actual electrotherapy on patients.				

2.3.1 Findings of literature review on measurement of RF EMFs from therapeutic diathermy equipment

The findings of the review reporting on measurements of radiofrequency EMF emissions in physiotherapy departments showed that three types of electrotherapy modalities i.e. CSWD, PSWD and MWD were investigated for EMF emissions in these studies. The reported electromagnetic frequency of CSWD and PSWD devices was 27.12 MHz and the frequency of MWD devices was 434 MHz and 2450 MHz (2.45 GHz). EMF measurements from MWD devices were reported in seven (58.3%) of the 12 studies included in this review while measurement from SWD devices were reported in all 12 of the studies (n=12, 100%). For SWD modalities, measurements from CSWD and PSWD were reported in 58.3% (n=7) and 41.7% (n=5) of studies respectively while in the remaining studies no information was reported on the type of SWD. The type of EMFs measured were mostly electric (E) field and magnetic (H) field, which were reported in 91.7% (n=11) studies while measurement of power density (*S*) was reported in 16.7% (n=2) of reviewed studies.

In some studies, maximum power output settings were used to measure EMFs in the worst-case scenarios (McDowell and Lunt, 1991; Grandolfo and Spinelli, 2002; Shields et al., 2004) while other studies measured power settings that were used during normal treatment (Tzima and Martin, 1994; Lerman et al., 1996; Hrnjak and Zivkoviae, 2002; Grandolfo and Spinelli, 2002). However, none of these studies defined what was meant by normal treatments. The number of diathermy devices used for EMF measurements ranged from 2 to 11 for MWD and from 2 to 540 for SWD. Among SWD modalities, there were 2- 10 PSWD devices and 3-15 CSWD devices. It is important to point out that 540 SWD devices reported in a study by Aniolczyk et al. (2004) was actually the number of SWD devices for which data was collected at the Central Registry of Sources of EMF Emissions in Poland. There were no details about how this data was collected and what parameters were used to measure EMFs from these devices; therefore, this data has limitations.

EMFs were measured during treatment of real patients in a few studies (Lerman et al., 1996; Grandolfo and Spinelli, 2002) while dummies were used in other studies (Tzima and Martin, 1994; Li and Feng, 1999; Grandolfo and Spinelli, 2002; Shields et al., 2004). The distances at which EMF measurements were taken ranged from 0.3 m to 3 m from the cables, electrodes and the consoles of diathermy devices. EMF intensities measured at less than 1 m distances were reported to be higher than the occupational exposure limits in eleven of twelve studies included in this review (Martinet al., 1990; 1991; McDowell and Lunt, 1991; Tzima and Martin, 1994; Lerman et al., 1996; Li and Feng, 1999; Tuschl et al., 1999; Hrnjak and Zivkoviae, 2002; Grandolfo and Spinelli, 2002; Shields et al., 2004; Macca et al., 2008). At 1 m distance, EMF strengths were also reported higher than permissible limits for occupational exposure in ten of twelve reviewed studies (Martin et al., 1990; 1991; Tzima and Martin, 1994; Lerman et al., 1996; Li and Feng, 1999; Tuschl et al., 1999; Hrnjak and Zivkoviae, 2002; Grandolfo and Spinelli, 2002; Shields et al., 2004; Macca et al., 2008). While a few studies reported EMFs higher than occupational exposure guideline limits even at 2-3 m distances from diathermy devices (Grandolfo and Spinelli, 2002; Shields et al., 2004). The authors of the majority of the studies reported that physiotherapists operating diathermy devices should not come closer than 0.5 m to the cables and/or electrodes (Martin et al., 1990; 1991). Some studies concluded that physiotherapists should stay at least at 1 m from diathermy device during electrotherapy treatment (Martin et al., 1990; 1991; Macca et al., 2008) while others called for a review of 1 m from diathermy devices as a safe distance for physiotherapists (Shields et al., 2004).

In addition, the use of capacitive electrodes was found to result in higher EMF intensities compared to inductive electrodes (Martin et al., 1991; Tzima and Martin. 1994). The next section, presents a summary of the findings of the review of these studies and the researcher’s comments.

2.3.2 Summary of findings of literature review on measurement of EMFs from therapeutic diathermy equipment

This literature review revealed that 83.3% (n= 10) of the 12 studies were conducted in seven European countries i.e. Austria (n=1), England (n=1), Italy (n=2), Poland (n=1), Republic of Ireland (n=1), Scotland (n=3), Yugoslavia (n=1). The remaining 16.7% (n=2) studies were conducted in Israel (n=1) and Taiwan (n=1). The number of the studies included in this review was limited, which might be due to selection criteria of English as the study language. Therefore, availability of other studies on this topic published in languages other than English could not be ruled out. The extracted data (given in Table 2.6) showed that 58.3% (n=7) of studies were published during the 1990s while the remaining (41.7%, n=5) were published in 2000s.

The sample size of SWD and MWD equipment studied was mostly reported; however, a few studies did not report the exact number of CSWD and PSWD devices (Li and Feng, 1999; Tuschl et al., 1999; Harnjak and Zivkoviae, 2002; Grandolfo and Spinelli, 2002; Aniolczyk et al., 2004 and Macca et al., 2008). A study by Grandolfo and Spinelli (2002) only reported the total sample size but did not provide the exact number of SWD and MWD devices. In the study by Aniolczyk et al. (2004), excluding data on 540 SWD and 4 MWD devices from the Polish Central Registry on EMF Emissions, the average sample size of diathermy devices studied was small i.e. total devices per study ranged from 2 to 21 devices. The number of SWD devices studied was higher (mean 8±6 devices / study) compared to MWD devices (mean 5±4 devices / study). It was interesting to note that half of the studies did not measure EMFs from MWD devices. There was no information as to why MWD devices were not included in 50% of the reviewed studies.

In a few studies (McDowell and Lunt, 1991; Shields et al., 2004), all large metallic objectives such as beds, radiators and racks were removed from the treatment room / cubicle before taking EMF measurements. This might not be a representative environment for electrotherapy treatment in daily clinical practice; hence, the measured intensities of EMFs might be lower. This is because the intensity of EMFs is reported to be enhanced by the presence of metallic objects within the close vicinity of the operating diathermy devices (Docker et al., 1992, 1994; Grandolfo and Spinelli, 2002). The removal of large metallic objects might be due to compliance with the guidelines regarding safe use of electrotherapy, which recommend that such objects should not be in the proximity of operating diathermy devices (Robertson et al., 2001) but that they be placed at the minimum distance of 3 m from diathermy devices (Baxter et al., 2006; Bazin et al., 2008). The other important issue with regard to measurement of EMFs is the distance from the console of diathermy devices at which the measurements should be taken. According to the Chartered Society of Physiotherapy (1997a, b), a distance of 1m from the therapeutic diathermy device console and 0.5 m from the cables and electrodes are the safe distances for physiotherapists. Most of the studies measured EMFs at these distances (Martin et al., 1990; 1991; McDowell and Lunt; 1991; Tzima and Martin, 1994; Lerman et al., 1996; Li and Feng, 1999; Tuschl et al., 1999; Harnjak and Zivkoviae, 2002; Shields et al., 2004; Macca et al., 2008). However, a number of studies (Martin et al., 1990; 1991; Tzima and Martin, 1994; Lerman et al., 1996; Li and Feng, 1999; Tuschl et al., 1999; Hrnjak and Zivkoviae, 2002; Grandolfo and Spinelli, 2002; Shields et al., 2004; Macca et al., 2008) reported that EMF intensities at these distances were higher than the recommended safe limits (Table 2.6).

In addition, a considerable number of these studies used worst-case scenarios for measuring EMF emissions by putting diathermy devices at the maximum power output. EMF intensities in such situations are expected to be usually higher because the strengths of EMFs are positively related to the device power output i.e. the higher the power output the greater the EMF intensity (Lau and Dunscombe, 1998; Hrnjak and Zivkoviae, 2002). Therefore, measuring EMFs from therapeutic diathermy devices using the maximum power output settings and saying that physiotherapists are exposed to higher EMFs might not be very convincing.

Moreover, EMF intensities were recoded for different durations, which were less than the average six minutes duration for calculating occupational exposures under the international guidelines (ICNIRP, 1998). Therefore, recording of EMFs higher than the permissible limits for durations of less than six minutes does not mean that physiotherapists in these departments were actually exposed to these EMF intensities, which in fact were the proxies for potential exposure of the physiotherapist to higher fields. Physiotherapists usually stay at the place of electrotherapy while operating the diathermy device for a time that is usually less than six minutes and hence they are less likely to be exposed to higher RF EMFs averaged for six minute limit (Grandolfo and Spinelli, 2002).

The researcher's comments on each of the reviewed studies are given in Table 2.6. The most common difficulty for the researcher was extraction of data on EMF intensities reported in these studies due to unclear presentation of measurement results such as the use of contour graphs for data presentations in some studies (Martin et al., 1990; 1991; Tzima and Martin, 1994; Grandolfo and Spinelli, 2002). In addition, it was observed that the methods of measuring EMFs emissions were different from one study to another. The differences included use of different instruments for recording EMF strengths, different power settings of diathermy devices, different distances at which measurements were taken, different physical environments in which the measurements were taken and the use of real patients and phantoms during the measurements. It was therefore difficult to generalise the findings from these studies. The measured intensities of EMFs however show a proxy measure for physiotherapists' potential exposure to RF EMFs. The exact level of physiotherapists' exposure to RF EMF emissions in their occupational environments can be assessed by using other methods such as using personal dosimeters that can be worn by physiotherapists during the working hours.

Overall, review of the findings of these studies suggested that RF EMFs intensities at 1 m distance from diathermy devices, which is the recommended safe distance for physiotherapists operating the device, were usually higher than the permissible limits for occupational exposure (Table 2.7). It is therefore more likely that physiotherapists operating diathermy devices could be exposed to RF

EMF intensities higher than the permissible limits, which might lead to development of adverse health effects. It is therefore important to study what physiotherapists do to protect themselves from possible exposure to RF EMFs from diathermy devices during electrotherapy in their clinical practice. In addition, investigation of physiotherapists' working environment especially the physical features of rooms / cubicles used for electrotherapy with diathermy is important. In this regard, the researcher developed the following questions to be addressed in this research.

Q. What are NHS physiotherapists' practices and procedures with respect to the safe use of electrophysical agents, particularly shortwave and microwave diathermies?

Q. What are physical features in the physiotherapy workplace particularly in treatment rooms / cubicles used for treatment with therapeutic diathermy modalities that may have potential to impact on health and safety of physiotherapists?

The next section presents a review of literature on adverse health effects and pregnancy outcomes reported to be associated with physiotherapists' exposure to RF EMFs from therapeutic diathermy devices.

2.4 Review of Literature on Adverse Health Effects and Pregnancy Outcomes Associated with Physiotherapists' Occupational Exposure to RF EMFs

Unintended and excessive occupational exposure to RF EMFs leading to potential adverse health effects and reproductive outcomes in physiotherapists operating SWD and MWD devices was reported in a number of studies conducted in 1980s

(Hamburger et al., 1983; Kurppa et al., 1983; Logue et al., 1985; McDonald et al., 1987). But, some researchers found that the ratios of observed and expected outcomes such as spontaneous abortions, stillbirths, birth defects and low birth weights (≤ 2500 g) were not statistically significant (McDonald et al., 1987). Therefore, to assess the evidence of association between occupational exposure to RF EMFs from therapeutic diathermy devices and adverse health effects and adverse pregnancy outcomes among physiotherapists, the researcher systematically reviewed literature published in the last two decades (i.e. from 1990 to 2010).

The literature review process as described in section 2.1 and the process of inclusion and exclusion of articles illustrated in Figure 2.9 led to identification of 11 studies that reported adverse health effects and adverse pregnancy outcomes among physiotherapists exposed to RF EMFs. Full articles of these studies (n=11) were obtained and reviewed. The data extracted from these articles included the publication year and study location, design of study, aims and objectives, subjects, sample size and the key findings of the research. Table 2.7 shows extracted data from the reviewed articles and the researcher's comments on each study.

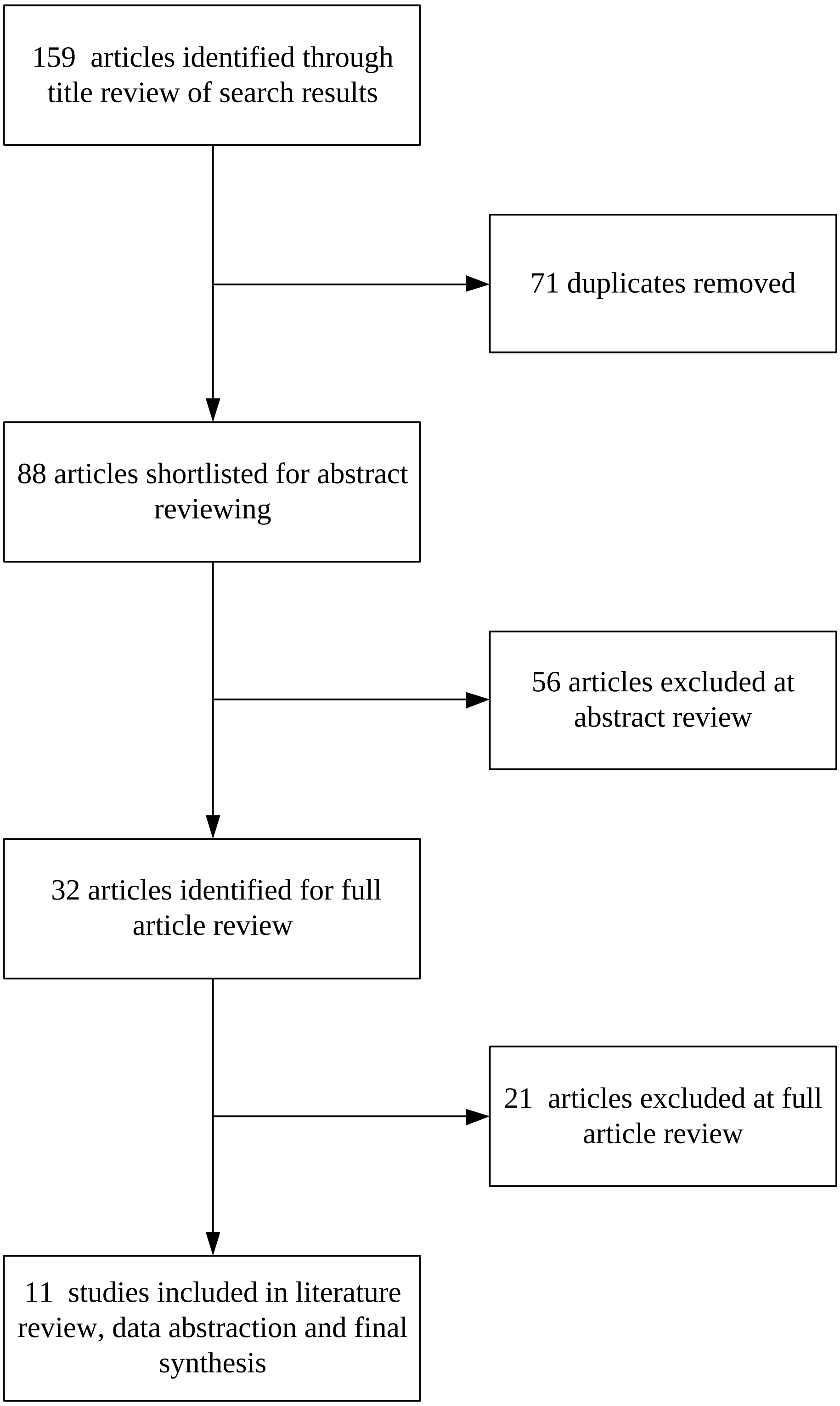

Figure 2.9 Flow chart of studies included and excluded

Table 2.7 Studies included in literature review on adverse health effects and pregnancy outcomes associated with physiotherapists' exposure to RF EMFs from SWD and MWD

Authors (year)	Taskinen et al. (1990)
Country	Finland
Study design	Nested case-control study
Study outcomes	SA mong physiotherapists and CMs in offspring
Source of RF EMF exposure	Use of SWD
Method for outcome information	Personal files from central register for health care personnel matched with hospital discharge register and Finnish register of CMs
Method for RF EMF exposure assessment	Questionnaire survey
Subjects	Physiotherapists
Sample size	For SA, cases =204 and controls =483; for CMs, cases =46 and controls = 187
Findings	For SAs (> 10 weeks), SWD use ≥ 5 hours/week = OR 2.5 ($p < 0.05$) became statistically not significant after removal of confounding factors i.e. febrile disease and previous abortion. For CMs: SWD exposure 1-4 h/week = OR 2.7 (95% CI: 1.2-6.1; $p < 0.05$). SWD exposure > 4 h/week had no significant effect on CMs. MWD exposure had no significant effect on SAs and CMs.
Researcher's comments	Moderate sample size. Retrospective study design covering 20 years (1973-1983); hence, influence of recall bias cannot be excluded.
Authors (year)	Larsen (1991)
Country	Denmark
Study design	Case control study

Study outcomes	CMs in physiotherapists' offspring
Source of RF EMF exposure	SWD use
Method for outcome information	National register of births, national register of hospital admissions, and national register of CMs
Method for RF EMF exposure assessment	Telephone interviews
Subjects	Physiotherapists
Sample size	For CMs, cases = 57 and controls = 267
Findings	No statistically significant association between CMs with high exposure to RF EMFs from SWD (OR = 1.7, 95% CI: 0.6-4.3, p = 0.7)
Researcher's comments	No explanation of 'high exposure'
Authors (year)	Larsen et al. (1991)
Country	Denmark
Study design	Case-control study
Study outcomes	SAs, TTP, LBW, GAB, SBs, PD and gender ratio
Source of RF EMF exposure	SWD use
Method for outcome information	Birth register and medical registers for abortions
Method for RF EMF exposure assessment	Telephone interviews
Subjects	Physiotherapists (female)
Sample size	4021 physiotherapists with 2334 pregnancies
Findings	High SWD exposure associated with altered gender ratio i.e. low ratio of boys compared to girls (OR= 4.9; 95% CI: 1.6-17.9). Other birth outcomes not statistically significant
Researcher's comments	Study limitations include recall bias and duration of exposure to RF EMFs

Authors (year)	Kallen et al. (1992)
Country	Sweden
Study design	Case-control study (within a cohort of 2043 births to 2018 physiotherapists)
Study outcomes	PB (< 38 wks), LBW (<2500 g), gender ratio, SB, PD and CMs
Source of RF EMF exposure	SWD and MWD use during pregnancy
Method for outcome information	Personal files from the national board of health and welfare matched with the medical birth register and the Swedish register of CMs
Method for RF EMF exposure assessment	Questionnaire survey
Subjects	Physiotherapists (female) (N=111)
Sample size	Adverse birth outcomes: cases = 37 and controls = 74
Findings	A higher incidence of SBs or CMs among babies born to physiotherapists who used SWD but lower than the expected.
Researcher's comments	Small sample size; no report of ORs statistics.
Authors (year)	Ouellet-Hellstrom and Stewart (1993)
Country	USA
Study design	Nested case control study
Study outcomes	SAs
Source of RF EMF exposure	Use of SWD and MWD six months prior to pregnancy or in 1st trimester
Method for outcome information	Self-reported
Method for RF EMF exposure assessment	Questionnaire survey
Subjects	Physiotherapists (female) (N= 42,403)
Sample size	Cases = 1753 SAs and controls = pregnancies other than ectopic pregnancies (total number not reported)

Findings	6,684 (57.6%) physiotherapists who ever used MWD or SWD. 1,791 pregnancies recognised SAs. Physiotherapists reporting MWD use 6 months prior to the pregnancy or in 1st trimester more likely to report a SA (OR 1.28, 95% CI: 1.02, 1.59) with a dose response ($\chi^2 = 7.25$, $p < 0.005$). No statistically significant association between SA and SWD exposure (OR 1.07, 95% CI: 0.91-1.24)
Researcher's comments	Sample size was large.Bias due to non-response (40%) and recall.
Authors (year)	Guberan et al. (1994)
Country	Switzerland
Study design	Case control study
Study outcomes	Atypical gender ratio and LBW (<2500 g)
Source of RF EMF exposure	Exposure to SWD and MWD RF EMFs in 1st trimester of pregnancy
Method for outcome information	Not reported
Method for RF EMF exposure assessment	Questionnaire survey
Subjects	Physiotherapists (female)
Sample size	1030 physiotherapists reported 1781 pregnancies. Cases =508 birth (262 male and 246 female); controls = 1273 births (641 male and 632 female)
Findings	No atypical gender ratio (males / females x 100) of offspring found. SWD exposure: gender ratio for cases = 107 (95% CI: 89-127) and controls = 101 (95% CI: 90-113). MWD exposure: gender ratio for cases = 85 (95% CI: 61-118) and controls = 106 (95% CI: 96-117). LBW not significantly associated with SWD exposure.
Researcher's comments	Findings in disagreement with studies by Larsen (1991) and Larsen et al. (1991). Covering a period of more than 2 decades may have resulted in recall bias of respondents.
Authors (year)	Tuschl et al. (1999)
Country	Austria

Study design	Case control study
Study outcomes	Immune system parameters
Source of RF EMF exposure	Use of SWD and MWD
Method for outcome information	Analysis of blood samples for total count of leucocytes and lymphocytes, and determination of lymphocyte activity by flow cytometry and monoclonal antibodies against surface antigens
Method for RF EMF exposure assessment	Measurement of RF EMFs from 7 SWD and 11 MWD devices and interviews
Subjects	Physiotherapists (male and female)
Sample size	Blood samples of 18 exposed physiotherapists working with SWD and MWD and 13 matched controls
Findings	EMFs measured from SWD were higher than occupational exposure limits. Over exposure to SWD did not result in statistically significant differences in the lymphocyte activity and total leucocytes and lymphocytes in cases compared to controls
Researcher's comments	Duration of exposure to RF EMFs by cases was not reported. No information on level of exposure or frequency, or duration of device use
Authors (year)	Lerman et al. (2001)
Country	Israel
Study design	Nested case control study
Study outcomes	SA, CMs, PB and LBW
Source of RF EMF exposure	SWD use
Method for outcome information	Questionnaire survey of physiotherapists matched with telephone interviews of physiotherapy departments with sick notes, hospitals and private clinics
Method for RF EMF exposure assessment	Questionnaire survey
Subjects	Physiotherapists (female)
Sample size	434 physiotherapists with 930 pregnancies. 300 cases with adverse outcomes (i.e. SA= 175, CMs = 45, PB = 47 and LBW = 33).

	630 controls with normal pregnancies
Findings	SWD exposure and LBW (OR 2.75, 95% CI: 1.07-7.04, p = 0.03) - a positive dose response relationship. LBW for male offspring (OR 3.7) and female (OR 2.9). Other pregnancy outcomes not significant i.e. PB (OR 0.87, 95% CI: 0.48-1.59, p=0.66) and SA (OR 0.9, 95% CI: 0.64-1.27, p=0.56). Statistically significant association between exposure to SWD and CMs (OR 4.19, 95% CI:1.58-11.13, p= .004) but disappeared after controlling confounding factors (OR 1.33, 95% CI: 0.68-2.75, p= .44)
Researcher's comments	No details about duration and frequency of SWD use by therapists. Findings supported earlier studies (Larsen et al., 1991). Self-reports but no verification from other sources. Selection bias may be acting as not all physiotherapists were invited.
Authors (year)	Cromie et al. (2002)
Country	Australia
Study design	Cross sectional survey
Study outcomes	General health and reproductive outcomes (i.e. live births, SBs, SAs, LBW, CMs, PDs and gender ratio
Source of RF EMF exposure	Use of SWD, MWD and other therapeutic EPAs
Method for outcome information	Self-reported
Method for RF EMF exposure assessment	Postal questionnaire survey
Subjects	Physiotherapists (male and female)
Sample size	824 registered physiotherapists
Findings	Response rate = 67.9% (n=536, female = 78%, male = 22%). Female physiotherapists' exposure to SWD and early SAs (gestation <10 weeks) OR 1.05 (95% CI: 0.36-3.04) and late SA (gestation 11-24 weeks) OR 1.52 (95% CI: 0.61-3.79). No statistically significant difference in SAs due to SWD exposure of male and female physiotherapists. Total SAs in physiotherapists 11.5% and 13.5% in the general population. Total CMs 1.9% in offspring of physiotherapists compared to 3% in the general population. Conclusion: No increased risk of adverse reproductive outcomes (i.e. SBs, SAs, LBW, CMs, PDs and altered gender ratio) due to occupational exposure to EPAs.

Researcher's comments	Small number of cases reported using EPAs and reporting SAs. Other limitations: recall bias, self-report and no verification from other sources.
Authors (year)	Israel et al. (2007)
Country	Bulgaria
Study design	Case control study
Study outcomes	Cardiovascular risks (e.g. hypertension and lipid profile)
Source of RF EMF exposure	SWD and MWD and
Method for outcome information	Blood analysis for lipid profile and measuring of blood pressure
Method for RF EMF exposure assessment	Determination of individual occupational exposure by calculations based on a formula (not reported here)
Subjects	Physiotherapists (male and female)
Sample size	Cases = 52 (4 male and 48 female), Controls = 52
Findings	Among cases, high total cholesterol (>5.2 mmol/l) OR = 1.57. 95% CI: 1.05-2.35, p =.018; high level of low density lipoprotein cholesterol (>3.4 mmol/l) OR = 1.84, 95% CI: 1.16-2.92, p = .004; hence potential increased risk of being dyslipidemic (a cardiovascular risk factor). Higher incidence of hypertension in cases (26.9%) vs. controls (23.8%) but statistically not significant.
Researcher's comments	No details on selection of participants. Indirect determination of EMF strengths using a formula, which might give different levels than actual measurements with dosimeters.
Authors (year)	Vangelova et al. (2007)
Country	Bulgaria
Study design	Case control study
Study outcomes	Excretion rates of stress hormones (i.e. cortisol, adrenaline and noradrenaline)
Source of RF EMF exposure	SWD and MWD uses

Method for outcome information	Analysis of urine samples
Method for RF EMF exposure assessment	Determination of individual occupational exposure to RF EMFs (calculated by a formula)
Subjects	Female physiotherapists (cases) and nurses (controls)
Sample size	Cases = 15 female physiotherapists. Controls = nurses (number not reported).
Findings	Excretion rates of stress hormones higher in cases (physiotherapists) compared to controls (nurses) i.e. cortisol ($F=7.17$, $p = 0.009$), adrenaline ($F=7.87$, $p =0.007$) and noradrenaline ($F=10.64$, $p =0.002$). Level of cortisol excretion significantly higher in urine samples taken at 8.30-11.00 am ($F=12.13$, $p <.001$) compared to the samples taken before 8.30 am or after 11.00 am.
Researcher's comments	Small sample of cases. Number of controls not reported. Duration and mechanism of exposure to RF radiation not reported. No details of timing for urine sampling whether taken before, during or after the use of EPAs.

CM = congenital malformations, EMFs = electromagnetic fields, EMR = electromagnetic radiation, EPA = electrophysical agents, GAB= gestational age at birth, LBW = low birth weight, MWD = microwave diathermy, OR = odds ratio, PB = premature birth, PD = perinatal death (death of foetus either in the uterus > 24 weeks pregnancy or SB or within the 1st 7 days of life), RF = radiofrequency, SA = spontaneous abortion, SB = stillbirth (death > 24 week pregnancy), SWD = shortwave diathermy, TENS = transcutaneous electrical nerve stimulation, TTP = time to pregnancy, US = ultrasound.

2.4.1 Findings of literature review on adverse health effects and pregnancy outcomes associated with physiotherapists' occupational exposure to RF EMFs

Searching a number of databases as mentioned above, eleven relevant studies (Table 2.7) were identified that were published between 1990 and 2010. Most of these studies were conducted in the Western Europe, and in particular in Scandinavian countries. Seven out of eleven studies (63.6%) were published in the 1990s while the remaining four studies (36.4%) were published in 2000s. The majority of studies (72.7%, n=8) focused mainly on adverse pregnancy outcomes associated with physiotherapists' occupational exposure to RF EMFs; the remaining studies investigated adverse health issues such as effects of exposure to RF EMFs on physiotherapists' cardiovascular system, stress hormones and the immune system (Table 2.8.)

Most commonly, a case control study design was used and participants were female physiotherapists. The sample size varied between studies and the number of cases ranged from 15 to 6684 and controls ranged between 13 and 1273. Exposure to RF EMFs was mainly with reference to SWD devices; however, a few studies investigated exposure to RF EMFs from MWD devices.

Studies included in this review reported a range of adverse health effects as well as adverse pregnancy outcomes and the significant findings from the reviewed studies are summarised by the researcher as shown in Table 2.8.

Table 2.8 List of adverse health effects and pregnancy outcomes associated with physiotherapists' exposure to SWD and MWD reported in reviewed studies

Adverse outcome	*RF EMF exposure source*	*Statistically significant*	*Not statistically significant*
Spontaneous abortion (gestation > 10 weeks)	SWD		Ouellet-Hellstrom and Stewart (1993): OR 1.07 (95% CI: 0.09-1.24) Taskinen et al. (1990): SWD ≥ 5 hours/week exposure: OR 1.6 (95% CI: 0.9-2.7) Larsen et al. (1991): OR 1.4 (95% CI: 0.7-2.9) Lerman et al. (2001): OR 0.9 (95% CI: 0.64-1.27) Cromie et al. (2002): OR 1.52 (95% CI: 0.61-3.79)
Spontaneous abortion	MWD	Ouellet-Hellstrom and Stewart (1993): OR 1.28 (95% CI: 1.02-1.59)	Taskinen et al. (1990): OR 1.8 (95% CI: 0.8-4.1) Cromie et al. (2002): OR statistics not reported
Subfecundity / Delayed time to pregnancy (>6 months)	SWD	Taskinen et al. (1990): SWD exposure ≥ 5 hrs /wk = OR 2.5, $p < 0.05$	Larsen et al. (1991): OR 1.7 (95% CI:0.7-4.1) Cromie et al. (2002): OR statistics not reported
Congenital malformations (CMs) in physiotherapists' offspring	SWD	Taskinen et al. (1990): SWD exposure 1-4 h/wk = OR 2.4 (95% CI: 1.2-6.1; $p <0.05$)	Lerman et al. (2001): OR 1.33, (95% CI: 0.68-2.75) Kallen et al. (1992): Observed cases (n=27) less than the expected (n=32) Cromie et al. (2002): Total CMs in physiotherapists' offspring (1.9%) less than in the general population (3%) Larsen (1991): OR = 1.7 (95% CI: 0.6-4.3)
Altered gender ratio (low ratio of boys to girls)	SWD and MWD	Larsen et al. (1991): SWD exposure associated with altered gender ratio (i.e. low ratio of boys compared to girls) OR= 4.9 (95% CI:1.6-17.9).	Kallen et al. (1992): SWD exposure: Observed cases higher than expected (1.08 vs 1.06) but statistically not significant Guberan et al. (1994): SWD exposure: gender ratio for cases = 107 (95% CI: 89-127) and controls = 101 (95% CI: 90-113); MWD exposure: gender ratio for cases = 85 (95% CI: 61-118)

Adverse outcome	*RF EMF exposure source*	*Statistically significant*	*Not statistically significant*
			and controls = 106 (95% CI: 96-117) - statistically not significant Cromie et al. (2002): OR statistics not reported
Low birth weight (<2500 g)	SWD	Lerman et al. (2001): Combined male and female offspring = OR 2.75 (95% CI: 1.07-7.04, p=.03), for male offspring OR = 3.7 and for female offspring OR = 2.9	Larsen et al. (1991): For boys OR 5.9 (95% CI:1.0-28.2, p = 0.087), for girls OR 0.7 (95% CI:0.0-3.2) Kallen et al. (1992): Observed cases less than expected (64 vs 92) Guberan et al. (1994): OR statistics not reported
Stillbirth	SWD	Kallen et al. (1992): OR statistics not reported	Larsen et al. (1991): OR 2.9 (95% CI:0.6-10.7) Kallen et al. (1992): Observed cases (i.e.7) < expected (i.e. 12) Cromie et al. (2002): OR statistics not reported
Premature birth (<38 weeks)	SWD		Larsen et al. (1991): For boys OR 3.2(95% CI:0.7-13.2), for girls OR 0.9 (95% CI:0.3-2.8) Lerman et al. (2001): OR 0.87(95% CI: 0.48-1.59) Kallen et al. (1992): Observed cases (i.e. 170) < expected (i.e. 200)
Perinatal death / death in first year of life	SWD		Larsen et al. (1991): OR 2.9 (95% CI:0.6-10.7) Kallen et al. (1992): Observed cases (i.e. 16) < expected (i.e. 23) Cromie et al. (2002): OR statistics not reported
Immune system parameters (i.e. total leucocytes and lymphocytes, and lymphocyte activity)	SWD		Tuschl et al. (1999): SWD overexposure did not produce statistically significant differences in the immune parameters of the cases compared to the controls

Adverse outcome	*RF EMF exposure source*	*Statistically significant*	*Not statistically significant*
High total cholesterol (TC) and low density lipoprotein - cholesterol (LDL-C) (risk of being dyslipidemic –a cardiovascular risk factor)	SWD and MWD	Israel et al. (2007): High TC (>5.2 mmol/l) OR = 1.57 (95% CI: 1.05-2.35, p =.018); high LDL-C (>3.4 mmol/l) OR = 1.84 (95% CI: 1.16-2.92, p = 0.004)	
High rates of excessive excretion of stress hormones (i.e. adrenaline, noradrenaline and cortisol)	SWD and MWD	Vangelova et al. (2007): Cortisol (F=7.17, p = 0.009), adrenaline (F=7.87, p =0.007) and noradrenaline (F=10.64, p =0.002). Cortisol excretion higher in urine samples taken at 8.30-11.00 am (F=12.13, p <.001)	
Hypertension	SWD and MWD		Israel et al. (2007): Incidence of hypertension in cases (26.9%) > controls (23.8%) but not statistically significant

OR = Odds ratio, CI = confidence interval, SWD = Shortwave diathermy, MWD = Microwave diathermy, mmol/l = millimoles per litre

2.4.2 Limitations of reviewed studies on adverse health effects and pregnancy outcomes associated with physiotherapists' occupational exposure to RF EMFs

There a number of limitations in these studies referred to in the researcher's comments column in Table 2.7. Most of these studies were case control studies and therefore conducted retrospectively over a period of several years such as eleven years by Taskinen et al. (1990), 20 years by Guberan et al. (1994) and indefinite period covered by others (Ouellet-Hellstrom and Stewart, 1993; Lerman et al., 2001). Thus, the question regarding exposure to RF exposure may be subject to recall bias. Additionally if respondents have had an adverse outcome, it is possible that there will be differential recall bias of exposure between cases and controls, although there is no good evidence for this phenomenon with reproductive outcomes. This is a major limitation of the findings from all case control studies and reinforces the need for prospective studies beginning prior to any outcome of interest.

In Addition, some researchers, such as Larsen (1991), Tuschl et al. (1999) and Lerman et al. (2001) investigated effects of high exposure to RF radiation but gave no specific details of the duration, intensity and mode of such high exposure. Even if such details are available, epidemiological methods (such as case control studies) can only show associations and not causation. Occupational exposure to RF radiation is also only one source of EMF and other sources outside of the physiotherapists' workplace should be included for a valid measure of RF exposure.

Another limitation was the high non-response rate of up to 40% in some studies (Ouellet-Hellstrom and Stewart, 1993); hence, the findings might be undermined by non-response bias. Data in these studies was usually obtained through multiple sources (Taskinen et al., 1990; Larsen et al., 2001) but single sources such as self-reported outcomes were also used for data collection (Cromie et al., 2002), which were not verified from other sources such as the medical records and / or registers of births and abortions. Moreover, study by Vangelova et al. (2007) studied excretion of stress hormones among physiotherapists but gave no details of whether urine samples were taken before, during or after the use of EPAs. It is possible that the high level of cortisol, adrenaline and noradrenaline found in physiotherapists by Vangelova et al. (2007) was due to general stress of work rather than the effect of exposure of RF EMFs.

2.4.3 Summary of the key findings

The findings of these studies on adverse reproductive outcomes are conflicting. For example, Taskinen et al. (1990) reported occurrence of spontaneous abortion associated with the use of SWD as statistically significant; however, several other studies (Larsen et al., 1991; Ouellet-Hellstrom and Stewart, 1993; Lerman et al., 2001; Cromie et al., 2002) did not find any statistically significant association between the use of SWD and spontaneous abortion. Gubern et al. (1994) did not confirm finding of altered gender ratio reported by Larsen et al. (1991). Similarly, Larsen et al. (1991) did not confirm finding of stillbirth reported by Kallen et al., (1992). Other researchers did not replicate finding of some adverse pregnancy outcomes such as spontaneous abortions associated with MWD use (Ouellet-Hellstrom and Stewart, 1993), low birth weight (Lerman et al., 2001) and effect on immune parameters (Tuschl et al., 1999).

Hence, there is a need for further research to establish association between these adverse health effects and pregnancy outcomes that have been associated with the physiotherapists' occupational exposure to RF EMFs from the use of EPAs, in particular SWD and MWD. In addition, the association of above mentioned adverse health effects with occupational exposure to SWD and MWD might have affected physiotherapists' perception about their health and safety at their workplace. Therefore, it seems reasonable to study physiotherapists' perception of health risk associated with their occupational exposure to RF EMFs from diathermy devices. The next section therefore defines risk perception, describes the main theories and predictors of risk perception and presents a review of literature on physiotherapists' risk perception from exposure to EMFs in physiotherapy departments.

2.5 Risk Perception

This section first introduces risk perception and describes the main approaches to risk perception. This is followed by presenting significant predictors of risk perception and the role of risk perception in the context of occupational health and safety. Finally, a review of published research on physiotherapists' perception of health risk associated with occupational exposure to RF EMFs is presented.

2.5.1 Introduction to risk perception

The study of risk perception has been a focus of scientific research that began in the late 1950s (Gregory et al., 1996) and has grown and gained importance particularly amongst governments, regulators or policymakers for addressing health and safety issues and risk management (Cabinet Office, 2002; Sjoberg et al., 2004). Research on risk perception, usually involves the study of how people understand, evaluate, characterise and rate various hazards including activities and technologies (Slovic, 1987). One finding of this work is that the meaning of risk varies between individuals and groups who might have either similar or different attitudes towards, and judgements and perceptions about, risk from the same hazard (Brun, 1994; Slovic, 2000a; Sjoberg et al., 2004). Therefore, effective risk management in both public and private organisations requires an understanding of the individual's perception of risk. In cognitive psychology, the term perception means those mental processes whereby an individual receives and considers information from their surroundings (physical and communicative) via the senses (Jungermann and Slovic, 1993). Therefore, risk perception is based on how the individual's information on the source of a risk has been communicated, the psychological mechanisms for processing uncertainty and any earlier experience of a hazard (Jaeger et al., 2001). This mental process results in perceived risk - a collection of ideas formed on risk sources relative to the information available to the individual and their basic common sense (Jaeger et al., 2001). Perception therefore refers to attitudes and judgements of individuals. For example, according to Kirch (2008, p. 1268), risk perception refers to an individual's subjective judgment about a hazard including its' characteristics and the severity of risk from it. In addition, risk perception involves assessment of the probability of risk and consequences because risk is a combination of the probability of an event (usually adverse) and the nature and severity of consequences of the event (Rayner and Cantor, 1987; Sjoberg et al., 2004). One focus of the present research concerns the physiotherapists' risk perception from their occupational exposure to RF EMFs. The next section, describes the main approaches to the study of risk perception.

2.5.2 Approaches to study risk perception

There are two main approaches to studying the perception of health risk (Rippl, 2002). These approaches are the psychometric approach of risk perception by Fischhoff et al. (1978; Slovic et al., 1982) and the cultural theory of risk perception by Douglas and Wildavsky (1982). There approaches of risk perception are described in the following section.

2.5.2.1 The Psychometric approach of risk perception

The psychometric approach to risk perception, most commonly known as the psychometric paradigm (Slovic, 1992; Siegrist et al., 2005), has its roots in psychology and the decision sciences (Fischhoff et al., 1978; Sjoberg et al., 2004). In this approach, risk perception is subjective in nature (Sjoberg et al., 2004) and is primarily affected by cognitive factors such as the 'dread of risk' factor and the 'unknown risk' factor (Rippl, 2002). These factors, especially the dread factor, explain most of the variance in the risk perception models in studies based on the psychometric approach (Slovic, 1992). In addition, several social, psychological, institutional and cultural factors also affect risk perception under this approach (Sjoberg et al., 2004). In studying risk, the psychometric approach of risk perception looks beyond the experts' view of risk as expressed quantitatively to the more qualitative approach of laypeople (Slovic, 2000c). Risk studies based on the psychometric approach have led to suggestions that while perceptions of experts and laypeople who are non-experts varied widely, laypeople's concepts of risk were valid, reflecting real concerns that were often richer than the so-called 'experts' concepts (Savadori et al., 2004; Slovic et al., 2004). Failure to reflect these views within risk assessments may result in risk management and risk communication that is destined to breakdown (Pidgeon et al., 1992; Slovic, 2000a; McMahan et al., 2002). In studies using the psychometric approach, risk perception is measured on different dimensions by rating of risk factors on Likert type scales (Fischhoff et al., 1978). In the psychometric approach, nine basic psychometric dimensions are described, which included voluntariness of risk, immediacy of effect, knowledge about risk to exposed person(s), knowledge about risk to science, control over risk, newness (new-old), chronic-catastrophic, common/dread, and severity of consequences (fatal-nonfatal) (Fischhoff et al., 1978; Slovic, 1992). However, a number of other dimensions such as trust, locus of control, emotional affect, accountability and blame have been investigated in risk perception studies based on this approach (Slovic, 1999; Lee et al., 2008a).

Moreover, the psychometric approach to risk perception has been reported to be useful in comparing risk perception among different cultures and countries (Sjoberg et al., 2004). However, a review of the psychometric approach based risk perception studies by Boholm (1998) compared cross cultural risk perceptions and concluded that there was a need for further refinements in risk perception studies in terms of the theories and the methods. The psychometric approach is also criticised for failing to provide answers as to why risk perception in social and ethnic groups is different (Flynn et al., 1994; Rohrmann, 1994; Rippl, 2002). In addition, the psychometric approach of risk perception has other weaknesses. For example, a lack of a theoretical foundation for this approach, explanation of a maximum variance up to 20% , use of a mean rating across risk leading to statistical misconceptions, absence of a scientific hypothesis that can be tested and a lack of focus on the kind of risk (e.g. risk to self, risk to others or general risk) (Gardner and Gould, 1989; Sjoberg, 1996, 2002; Ng and Rayner, 2010). In addition, the psychometric approach is criticised for lacking the distinction between different respondents with the exception of laypersons and experts, linking perception of risk with the physical properties of the hazard and separating it from the respondent's construction of risk and lack of explanation as to why risk perception by men and women is different (Marris et al., 1998). Moreover, using a psychometric questionnaire in risk perception is considered to limit the respondents' views to selected few hazards and exclusion of other hazards that might be also important. The quantitative psychometric questionnaires on risk perception also fail to provide information on the complexity involved in risk perception (Borodzicz, 2005). However, the psychometric approach to risk, despite all the above limitations, is widely used because it provides data that can be replicated, with simple and easily understood models, which are realistic and suitable for policy making; hence, it is more powerful hence preferable than the cultural theory of risk perception (Marris et al., 1998), which is described next.

2.5.2.2 The cultural theory of risk perception

The cultural theory of risk perception is rooted in anthropology, social sciences and political sciences (Douglas and Wildavsky, 1982; Sjoberg et al., 2004). In this approach to risk perception, the individuals' perception of risk is a result of social and cultural institutions and the ways of life known as the worldviews (Douglas and Wildavsky, 1982; Marris et al., 1998). In this approach, perception of risk is measured through two dimensions i.e. cultural biases and the worldviews (Douglas and Wildavsky, 1982). The worldviews dimension provides four types of worldviews namely hierarchy, egalitarianism, individualism, and fatalism (Douglas and Wildavsky, 1982; Rayner and Cantor, 1987). Using these four worldviews, risk perception from different hazards is measured at two levels i.e. a grid level and group level, as shown in Figure 2.10 (Douglas and Wildavsky, 1982; Wildavsky and Dake, 1990). In the cultural theory of risk perception, the 'grid' means the level of restrictions imposed on an individual's life by external factors and the 'group' means the integration of an individual in the confined social units, which could be a group, community or an organisation (Thompson et al., 1990). Consequently, the ‘grid’ shows an individual’s behaviour and the ‘group’ indicates an individual’s identity; the ‘grid’ also reveals the individual’s power while the ‘group’ shows one’s status (Marris et al., 1998; Caulkins, 1999). In other words, the ‘grid-group’ represents a power-status model in which the grid denotes internal differences based on hierarchy within a culture and the group represents exclusion and inclusion including social acceptance as a result of membership (Kemper and Collins, 1990).

Based on the grid and group dimensions (Figure 2.10), individuals with high group and high grid are considered as ‘hierarchalists’, those with high group and low grid are called as ‘egalitarians’, people with high grid and low group are branded as ‘fatalists’ and persons in the low grid and low group are identified as ‘individualists’ (Marris et al., 1998).

In terms of risk perception, the ‘hierarchalists’ are people who make or like decisions from the top (Caulkins, 1999) and they prefer the minimum risk and greatest safety for the majority and they may ignore risk to the minority (Yim and Vaganov, 2003). The ‘egalitarians’ would include people with moral purity (Caulkins, 1999) and they safe guard safety interests of others and believe in participation of the minority in the risk management process (Yim and Vaganov, 2003). The ‘fatalists’, according to Caulkins (1999) are people who are risk averse and they are less optimistic about risks from social structures (Yim and Vaganov, 2003). The ‘individualists’ include individualistic and entrepreneurial persons for whom risk is an opportunity (Caulkins, 1999) and they care more about their own benefits which determine their attitudes towards risks (Yim and Vaganov, 2003). Therefore, these four types of individuals might have different levels of perception of risk from same hazards. For examples, according to Yim and

Vaganov (2003), hierarchalists have low perception of risk compared to fatalists who have high perception of risk from nuclear energy and public transportation.

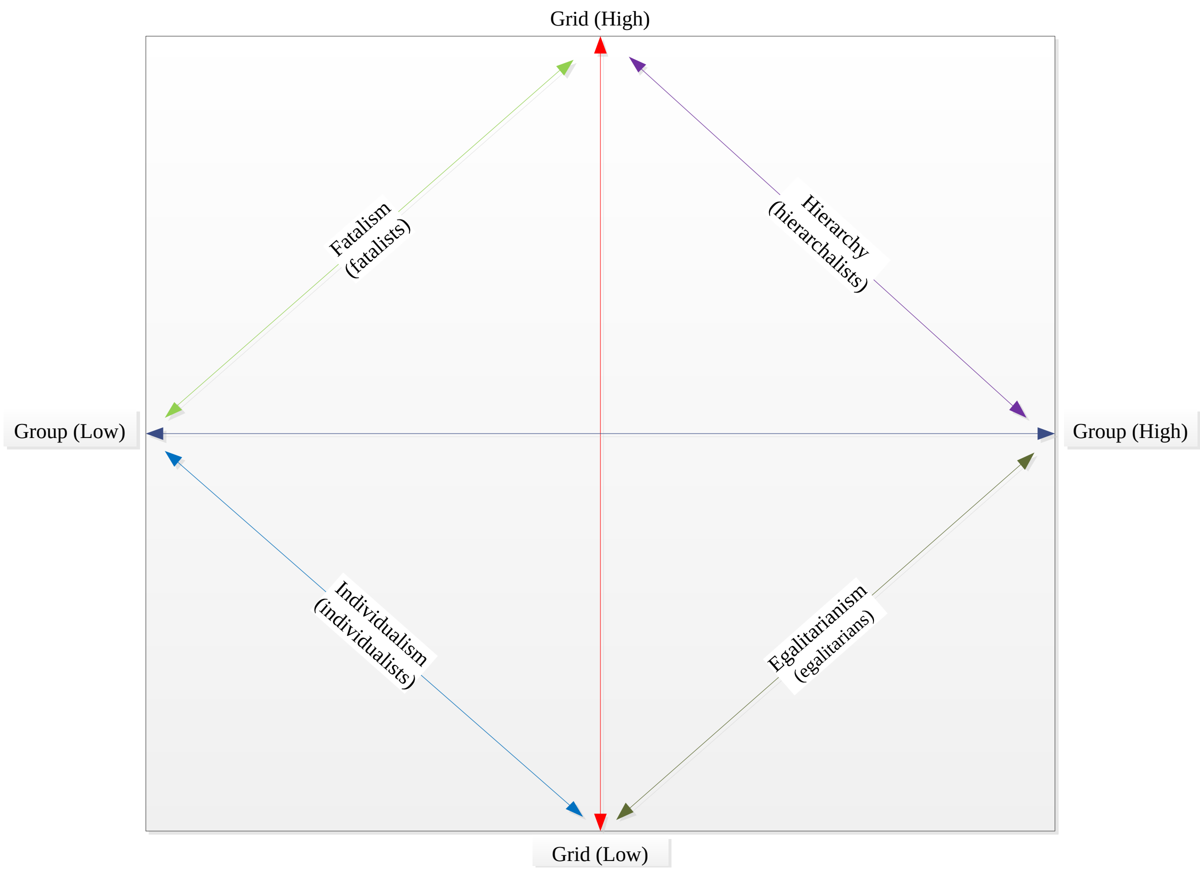

Figure 2.10 Grid/Group Dimensions of Worldviews in the Cultural Theory of Risk Perception

Source: Created by the researcher based on information taken from Marris et al. (Marris et al., 1998) and Caulkins (Caulkins, 1999)

Thus, considering the cultural biases and worldviews, the cultural theory of risk perception provides better understanding of risk perception which under this approach takes account of individuals' perceptions and preferences of risks based on a number of social, political, cultural, economic and political factors (Dake, 1992). As such, risk perceptions obtained through the cultural biases and worldviews approach are much more robust than risk perceptions obtained only through personality and knowledge measures (Wildavsky and Dake, 1990). In addition, grid/group dimensions provide opportunities to study comparative risk perceptions not only in smaller cultures but within larger societies (Kemper and Collins, 1990). In cultural theory of risk perception, perception of risks from hazards is rated using Likert type scales (Brenot et al., 1998). The perception of risk under this theory is determined by social, cultural and political variables (Douglas and Wildavsky, 1982; Sjoberg et al., 2004 1006), demographic variables, as well as the individuals' knowledge and personality (Wildavsky and Dake, 1990). Thus, this approach provides better predictions of perception of risk with respect to a wide variety of risk factors (Wildavsky and Dake, 1990).

However, like the psychometric approach to risk perception, the cultural theory of risk perception has a number of some limitations. The most important limitation of the cultural theory of risk is the very modest level of explanation of variance, which is between 5% (Sjoberg et al., 2004 1006) and 6% (Brenot et al., 1998). The other limitation of this approach to risk perception is the applicability to the types of risks. For example, the cultural theory of risk perception is considered to be better in explaining public responses for policies concerning social and economic issues rather than risk (Brenot et al., 1998). This approach is also criticised with respect to a number of theoretical issues. For example, the 'stability' concept under which the individuals are considered to affiliate to / remain in the same cultural / social institution(s) and the 'mobility' concept which suggests that individuals might move between cultural / social intuitions and adopt the cultural biases / worldviews of the host institution(s); thus, there is confusion as to whether the focus of analysis is individuals or institutions (Marris et al., 1998). Another problem with this approach is the use of the survey questionnaire; the supporters of the stability concept suggest the use of qualitative methods for eliciting cultural biases while the followers of the mobility concept favour the use of quantitative survey methods (Marris et al., 1998). Moreover, this approach is criticised for lacking a theoretical backing for linking cultural biases and grid-group dimensions as well as difficulty in the quantitative analysis of the latter dimension (Marris et al., 1998). Yet another limitation of this theory is the lack of explanation of why individuals embrace a specific cultural viewpoint as well as a lack of justification for putting cultural views /biases that are diverse on two orthogonal dimensions (Breakwell, 2007, p. 74-75). According to Boholm (1996), cultural theory has a number of weaknesses such as a poor defining of the association between social relationships and cultural biases, susceptibility of grid/group dimensions' to differing explanations and no place for the change in the model. The last but not least of the criticisms of the cultural theory of risk perception is the lack of robust quantitative evidence that risk perception is strongly predicted by cultural views (Sjoberg, 1997).

Given the advantages of the psychometric approach such as the quantitative nature, ease of use and data analyses as well as opportunities for modelling, the researcher applied the psychometric approach to study physiotherapists' perception of health risk within the occupational health and safety context, reported in this thesis. In modelling risk perception, the predictors of risk perception play an important role. It is therefore important to describe the predictors of risk perception in the following section.

2.5.3 Predictors of risk perception

Risk, according to Stilgoe (2007), cannot be compartmentalised as either social or scientific because it is the creation of both nature and society. Perception of risk therefore is complex (Mehrotra et al., 2009) and multidimensional (Bickerstaff, 2004), which is an important consideration from the risk management perspective (Johnson, 2004). Perception of risk is the result of an individuals' cognitive feelings about a hazard as postulated in the psychometric paradigm of risk perception (Fischhoff et al., 1978; Sjoberg et al., 2004 1006) and the outcome of an individuals' perceptions regarding a hazard on the basis of his/her cultural biases and worldviews as suggested in the cultural theory of risk perception (Douglas and Wildavsky, 1982; Marris et al., 1998). Given the multidimensionality of risk perception, numerous diverse factors influence individuals' perception of risk. For example, socio-political factors like trust, power, status and alienation (Flynn et al., 1994), social, political and economic principles and values (Modan, 1997), technical, psychological and social attributes of hazards (Yim and Vaganov, 2003) as well as complex social, political, psychological, societal, and cultural factors and processes (Bickerstaff, 2004; Siegrist et al., 2005). In addition, risk perception is predicted by an individual's attitude (affect, risk sensitivity and specific fear (2000a, c) as well as by an individual's experience, interests and concerns, ability, wealth, motivation, values, worldviews, emotions, moods, attitude toward the risk source, and a range of psychological factors (Yim and Vaganov, 2003). Thus, risk perception is a mixture of fear, values and facts (Cross, 1998).

Taking into account the diversity and multiplicity of factors affecting risk perception described in the preceding paragraph, predictors of risk perception can be broadly divided into different categories such as cognitive, social, cultural, political, economic and demographic variables. The researcher therefore prepared a list of predictors of perception of risk associated with different types of risks

(Table 2.9), which are relevant to the research questions addressed in the study by the researcher.

It is important to note that the above-mentioned factors that influence perception of risk vary in their explanatory power in predicting risk perception. For example, psychological predictors such as attitude (affect), risk sensitivity and specific fear (dread) have been reported to explain most of the variance in perception of health risk (Sjoberg, 2000a). On the other hand, the cultural biases and worldviews are reported to explain <10% of the variance in risk perception (Brenot et al., 1998; Sjoberg et al., 2004 1006). In addition, socio-demographic variables' contribution in explaining the variance in risk perception is dependent upon the type of hazard / risk (Kahan et al., 2007; Lee and Lemyre, 2009; Mehrotra et al., 2009). Studies on perception of risk from specific hazards such as nuclear waste conducted in specific countries such as Sweden have shown explanation of up to 65% of the variance by combination of variables such as attitudes, trust and general sensitivity to risk (Sjoberg, 1996). However, the overall level of variance explained up to 20% through the psychometric approach and between 5% and 10% via the cultural theory of risk perception (Ng and Rayner, 2010). This suggests that attitudinal variables along with socio-demographic variables may provide better chances to extract the maximum variance in risk perception modelling. In the present study, the researcher tested attitudes and socio-demographic variables as predictors of physiotherapists' perception of risk. Therefore, besides information on the contributions of risk perception, it is also important to know how these attitudinal variables relate to demographic predictors of risk perception.

Gender is an important predictor of risk perception and several studies (Table 2.9) have reported that perception of risk by females / women is generally higher compared to males / men. Age is another demographic factor that is a significant predictor of risk perception mentioned in a number of studies (Table 2.9), which have reported that age and risk perception are positively related which means as age increases the perception of risk also increases, which suggests that perception of risk among young people is lower than older people. However, a few studies have reported that younger age is positively associated with increased perception of risk from lifestyle risks such as smoking and smoking related diseases e.g. heart diseases and cancer (Oncken et al., 2005; Krewski et al., 2006).

Table 2.9 Predictors of health risk perception and types of hazards

Predictor	*Risk in general*	*Nuclear and ionising radiation risks*	*Non-ionising radiation / EMF risks*	*Chemical risks*	*Biological risks*	*Social / lifestyle / behavioural risks*	*Environmental risks*
Gender	(Sjoberg, 2000c; Chauvin et al., 2007)	(Cutter and Tiefenbacher, 1992; Davidson and Freudenburg, 1996)	(Frick et al., 2002; Blettner et al., 2009; Krewski et al., 2009) (Lemyre et al., 2006)	(Cutter and Tiefenbacher, 1992; Hampson et al., 2000; Wester-Herber and Warg, 2002)	(Mehrotra et al., 2009)	(Greenberg and Schneider, 1995; Hampson et al., 2000; Lemyre et al., 2006; Kolbe-Alexander et al., 2008)(Iacobelli et al., 2008)(Oncken et al., 2005; Krewski et al., 2006; Lee et al., 2008b; Ulla Diez and Perez-Fortis, 2009; Wang et al., 2009; Allman-Farinelli et al., 2010)	(Greenberg and Schneider, 1995; Davidson and Freudenburg, 1996; Larose and Ponton, 2000; Wester-Herber and Warg, 2002; Siegrist et al., 2005; Krewski et al., 2009)
Age	(Jaggia and Thosar, 2000; Chauvin et al., 2007)		(Krewski et al., 2009)	(Chassin et al., 2001)		(Chassin et al., 2001)(Iacobelli et al., 2008)(Oncken et al., 2005; Krewski et al.,	(Brody et al., 2004; Krewski et al., 2009)

Predictor	*Risk in general*	*Nuclear and ionising radiation risks*	*Non-ionising radiation / EMF risks*	*Chemical risks*	*Biological risks*	*Social / lifestyle / behavioural risks*	*Environmental risks*
						2006; Lee et al., 2008b)	
Race / ethnic origin	(Slimak and Dietz, 2006; Gandhi et al., 2008)	(Whitfield et al., 2009)	(Levallois et al., 2002)		(Mehrotra et al., 2009)	(Oncken et al., 2005)	(Flynn et al., 1994; Brody et al., 2004)
Education	(Slimak and Dietz, 2006; Chauvin et al., 2007)		(Lemyre et al., 2006; Blettner et al., 2009; Krewski et al., 2009)			(Oncken et al., 2005; Krewski et al., 2006; Lemyre et al., 2006)	(Larose and Ponton, 2000; Brody et al., 2004; Lemyre et al., 2006; Krewski et al., 2009)
Experience							
Knowledge	(Al Shafaee et al., 2008; Vandermoere, 2008)	(Mihai et al., 2005)		(Wester-Herber and Warg, 2002; Hay et al., 2005)		(Hay et al., 2005)	(Wester-Herber and Warg, 2002; Schoell, 2009)
Awareness	(Behrens and Brackbill, 1993)					(Slovic, 2001; Szklo and Coutinho, 2009)	(Brody et al., 2004)

Predictor	*Risk in general*	*Nuclear and ionising radiation risks*	*Non-ionising radiation / EMF risks*	*Chemical risks*	*Biological risks*	*Social / lifestyle / behavioural risks*	*Environmental risks*
Geographical location	(Orton et al., 2001; Viklund, 2003; Krewski et al., 2006)			(Poortinga et al., 2008)			(Larose and Ponton, 2000)
Wealth / income			(Levallois et al., 2002; Lemyre et al., 2006)			(Lemyre et al., 2006; Lee et al., 2008b; Ulla Diez and Perez-Fortis, 2009)	(Brody et al., 2004; Lemyre et al., 2006) (Slimak and Dietz, 2006)
Cognitive factors							
Attitude / affect	(Sjoberg, 2000a, c)						
Risk sensitivity	Sjoberg, 2000a)(Sjoberg, 2000c)						
Somatisation tendency			(Frick et al., 2002; Levallois et al., 2002)				
Personality						(Pedersen and McCarthy, 2008)	

Predictor	*Risk in general*	*Nuclear and ionising radiation risks*	*Non-ionising radiation / EMF risks*	*Chemical risks*	*Biological risks*	*Social / lifestyle / behavioural risks*	*Environmental risks*
Dread	(Sjoberg, 2000a)(Sjoberg, 2000c)	(Sjoberg and Drottz-Sjoberg, 2009)					
Anxiety	(Kaellmen, 2000)					(Zhao and Cai, 2009)	
Personal factors							
Value placed on personal health						(Chassin et al., 2001)	
Familiarity	(Roth et al., 1990)						
Personal vs. general risk	(Kaellmen, 2000)					(Slovic, 2001; Vanlaar et al., 2008; Szklo and Coutinho, 2009; Zhao and Cai, 2009)	
Self-efficacy	(Kaellmen, 2000)					(Zhao and Cai, 2009)	
Expert vs lay people (non-experts)	(Renn, 2004; Savadori et al., 2004)	(Mihai et al., 2005; Purvis-Roberts et al., 2007)		(MacGregor et al., 1999)			(Slimak and Dietz, 2006)
Locus of control	(Krewski et al., 1995; Kaellmen,			(Lee et al., 2008a)	(Lee et al., 2008a)	(Lee et al., 2008a)	

Predictor	*Risk in general*	*Nuclear and ionising radiation risks*	*Non-ionising radiation / EMF risks*	*Chemical risks*	*Biological risks*	*Social / lifestyle / behavioural risks*	*Environmental risks*
	2000)						
Trust	(Viklund, 2003)	(Viklund, 2003; Whitfield et al., 2009)		(Poortinga et al., 2008)			(Schoell, 2009)
Media	(Wahlberg and Sjoeberg, 2000; Agha, 2003; Nichol et al., 2008)						(Brody et al., 2004)
Method of risk communication			(MacGregor et al., 1994)				
Scientific evidence			(MacGregor et al., 1994)				
Culture / tradition / social context						(Pedersen and McCarthy, 2008)	(Schoell, 2009)
Religious beliefs							(Slimak and Dietz, 2006)
Occupational factors							
Managers vs. employees	(Dickson et al., 2004)						

Predictor	*Risk in general*	*Nuclear and ionising radiation risks*	*Non-ionising radiation / EMF risks*	*Chemical risks*	*Biological risks*	*Social / lifestyle / behavioural risks*	*Environmental risks*
Occupational health and safety protocols	(Leiter, 2005; van Gemert-Pijnen et al., 2006)						
Workplace safety climate and training	(Leiter and Robichaud, 1997; Rundmo, 2000; Arezes and Miguel, 2005; Leiter et al., 2009)		(Richter et al., 2000)				
Employees' attitudes towards safety and accident prevention	(Rundmo, 2000)						

Race and ethnic origin are reported as significant predictors of risk perception in most of the studies (reported in Table 2.9); however, these variables were not found to be significant predictors in perception of risk in a study on ecological risks such as the climate change (Slimak and Dietz, 2006). Level of education is reported to be negatively correlated with perception of risk in many studies (Table 2.9), which suggests that people with lower education levels have higher perception of risk and vice versa.

In addition, it is a well-accepted view in the risk perception research that experts perceive a lower risk level compared to lay people / non-experts (Savadori et al., 2004; Mihai et al., 2005; Purvis-Roberts et al., 2007). Income is another socio-demographic factor that is negatively correlated with perception of risk, which suggests that people with low income have higher perception of risk than people with higher income level, as reported in a number of studies (Table 2.9).

Moreover, research has shown that individuals perceive higher risk from general risks compared to personal risks (Kaellmen, 2000). In addition to the above-mentioned predictors, the media is another important factor that influences perception of risk particularly about general risks such as environmental risks (Brody et al., 2004) while perception of risk from personal risks is little influenced (Wahlberg and Sjoeberg, 2000). For some personal risks, however, a study (Agha, 2003) has shown that mass media messages significantly increase the perception of personal risks such as for HIV/AIDS risk. In addition, there is little consensus about how the media influences risk perception. According to Mazur and Lee (Mazur and Lee, 1993), it is the frequency of coverage rather than the content of media messages that influences perception of risk. While others argue that it is the content, particularly the coverage of physical consequences in media messages, that determines the perception of risk (Renn et al., 1992; Freudenburg et al., 1996). Trust is another factor that affects perception of risk albeit with a weak explanatory power (Viklund, 2003). For example, trust in risk governance organisations and regulators affects / reduces perception of risk from hazards that are beyond an individual's control such as nuclear risks (Viklund, 2003; Whitfield et al., 2009) and indoor radon gas (Poortinga et al., 2008) while trust in the media can also influence perception of risk from hazards such as environmental risks (Schoell, 2009). Occupational factors such as occupational health and safety protocols (Leiter, 2005; van Gemert-Pijnen et al., 2006), workplace safety climate and training (Leiter and Robichaud, 1997; Arezes and Miguel, 2005; Leiter et al., 2009) and attitudes towards safety and accident prevention affect workers' perception of occupational risks (Rundmo, 2000). It is therefore important to describe the role of risk perception in the occupational health and safety management, which is given in the following section.

2.5.4 Role of risk perception in occupational health and safety management

This section briefly describes the role and importance of the study of risk perception in the management of health and safety in occupational environments. Under the current regime of occupational health and safety legislation in the UK (HMSO, 1974, 1992, 1999), protection of health and safety of employees is primarily the employers' responsibility but employees are also responsible to some degree (Aw et al., 2007, p. 3). The main aim of occupational health and safety management is the identification, reduction and ultimately elimination of hazard(s) in the workplace. Occupational hazards can be physical, chemical, biological and psychosocial and exposure to these hazards varies between workplaces depending on the nature of organisations and their processes (Aw et al., 2007, p. 8). For example, in hospitals the most common occupational hazards encountered by staff include exposure to biological agents such as microorganisms; chemicals such as sterilisers, detergents, vaccines, anaesthetic gases; physical agents such as radiation, both ionising and non-ionising and psychosocial hazards such as work related stress (Aw et al., 2007, p. 11, 193). Therefore, the workers, including healthcare workers, need to be protected from excessive exposure to occupational hazards from the occupational health and safety management perspective. This requires a set of linked interventions: the identification of hazards, appraisal and assessment of risks, introduction of management interventions and control procedures, and auditing and reviewing of both the effectiveness of the protective measures and the risk control procedures (Aw et al., 2007, p. 8; Renn, 2008, p. 174-184). Risk assessment comprises risk estimation and risk evaluation (King, 1998). In occupational risk management, experts in occupational health and safety conduct risk estimation by measuring exposures to risks and comparing with the scientifically established standards (Tranter, 2004). This technical scientific estimation of risk by experts could be supplemented with risk evaluation by studying the risk perception that provides social scientific estimation of risk by individual workers in the risk assessment process (King, 1998; Spurgeon, 1999). Hence, study of workers risk perception becomes an important because it can provide data on workers concerns that can be useful for informing risk management policies and processes (Renn, 1992). This suggests that determination of risk perception in an occupational environment, according to Ocek et al. (2008), should precede development of occupational risk minimisation procedures and application of risk management approaches because risk perception by workers, who are generally not experts in risk, could provide data on concerns of workers, who are important stakeholders of risk management in an organisation. This could feed, along with the experts' risk assessment, into the risk appraisal process that is an important part of the risk management process (Renn, 2008, p. 67,72-73). This information would help risk managers to make more informed risk management policies that take account of both the expert views and the workers, the latter being directly affected in the case of any adverse event due to exposure to a hazard (Renn, 2008, p. 67).

In addition, study and knowledge of workers' perceptions about risks and health consequences from occupational exposure to potential risk factors are also important because workers can either underestimate or overestimate risks at their workplace (Behrens and Brackbill, 1993; Health and Safety Executive, 2000) and the level of perceived occupational risks can affect workers' safety behaviour in the workplace (Rundmo, 1996; Arezes and Miguel, 2005). There is evidence that perception of risk in the workplace is associated with occupational accidents such that workers who perceive low risk in a workplace become involved in accidents due to over estimation of workplace safety while those who perceive high risks also become involved in work related accidents due to stress as a result of not being safe (Clarke and Cooper, 2004). For example, an occupational risk perception study of health workers' (i.e. physicians, nurses, laboratory technicians and cleaners) by van Gemert-Pijnen et al. (2006) found that healthcare workers overestimated their knowledge and skills about risks in their occupational environment and their compliance to occupational health and safety protocols was influenced by their perception of risk. Study of risk perception by workers therefore becomes an important component in assessing the level of risk perception from the workers' occupational health and safety perspective. In addition, study of workers' risk perception is significant because there is evidence that there are differences between the managers and the workers in their perception of level of risk. For example, perception of low risk by senior managers at the directorate level in NHS trusts compared to high risk perception by nurses working in accident and emergency (A&E) departments in the National Health Service (Dickson et al., 2004).

The National Health Service (NHS), the biggest employer in Europe, predominantly uses the quantitative model of risk assessment. The standard model is used in most NHS trusts to assess risks including health and safety and clinical risks (Joint Standards Australia/Standards New Zealand Committee, 1999). This model, based on probabilities and consequences, may have weaknesses when used by risk non-experts because they can recognise statistical probabilities i.e. the likelihood of something happening, and may interpret these in similar ways to experts but they are less likely to agree on consequences, where other factors such as cognition, culture and society are also acting (Slovic et al., 2004). DuPont (1980) and Weiner (1993) cited by Slovic (2000b) argue that non-experts with respect to risk should not be involved in the risk assessment process; however, it is a legal requirement under health and safety law (Health and Safety Executive, 2002a) to consult and involve employees in the risk assessment process. Employees' participation and consultation in risk assessment programs is perhaps recommended to integrate their concerns measured through their risk perception which can be used along with risk assessment by experts in the risk appraisal process required for risk management (Renn, 2008, p. 67,72-73) and to improve an organisation's 'safety culture' and reduce accidents (Fleming and Larder, 1999;

Health and Safety Laboratory, 2002; O'Dea and Flin, 2003). The following section presents a literature review on physiotherapists' perception of risk from exposure to radiofrequency electromagnetic fields in their occupational environment.

2.5.5 Review of Literature on Physiotherapists' Perception of Risk from EMFs in Physiotherapy Departments

This section presents a review of published research on physiotherapists' perception of health risk from exposure to radiofrequency electromagnetic fields in physiotherapy departments. The literature was searches using the literature review process described in the section 2.1. Figure 2.11 presents a flow chart of excluded and included studies, which shows that from 155 potential articles identified through literature searches only one article was found relevant. The shortlisted article was fully reviewed and data was abstracted on a number of variables i.e. the publication year and location of the study, the study design, the aims / objectives of the study, method of data collection, participants and sample size, and the key findings, which along with the researcher's (reviewer's) comments are shown in Table 2.10. The following section presents the findings of this literature review.

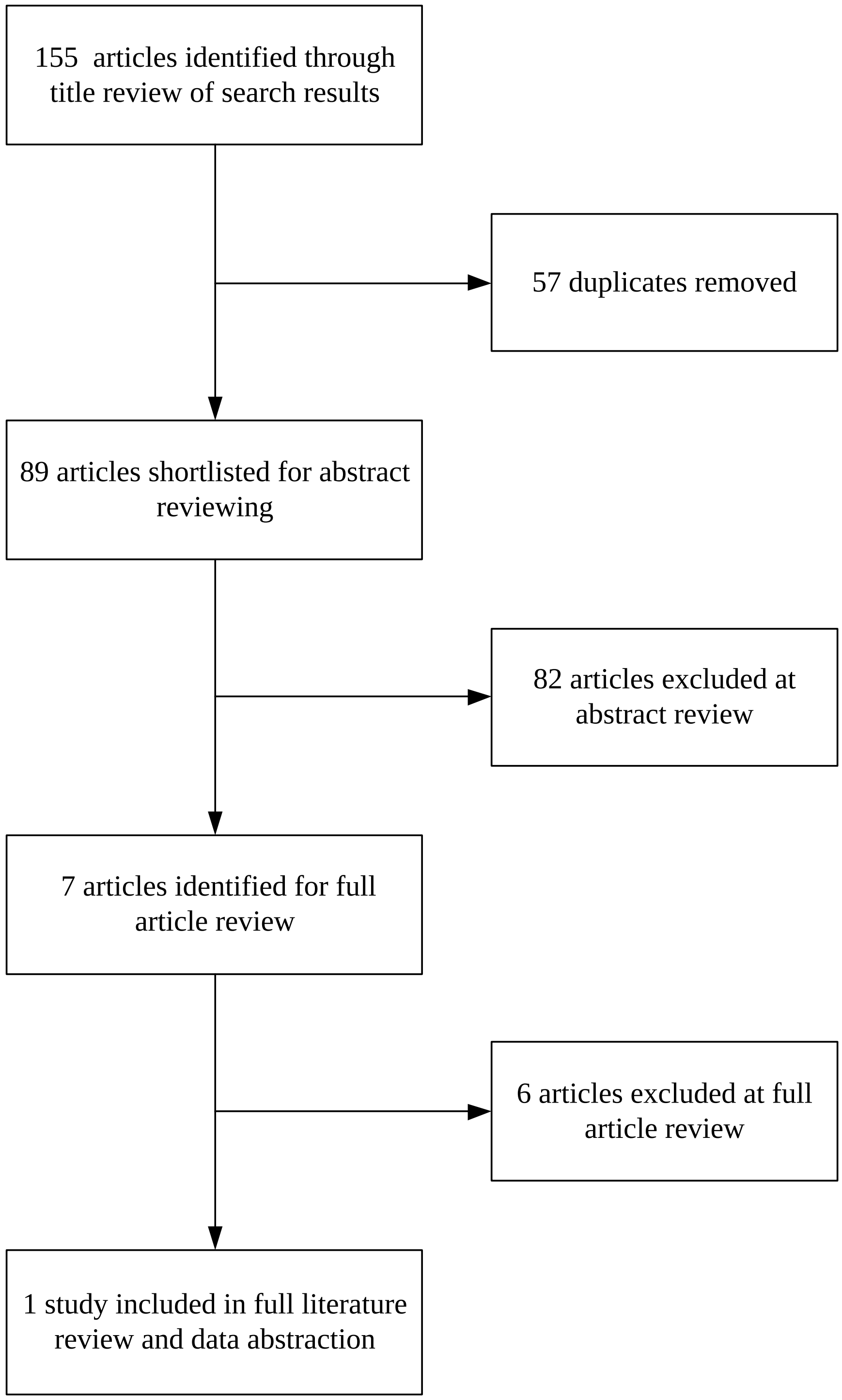

Figure 2.11 Flow chart of studies included and excluded

Table 2.10 Studies on physiotherapists' perception of risk from occupational exposure to radiofrequency electromagnetic fields

Reference	*Year*	*Country*	*Type of study*	*Aims and objectives*	*Methodology*	*Subjects*	*Sample size*	*Findings*	*Researcher comments*
(Shields et al.)	2005	Republic of Ireland	Cross sectional survey	Physiotherapists' perception of risk from exposure to radiofrequency radiation at workplace	Postal questionnaire survey	Physiotherapists	N=225	Response rate = 90% (n=203). Physiotherapists perceived low health risk (mean rating = 2.49±0.6) and low health consequences (mean rating = 2.2±0.7) from EMFs in physiotherapy departments. Protection from EMF risk in physiotherapy departments was reported as highly possible (mean rating = 3.5±1.1).	Moderate sample size. Only mean values of risk ratings reported No predictors and model(s) of physiotherapists' risk perception reported. Risk ratings divided by gender of physiotherapists not reported.

2.5.5.1 Findings of literature review of physiotherapists' perception of risk

Searching a number of databases as mentioned above, only one study relevant to physiotherapists' perception of risk from occupational exposure to radiofrequency electromagnetic fields at the physiotherapists' workplace was found, which is presented in (Table 2.10). This study was conducted in the Republic of Ireland and involved 225 physiotherapists working in hospital based physiotherapy departments. The response rate in this study was very good (90%) and the sample size was moderate (N=225) (Table 2.10).

Results of this study revealed that physiotherapists' perceived low risk from RF EMF emissions in physiotherapy departments and the respondents reported that they were able to protect themselves from RF EMF risk at their workplace. The respondents also reported low health consequences from their occupational exposure to RF EMFs (Table 2.10).

This study however did not report on any models or predictors of physiotherapists' risk perception from occupational exposure to RF EMFs. In addition, identification of only one study on physiotherapists' perception of risk from their occupational exposure to RF EMFs suggests that there is dearth of literature on this topic; hence, there is need for more research this issue.

In the light of this, the researcher developed following research questions.

Q. What are levels and predictors of NHS physiotherapists' perception of risk, health consequences and protection from exposure to RF EMFs in NHS physiotherapy departments?

2.6 Summary of Literature Review and Identification of Research Gaps

This chapter presented a review of research literature on four subject areas, summarised below, related to physiotherapists' exposure to radiofrequency electromagnetic fields in their occupational environment. The parameters of the literature review included primary research studies published in English language between January 1990 and June 2010. Literature was searched through a number of online bibliographic databases and the databases that were searched for all four subject areas were Medline/OvidSP, PubMed Central, CINAHL/ EBSCOhost, ScienceDirect, Scopus, and ISI Web of Knowledge. A set of keywords was used for searching the literature on each of the four topics. Keywords that were common for literature searches on all four topics were electrophysical agents, electrotherapeutic devices, electrotherapy, microwave diathermy, physiotherapy, physical therapy, physiotherapist, physical therapist, shortwave diathermy, and therapeutic diathermy.

The first subject area of the literature review was the availability, use, non-use and non-availability of equipment of nine electrotherapy modalities i.e. ultrasound, PSWD, CSWD, laser, interferential, TENS, biofeedback, MWD and H-wave in physiotherapy departments /clinics. For this topic, 22 studies were shortlisted for a full review. The findings of the literature review on this topic revealed that there were variations in the availability and use across the above mentioned electrotherapy modalities, which varied between physiotherapy departments / clinics in public and private sectors, between different countries and between the years of study i.e. from 1990 to 2010. Overall trends in the use and availability showed that ultrasound was the most common modality available and most commonly used modality, which was followed by interferential, TENS and biofeedback modalities, across the countries. The availability and use of PSWD was variable between countries, for example, this modality was commonly available and used in the UK and the Republic of Ireland compared to Australia Generally, the availability and use of CSWD and laser was less common. Overall, the least available and used modalities were MWD and H-wave. The non-availability and non-use despite equipment availability was highest for H-wave and MWD. However, none of the 22 reviewed studies reported complete cessation of use or non-availability of any of the above-mentioned nine electrotherapy modalities in any country. In addition, it was found that a study published in 1995 by Pope et al. (1995) was the last study in the past twenty years that reported the availability, use and non-use despite equipment availability of these nine electrotherapy modalities in physiotherapy departments in England. However, a few studies conducted afterwards reported either the availability and / or use of only a few electrotherapy modalities or their primary aim was to study use of specific electrotherapy modalities with respect to specific medical conditions. For example, treatment of soft tissue lesions with US, SWD and laser (Kitchen and Partridge, 1996; Kitchen and Partridge, 1997), audit of use of PSWD (Al-Mandeel and Watson, 2006), pain management with interferential (Tabasam and Johnson, 2006) and with TENS (Scudds et al., 2009) .

Therefore, this study was required for two reasons: to update the body of knowledge on electrotherapy equipment availability, use and non-use in a sample of the NHS physiotherapy departments in England and to ascertain frequency of use of EPAs by NHS physiotherapists. In this way, the frequency of exposure to EMFs during the use of electrotherapy equipment by physiotherapists can be determined. The researcher therefore developed the following research questions with respect to the research reported in this thesis.

> Q1. What is the current level of availability and frequency of use of nine different types of electrophysical agents in NHS physiotherapy departments?

The second subject area of the literature review was measurements of RF EMFs from PSWD, CSWD and MWD devices in physiotherapy departments. On this topic, twelve studies were shortlisted for data extraction on the intensities of RF EMFs. The findings of the review revealed that EMFs were measured at distances from the console of diathermy devices, cables and electrodes to the user between 0.3 m and 3 m. It is reiterated that physiotherapists' professional guidelines have suggested that 1 m distance from the device console is a safe distance for physiotherapists operating the diathermy devices (Chartered Society of Physiotherapy, 1997d; Baxter et al., 2006; Bazin et al., 2008). EMFs intensities at 1 m distance from device console were reported for PSWD, CSWD and MWD. At 1 m distance measured E fields were between 4 V/m and 107 V/m and H fields between 0.01 and 0.11 A/m from PSWD devices. At 1 m distance, EMF measurements revealed E-field strengths between 19 V/m and 380 V/m and H fields between 0.03 A/m and 0.36 A/m for CSWD and E fields up to 32.8 V/m and H fields equal to 0.08 A/m for MWD. Measurements of EMFs at 1.5 m and 2 m from diathermy console were reported only for CSWD. EMFs measured at 1.5 m from CSWD equipment revealed intensities of E fields between 6.8 V/m and 83 V/m, H fields between 0.02 A/m and 0.34 A/m. At 2 m distance from CSWD, measured E field strengths were between 4.8 V/m and 39.8 V/m, H fields between 0.02 A/m and 0.07 A/m and power density between <0.1 mW/cm^2 and 4 mW/cm^2. The above mentioned measured EMF strengths at 1 m distance from PSWD, CSWD and MWD diathermy devices reported in a number of reviewed studies (Martin et al., 1990b; Martin et al., 1991; Tzima and Martin, 1994; Lerman et al., 1996; Li and Feng, 1999; Tuschl et al., 1999; Grandolfo and Spinelli, 2002; Hrnjak and Zivkoviae, 2002; Shields et al., 2004b; Macca et al., 2008) were higher than permissible limits for occupational exposure, which are reported in Table 1.3. In addition, EMFs measured at 1.5 m and 2 m distances from CSWD devices were also found higher than occupational exposure guideline limits in a few studies (Grandolfo and Spinelli, 2002; Hrnjak and Zivkoviae, 2002; Shields et al., 2004b). These findings suggested that physiotherapists could possibly to be exposed to RF EMF intensities higher than the permissible limits during the use of diathermy devices. Hence, study of physiotherapists' practices and procedure to protect themselves from possible exposure to RF EMFs from diathermy devices becomes important. In addition, the study of the physical features of rooms / cubicles used for electrotherapy with SWD diathermy can be important with respect to exposure. The researcher therefore developed the following two questions to be addressed in this research.

> Q2. What are physiotherapists' practices and procedures in the safe use of electrophysical agents, particularly shortwave and microwave diathermies?
>
> Q3. What are physical features in the physiotherapy workplace particularly in treatment rooms / cubicles used for treatment with

therapeutic diathermy modalities that may have potential to impact on health and safety of physiotherapists?

The third subject area included in this literature review was a review of the studies on adverse health and pregnancy outcomes associated with physiotherapists' occupational exposure to RF EMFs. In total, eleven studies on this topic were shortlisted for full review. The findings of the data abstracted from some of these 11 studies provided evidence that physiotherapists' occupational exposure to RF EMFs from SWD diathermy was statistically significantly associated with a number of adverse reproductive outcomes. These included congenital malformations (OR 2.4, 95% CI 1.2-6.1), delayed time (> 6 months) to pregnancy (OR 2.5, $p < 0.05$), altered gender ratio i.e. low ratio of boys to girls (OR 4.9, 95% CI 1.6-17.9), low birth weight (<2500 g) (OR 2.75, 95% CI 1.07-7.04) and still birth (OR statistics not reported). There was a statistically significant association between exposure to MWD and spontaneous abortion (OR 1.28, 95% CI: 1.02-1.59). In addition, exposure to SWD and MWD was statistically significant associated with increased levels of total cholesterol level (>5.2 mmol/l) (OR 1.57, 95% CI 1.05-2.35) and low density lipoproteins (>3.4 mmol/l) (OR 1.84, 95% CI 1.16-2.92) in blood samples and adrenaline, noradrenaline and cortisol excretion in high rates in urine samples of physiotherapist. However, a number of studies included in this review did not find any statistically significant associations between adverse pregnancy outcomes and exposure to SWD and MWD. In addition, no study investigated adverse reproductive outcomes associated with male physiotherapists' exposure to SWD and MWD devices. These findings suggested a need for further research.

The last subject area included in this literature review was a review of studies on physiotherapists' perception of risk from exposure to RF EMFs in their occupational environment. Systematic searches of published literature from 1990 to 2010 identified 155 articles but only one study (Shields et al., 2005), that was relevant to this topic was shortlisted. A review of this study revealed that it was conducted with a sample size of 225 physiotherapists in the Republic of Ireland in 2005. The response rate was good (90%) but only descriptive statistics were used for analysing physiotherapists' ratings of perception of risk from exposure to EMFs in physiotherapy departments and a number of other hazards. The study concluded that physiotherapists' perceived low health risk (mean = 2.49±0.6), low health consequences (mean = 2.2±0.7) and that protection was highly possible (mean = 3.5±1.1) from exposure to EMFs in physiotherapy departments. The reviewed study however had a few limitations such as moderate sample size, no report of multivariate statistical analyses and predictors of physiotherapists' risk perception as well as no analysis of risk rating by gender, which is an important determinant of risk perception. The above-mentioned limitations suggest a need for a study that could address the following question.

> Q4. What are levels and predictors of NHS physiotherapists' perception of risk, health consequences and protection from exposure to RF EMFs in NHS physiotherapy departments?

To answer the above mentioned four questions (i.e. Q1-Q4), the researcher conducted a research study that is reported in this thesis. The methodology used in the present study is presented in the next chapter.

3 METHODOLOGY

This chapter describes the methodology used in the research reported in this PhD Thesis. It starts with presentation of the research questions addressed in this research and the aims and objectives of this study. Thereafter, it presents a background discussion of research methodology, which is followed by description of the audit, surveys and observational methods. Then an introduction of the research population, sampling methods and sample size determination is presented. It is followed by the process used to contact the participants and an introduction of research interventions. This is followed by a description of surveys and observational study methods used in this research. Then development of the practices and procedures questionnaire and adoption of the risk perception questionnaire are described. This is followed by account of pilot testing and administration of the two survey questionnaires, descriptions of the main field study, data collection and compilation and ethical issues addressed follow. The reliability, validity and bias issues are also described. Finally, statistical methods used for data analysis i.e. descriptive statistics and inferential statistical techniques such as exploratory and confirmatory factor analyses, sequential multiple linear regression and structural equation modelling are explained.

3.1 Research Questions, Aims and Objectives

This section reports the research questions addressed in this research as well as the aims and objectives of this study, as follows.

3.1.1 Research questions

This occupational health and safety study from physiotherapists' perspective has attempted to answer four questions as follows.

Q1. What is the current level of availability and frequency of use of nine different types of electrophysical agents in NHS physiotherapy departments?

Q2. What are NHS physiotherapists' practices and procedures with respect to the safe use of electrophysical agents, particularly shortwave and microwave diathermies?

Q3. What are physical features in the physiotherapy workplace particularly in treatment rooms / cubicles used for treatment with therapeutic diathermy modalities that may have potential to impact on health and safety of physiotherapists?

Q4. What are levels and predictors of NHS physiotherapists' perception of risk, health consequences and protection from exposure to RF EMFs in NHS physiotherapy departments?

The aims and objectives of this study are presented below.

3.1.2 Aims

The aims of this research study were as follows:

E. Investigation of physiotherapists' frequency of use of EPAs in the NHS physiotherapy departments and clinics

F. Study of physiotherapists' practices and procedures in the safe use of electrotherapy devices

G. Study of physiotherapy departments' physical features from the physiotherapists' occupational health and safety perspective

H. Study of physiotherapists' rankings and predictors of perception of health risk, health consequences and protection against health risk from exposure to RF EMFs in their workplace

3.1.3 Objectives

The objectives of this PhD study were as under:

d) To develop and apply a questionnaire tool:

   iii. To examine the availability and frequency of use of the major types of electrotherapy devices in NHS physiotherapy departments

   iv. To audit physiotherapists' practices and procedures in the safe use of electrophysical agents with a special focus on PSWD, CSWD and MWD modalities.

e) To identify specific physical features of physiotherapists' work environment workplace particularly in treatment rooms / cubicles used for treatment with therapeutic diathermy modalities in a sample of NHS hospitals and clinics that may raise safety issues for physiotherapists

f) To adapt and apply a health risk perception questionnaire:

   iv. To ascertain physiotherapists' self-reported current lifestyle and health status, and knowledge and awareness of environmental and health issues

   v. To study physiotherapists' perception of risk, health consequences and protection from EMFs in physiotherapy departments and other known hazards

   vi. To develop predictive models and identify predictors of physiotherapists' perception of health risk, health consequences and protection from various occupational, social, and environmental risks

The following section presents a brief introduction to research methodology.

3.2 Introduction to Research Methodology

The term 'methodology' is defined as "the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes" (Crotty, 1998, p.3). In other words, a methodology is a systematic way or approach of studying a phenomenon or research problem (Kothari, 2011). The basic approaches to research have been divided into two categories i.e. qualitative approach and quantitative approach (Silverman, 2000; Kothari, 2011). Depending on the nature of the research issue, a research methodology therefore can be qualitative, quantitative or mixed. Every type of research methodology has both advantages and disadvantages (Silverman, 2000, p.79). The selection of the research methodology therefore depends on the aims and objectives of the study, which determine selection of the most appropriate research method(s) (Kothari, 2011). Research methods are defined as "the technique or procedures used to gather and analyse data related to some research question or hypothesis" (Crotty, 1998, p.3). There are numerous research methods and none of them is right or wrong but less or more useful (Silverman, 2000, p.79).

Given the aims and objectives of this research, as described above in section 3.1, the quantitative research approach was used in this study. This approach was chosen because it provided choice of selection of a number of data gathering methods as follows. Consequently, three research methods were deemed the most appropriate means to gather the data to achieve the aims and objectives of this study. The methods included an audit of electrotherapy equipment availability and use and the practices and procedures adopted in physiotherapy departments using a questionnaire tool, a semi-structured observation method using a diary tool for studying physical features of physiotherapists' working environment, and a cross sectional questionnaire survey for studying physiotherapists' risk perception. These research methods are described as follows in the following order. First of all, audit is described, then the survey method is discussed and finally the observation method is described.

3.3 Audit

An audit is the process that evaluates practice against standards (Benjamin, 2008). According to Newman and Carter (2007), audit is defined as a systematic and multidisciplinary appraisal of a facility, procedure/process or system. For example, in clinical practice audit may involve an evaluation of the procedures and practices put in place to meet the established standards and guidelines. From occupational health and safety perspective, an audit is an impartial collection, evaluation, and reporting of information about a workplace (Newman and Carter, 2007). Audit therefore can help in identifying areas of concern and suggesting ways to address them (National Institute for Health and Clinical Excellence, 2002). There are different approaches of conducting organisational auditing such as the questionnaire approach (Clampitt, 2009), the interview approach (Millar and Tracey, 2009) and the focus group approach (Dickson, 2009). Traditionally, health and safety audit is undertaken with a checklist, which might take the shape of a survey questionnaire in which questions are asked in a manner that can provide measureable answers so that the collected information can be compared with the standards (Grammeno, 2009, p. 139). In environmental health and safety audits, a questionnaire is generally sent to the organisation prior to the visit (Cahill and Kane, 2011). It is, however, important to highlight that often an audit and a research survey are misunderstood as one and the same thing due to a number of similarities between the two such as use of a questionnaire, a population of interest, a method and design of achieving the aims (Wade, 2005). However, the audit and the research survey are different from each other. The former provides information against a set standard while the latter generates new knowledge and may test hypotheses (National Research Ethics Service, 2007). Thus, findings of an audit can be applicable only to the subjects or organisations involved in the audit while the findings of a research survey could be generalised for a wider population.

The researcher developed a practices and procedure questionnaire, described later, to undertake an audit of the availability and frequency of use of electrotherapy devices and physiotherapists' practices and procedures in using electrotherapy from an occupational health and safety perspective.

3.4 Survey Method

The term survey has been defined as 'a method of gathering information from a sample of individuals' (Scheuren, 2004, p.9). Surveys are a significant source of fundamental scientific knowledge and they can be used either independently or in combination with other methods. The surveys are therefore used extensively in research in several fields (Neuman, 2000; Scheuren, 2004).

In the survey method, the researcher follows a deductive approach by beginning with a theoretical or applied research problem and ending with empirical measurement and data analysis (Neuman, 2000). The survey is used to obtain people's opinions, attitudes, perceptions and descriptions of events or other factors, collect information on organisational policies and practices and determine cause and affect relationships (Ghauri and Gronhaug, 2002; Baruch and Holtom, 2008). Study of risk perception, according to Sjoberg (2000b), is the study of attitudes and expectations, which can be better studied by survey method using self-administered questionnaire(s).

In surveys, information is collected from a sample population of interest (Scheuren, 2004) and the information-gathering instrument used in surveys is the questionnaire, which can be either short or long and include either closed or open-ended questions or both. The survey method has both advantages and disadvantages, which are summarised as follows.

The advantages of the survey method include speedy and economical collection of anonymous data from a target population that ideally should be generalisable (Scheuren, 2004). In the survey, it is possible to ask large numbers of people at one point in time about several factors including their beliefs, attitudes, expectations, opinions, characteristics and behaviours and to also measure other variables (such as identification of latent variables) and test several hypotheses (Neuman, 2000; Ghauri and Gronhaug, 2002; Scheuren, 2004). If the target population is a random sample and the response rate is high for example a response rate ≥ 60%, the quantitative information gathered through this method can be generalised (Armstrong and Ashworth, 2000; Scheuren, 2004).

The disadvantages of the survey method include the fact that the cross sectional study ascertains information at one time point only. It may also suffer from respondents' apathy or fatigue (for example if there are too many questions or the questionnaire takes too much time to complete it), return of incomplete questionnaires (perhaps due to poor question wording or order), and biased answers as well as sampling problems. In addition, a low response can be another limitation of survey method and the non-response can decrease the effective sample size and affect the data quality (Bowling, 2009, p. 288-290). Researcher bias can also lead to uncertainty of the survey conclusions (Scheuren, 2004).

Surveys are classified depending on the mode of conducting or administering the survey such as postal (mail), telephone, face-to-face, email and the online (web) surveys (Kalton, 2000; Scheuren, 2004; Dillman, 2007; Sue and Ritter, 2007; Shaughnessy et al., 2009). Although the online (Internet / web-based) surveys are becoming popular (Wright, 2005), postal (mail) surveys and interviews (either telephone or in-person/face-to-face) are the most commonly applied types of surveys (Ghauri and Gronhaug, 2002; Scheuren, 2004). Therefore, postal surveys and interview surveys are discussed below.

3.4.1 Postal survey

A postal survey, 'mail survey' or 'self-administered questionnaire survey' uses a self-administered questionnaire accompanied with an introductory letter and a return envelope that is mailed to the selected respondents (Babbie, 1973; Bowling, 2009). Like any other research method, postal surveys are associated with a number of advantages and disadvantages as follows.

3.4.1.1 Advantages of postal surveys

Postal surveys are a very common form of undertaking survey research (de Chernatony, 1993) because they provides several advantages (Babbie, 1973). For example, postal survey requires less time, money and staff for the large samples of research populations compared to other types of surveys such as telephone surveys and in-person interviews (de Chernatony, 1993; Scheuren, 2004). The survey can cover a geographically scattered population, and the respondents can complete the questionnaire at their convenience (de Chernatony, 1993; Johnson, 2010, p. 99). The survey also provides anonymity, avoids interviewer bias and can be conducted by a single researcher (Neuman, 2000). The cross sectional survey is able to report objectively in that the researcher has no input in the response except to record and enter the data accurately and according to a designated code (Personal communication from Dr Alexandra Farrow). The data collected can be analysed relatively easily, particularly with information from closed ended questions (Johnson and Turner, 2003).

3.4.1.2 Disadvantages of postal surveys

There are a number of disadvantages of postal surveys. For instance, target sample population lists obtained from a third party can be incomplete and out-dated, hence biased (Scheuren, 2004). The response rate can be lower in postal surveys compared to in person interviews (Cartwright, 1988; Bowling, 2009, p. 290). There can be non-return of survey questionnaires (Neuman, 2000); therefore constant monitoring of the returns and sending of follow-up mailings to the non-responders is required for improving the response rate (Babbie, 1973; De Vaus, 2004, p. 136; Johnson, 2010, p. 114). It is also possible that partially completed questionnaires are returned (Johnson and Turner, 2003). Researchers do not have control on conditions under which a survey questionnaire is completed (Neuman, 2000). Therefore, non-return and return of partially completed survey questionnaires contribute to a low response rate (Neuman, 2000) and the low response for example <60% can compromise the research validity and generalisability (Junghans and Jones, 2007; Van Geest et al., 2007). In addition, the format of survey questionnaire may provide a limited choice to the researcher to ask questions (Neuman, 2000). Other disadvantages of questionnaire survey include a need for considerable time to analyse data for open-ended questions (Johnson and Turner, 2003).

3.4.2 Interview surveys

Depending on the mode of conducting a survey, interview surveys can be divided into two categories i.e. telephone interviews and face-to-face interviews, which are described as follows.

3.4.2.1 Telephone Interview Surveys

Telephone interviews are conducted via a phone call to the respondent. This type of survey is very efficient for gathering information especially when timeliness is a factor and the length of the survey is restricted to a few questions. Hence, this method is widely used (Scheuren, 2004). The respondents in telephone interview surveys may be evasive and less candid (Freeman et al., 1982; Dooley, 2001, p. 123). Compared to in-person interviews, the telephone surveys are cheaper (Kalton, 2000). Unlike the in-person interview, telephone interview surveys do not require geographical clustering of the research population. Nevertheless, the population has to be well defined with respect to the research question(s). Travel time and associated costs can be saved with telephone interviews (Freeman et al., 1982; Dooley, 2001, p. 122). The source of the telephone survey sample is based on telephone directories, which might be not be up-to-date; hence, households with telephones but not enlisted as well as those households who do not have telephones would be excluded from telephone surveys (Scheuren, 2004).

Non-response rates are higher for telephone interview surveys compared to in-person interview surveys (Cartwright, 1988; Bowling, 2009, p. p. 290)., which could be a source of significant bias (Kalton, 2000; Bowling, 2009, p. p. 289).

According to Day and Campbell (2003) administration of questionnaire by telephone is convenient and cost-effective for data collection compared to the in-person interviews. Generally, the response rate in telephone interviews is lower than face to face interviews (Cartwright, 1988; De Vaus, 2004, p. 127; Bowling, 2009, p. 290); however, a higher response rate for telephone interviews compared to in-person interviews is not impossible (Fenig et al., 1993). In addition, telephone interviews are preferred over in-person interviews owing to lower costs, good quality of the data collected and the analytical advantages and saving of time (Freeman et al., 1982). Good quality of data involves good reliability, good validity and good response rate at least 60% (Punch, 2003, p. 41-42).

3.4.2.2 The In-person (face-to-face) Interview Survey

In-person or face to face interviews may take place at either the respondent's home or work and are generally more costly than mail or telephone surveys (depends on the size of the population being targeted: large surveys can be very expensive for post and for reminder letters with another questionnaire). The response rate can be higher in interviews compared to telephone and postal surveys (Cartwright, 1988; De Vaus, 2004, p. 127; Bowling, 2009, p. 290). In-person interviews can yield richer and more descriptive outputs and could be essential particularly when complex information is required (Scheuren, 2004). Day and Campbell (2003) applied both telephone and face-to-face methods and found the telephone interviews to be a convenient and cost-effective method. According to a literature review of 25 years of survey research (Kalton, 2000), non-response rates are lower in in-person surveys compared to telephone surveys. To contain the costs, the main requirement of an in-person interview survey is that it requires geographical clustering of the sample population (Freeman et al., 1982). In addition, the interviewer must be trained properly in order to carry out a quality face to face interview survey (Scheuren, 2004).

3.4.3 Survey Questionnaire

The most important thing in the survey is the questionnaire, which could be descriptive and/or analytical as well as structured, semi structured or unstructured (Ghauri and Gronhaug, 2002). Development of the questionnaire needs a lot of planning and careful consideration (Scheuren, 2004). Review of the relevant literature is very vital in developing the questionnaire (Ghauri and Gronhaug, 2002). The questionnaire may comprise closed-ended and open-ended questions, which are operationalised as dependent, independent and extraneous variables (Neuman, 2000; Ghauri and Gronhaug, 2002). In survey questionnaire, the questions should be clear, concise, specific, straightforward and in right order and polite and soft language (Ghauri and Gronhaug, 2002). There should be no use of jargon, slang, abbreviations, emotional language, prestige bias, two or more questions joint together, asking questions that are beyond respondents' understanding and asking future intentions under hypothetical circumstances in a survey questionnaire (Neuman, 2000). The layout and length of questionnaire is also important because it affects the response rate and responses (Ghauri and Gronhaug, 2002; Scheuren, 2004). However, there is no standard length of a survey questionnaire (Neuman, 2000; Ghauri and Gronhaug, 2002); but it should not be too long and tedious from respondents' perspective (Ghauri and Gronhaug, 2002). For questionnaire survey, the respondents should be selected by random sampling which is well grounded in statistical and probability theories (Scheuren, 2004). The confidentiality and integrity of the information provided by the respondents is extremely important (Scheuren, 2004).

The respondents may have the option to be anonymous or reveal their identity, which may depend on the nature of survey information. A good survey requires good thinking and effort (Neuman, 2000) and planning particularly from resources view point in particular time and cost (Scheuren, 2004). It is also essential to be careful in designing survey research and generalising the survey results (Neuman, 2000).

3.4.4 Survey research designs

Design of the survey research, according to Shaughnessy et al. (2009, p.152), can be of different types such as the cross-sectional design [for example a cross sectional study of effects of daily exposure to RF EMFs on sleep quality (Mohler et al., 2010)], successive independent sample design [a series of cross sectional surveys for example a study on changes in risk behaviours and prevalence of sexually transmitted infections among female sex workers (Ramesh et al., 2010)] and longitudinal design [such as in the longitudinal cohort study of a workforce for example the Whitehall Study of UK civil servants (Bosma et al., 1997; Batty et al., 2011)]. In this study, cross sectional survey design was used. This survey design and the other survey designs mentioned above are described in the following sub-sections.

3.4.4.1 Cross sectional survey design

Cross sectional design is the most common type of survey design in which one or more random samples of the population of interest are drawn at one point in time. Analysis of the survey data first produces descriptive statistics of all the variables or questions asked in the questionnaire tool relating to the characteristics of the participants in the study. Analysis of the characteristics that are the independent variables (IVs) such as age, gender, education or experience with respect to the dependent variable(s) (DV) for example behaviour and attitudes such as perception of risk generate(s) conclusions about the relationship between the DVs and IVs. Therefore, cross sectional designs are used in research for studying the current or past behaviours and attitudes of participants about any issues or events of interest (Bowling, 2009, p. 217).

The research in a cross sectional study is not affected by historical effects (Portney and Watkins, 2009, p. 280; Shaughnessy et al., 2009, p. 152) and is therefore more appropriate for descriptive and predictive goals of survey research. It is however not suitable for cross sectional surveys to determine changes in participants' attitudes and behaviours over time (Shaughnessy et al., 2009, p. 152-153), which requires a longitudinal design. Other limitations of cross sectional studies are recall bias about past attitudes and events (Bowling, 2009, p. 217).

Cross sectional studies are however cheaper than longitudinal studies and provide useful information from the study participants at one point in time. Cross sectional studies are therefore an inexpensive first step in the process of identifying and measuring the extent of the research problem(s), for example, the prevalence of a particular disease and collecting information on possible risk factors, but do not provide information about the incidence of the event such as a disease (Bowling, 2009, p. 217). A cross sectional study is therefore often called a prevalence study (Peat et al., 2002, p. 50-51). In addition, cross sectional studies can only identify statistical associations between variables but do not suggest the causality (Bowling, 2009, p. 217).

3.4.4.2 Successive independent sample design

Successive independent sample design is actually a series of cross sectional surveys that are undertaken, successively, over some time. This design requires different samples of the same population over a specified period of time (1 month, 6 month, 1 year, 5 years, etc.) who are asked the same and other questions; therefore, it is more suitable to measure changes in the attitudes and behaviours within a target population over some time (Shaughnessy et al., 2009). Results refer to overall changes (percentages) within the study population as it does not help in knowing how individual respondents have changed over the time (Shaughnessy et al., 2009). In addition anonymity might be lost if changes for individuals were known (Shaughnessy et al., 2009).

3.4.4.3 Longitudinal design

Longitudinal survey design requires study of either the same sample of population over time called a panel or different samples each time the data is collected known as a trend (Bowling, 2009, p.217). Thus longitudinal surveys also known as follow up surveys help in determination of the magnitude (extent) and direction of change in the participants, particularly with respect to a naturally occurring event (Shaughnessy et al., 2009 p. 156). This type of survey is useful for measuring incidences of diseases as well as understanding relationships of cause and effect and also studying trends in attitudes and behaviours; hence, these types of surveys are popular among social scientists and epidemiologists (Bowling, 2009, p. 218). This survey design, however, has a few major drawbacks. For example, expensive to maintain and follow-up of large number of participants, participants' attrition over the study period such as drop out of the study due to natural causes such as death, geographical mobility and non-traceability, refusal after some time and difficulty in finding participants who can be willing to commit themselves to take part in a study over long time, as well as a need for a lot of time and administration (Bowling, 2009, p. 218-219; Shaughnessy et al., 2009 p. 156).

3.5 Observation Methods

Researchers are divided on how to define observation in the context of research (Sailors and Flores, 2011, p. 225). Some researchers have defined observation as a data collection method (Frankfort-Nachmias and Nachmias, 1996, p. 205; Sarantakos, 1998, p. 67; Tashakkori and Teddlie, 1998) while others consider observation as a research method which enable collections of qualitative and quantitate data (Barker et al., 2002; Sailors and Flores, 2011). Quantitative observation most commonly involves a smaller sample size, addresses a number of diverse research questions and provides precise information due to predefined context of the study (Barker et al., 2002, p. 128). There are various types of observation such as participatory, non-participatory, structured, semi-structured, unstructured, natural, laboratory, scientific, open, hidden, active, passive, direct and indirect (Sarantakos, 1998, p. 67), controlled and non-controlled (Frankfort-Nachmias and Nachmias, 1996, p. 213) as well as reactive or obtrusive and non-reactive or unobtrusive (Bernard, 1994, p. 310-359). The researcher used semi-structured observations in this study.

Observation, as a data collection method, could be an event observation, time-point observation, time-interval observation and continuous observation (Sarantakos, 1998, p. 67). The researcher conducted one time observational visit to each physiotherapy department involved in this study. According to Camomilli (2007), visit to a facility or organisation from occupational health and safety audit perspective should be kept as short as possible to meet the objectives and avoid disturbance of the organisation's activities and workers (Camomilli, 2007). In this study, therefore, each observational visit to each physiotherapy department took about 30 minutes.

According to Mahoney (1997), observations are generally directed by structured protocols. In addition, nothing is irrelevant and field notes taking is very important in observational study (Toren, 1996, p. 103). Field notes comprise factual, accurate and thorough account of the observed phenomenon (Mahoney, 1997). Cain and Finch (2004) are of the view that ideally the observation should be a part of all research projects. Observation method can be used either independently or in combination with other research methods. For example, combination of observations, in-person interviews and field notes in a study on abandonment of manual wheelchairs by patients with a spinal cord injury (Kittel et al., 2002).

The researcher used observations for collecting quantitative data about the physical features of physiotherapy workplace, particularly in treatment rooms / cubicles used for treatment with therapeutic diathermy modalities, which may raise safety issues for physiotherapists. During observational visits to physiotherapy departments, the researcher used diary tool for data collection on physical features of physiotherapists' work environment workplace (Appendix VIII). Diary is a well-recognised tool for data collection in healthcare, epidemiology, and behavioural sciences (Ferguson, 2005) as well as in organisational auditing (Hargie and Tourish, 2009). Research using diary tool can use three types of measurements i.e. checklists, rating scales and open-ended, which can be used either separately or jointly (Reis and Gable, 2000; Ferguson, 2005). The researcher used open-ended measures for data collection. Dairy data can be collected by different means such as a notebook / diary / paper and pencil /pen, handheld personal digital assistants (PDA) and mobile phones (Bolger et al., 2003; Ferguson, 2005). Therefore, the researcher used a diary (Appendix VIII) for notes taking / data collection during semi-structured observational visits to physiotherapy departments.

The observation method like all other methods of data collection has some advantages and disadvantages (Frankfort-Nachmias and Nachmias, 1996, p. 205), which are described below.

3.5.1.1 Advantages of observation methods

The most important advantage of observation is its directness, which facilitates researchers to study behaviour as it occurs (Frankfort-Nachmias and Nachmias, 1996, p. 206; Barker et al., 2002, p. 120) and collect data first hand (Frankfort-Nachmias and Nachmias, 1996, p. 206; Mahoney, 1997). The observation method could be applied in any setting, anywhere and to any population (Toren, 1996, p. 102; Bernard, 2006, p. 140) and it is a unique method of data collection especially in areas where other methods are inappropriate (Sarantakos, 1998, p. 67). The observation method helps in understanding and studying the effect and relationship of the environment (such as workplace) and the research population (Frankfort-Nachmias and Nachmias, 1996, p. 207; Barker et al., 2002, p. 120). In addition, data collected through observation is well defined because of the properly described and well-controlled process of observational research (Sailors and Flores, 2011).

3.5.1.2 Disadvantages of observation methods

There are several disadvantages associated with the observation method, which can be divided into two categories i.e. method related and observer related. The method related disadvantages included high costs and time consuming (Mahoney, 1997) and introduction of bias in the study (Mann, 2003), for example, change of behaviour of population due to their observation (Stevens et al., 1993; Mahoney, 1997; Barker et al., 2002, p. 120). In addition, observation methods are most privacy threatening data collection methods especially for the participants (Mahoney, 1997). The observer related limitations of observation method include a need for an experienced, skilled and specially trained observer (Bernard, 1994, p. 144; Mahoney, 1997; Sarantakos, 1998, p. 67; Barker et al., 2002), the lack of observer's control over the situation (Mahoney, 1997) and introduction of bias due to observer's (researcher's) expectations (Sarantakos, 1998, p. 67).

3.6 Research Methods Used in This Research

In the present study, the researcher used the quantitative research approach and applied three quantitative research methods for data collection, which are described as follows. First, an audit of electrotherapy equipment availability and use and the practices and procedures in the safe use of electrotherapy in physiotherapy departments by administration of a self-completed questionnaire. Second, a semi-structured observational visit to each of the 46 physiotherapy departments that agreed to take part in the practices and procedures study using a diary tool (Appendix VIII). The observational visits, described later in this chapter, were carried out with a particular focus on physical features of departmental areas where electrotherapy was administered. Third, a cross sectional survey of risk perception was conducted by administration of a self-completed risk perception questionnaire to all physiotherapists working in 46 physiotherapy departments. The survey questionnaires used in the present study are described in the following section.

3.7 Survey Instruments Used in This Research

In this research, two types of survey instruments were used for data collection. The first survey instrument was entitled the ‘practices and procedures questionnaire’ and the second instrument was called ‘risk perception questionnaire’. The development, content and administration of the two questionnaires are described as follows.

3.7.1 Development of practices and procedures questionnaire

The ‘practices and procedures (P&P) questionnaire’ was designed / developed in house. The design of the P&P questionnaire was informed by review of literature on electrotherapy equipment availability, use and non-use (reported in section 2.2), review of studies on measurement of EMFs from MWD, CSWD and PSWD devices (reported in section 2.3). In addition, study of (inter-)national guidelines and legislation on occupational exposure to EMFs (reported in sections 1.5.1 and 1.5.2) and professional guidelines on physiotherapists’ health and safety during electrotherapy use and safe use of electrotherapy (reported in section 1.5.3) informed development of the P&P questionnaire. First version of the P&P questionnaire (Appendix VI) comprised 25 questions, which asked information on various issues related to electrotherapy. Sixteen questions asked information with respect to nine electrotherapy modalities, which included CSWD, PSWD, interferential, microwave diathermy (MWD), biofeedback (muscle stimulator) ultrasound, transcutaneous electrical nerve stimulation (TENS), laser and H-wave. Information asked in the First version of the practices and procedures questionnaire was about four themes i.e. device / equipment issues, user / operator (physiotherapist) issues, occupational environment (workplace) issues and treatment issues as follows.

3.7.1.1 Device (equipment) issues

Device related questions asked information on the number of devices available, device make/model, device manufacture, mode and output settings of device, order of modality use, responsibility and frequency of device maintenance, availability of device manual, and the frequency of used of SWD modalities in the department.

3.7.1.2 User / operator (physiotherapist) issues

User / operator (physiotherapist) related questions asked information on operator's distance from device when in use, training in safe use of modality, and contraindications for using electrotherapy devices.

3.7.1.3 Occupational environment (workplace) issues

The occupational environment (workplace) related questions asked information on the presence of metallic objects in treatment cubicles/ rooms used for electrotherapy, nature of the partitions between the cubicles / rooms, number of persons in a cubicle, size of the treatment cubicles / rooms, and the nature of plinth used during electrotherapy.

3.7.1.4 Treatment issues

The treatment related questions asked information on the length of treatment time, method / type of electrodes application used for SWD, techniques used for electrotherapy with SWD and intensity at which thermal effect occurs.

Most of the questions included in this questionnaire were closed ended while a few questions i.e. reasons for not using PSWD and CSWD, restrictions / contraindications for using PSWD and CSWD, and reasons for preference for CSWD and PSWD were open ended.

3.7.2 Pre-testing of practices and procedures questionnaire

The first version of the practices and procedures questionnaire was pre-tested on six physiotherapists who were members of academic staff in the Physiotherapy Division of Department of Health and Social Care at Brunel University. Comments received during pre-testing suggested removing the name of department from the questionnaire to make it anonymous. Thus, the heading asking the name of participating department was removed and questionnaire was revised. The revised questionnaire was pilot tested in seven departments as described in section 3.13 in this chapter. The questionnaire was again revised in the light of comments received in the pilot study as explained below.

3.7.3 Amendment of practices and procedures questionnaire

The practices and procedures questionnaire was modified in the light of pilot study by removing eight questions, mostly related to the device and treatment issues, and adding five new questions, which were mostly about a new theme i.e. departmental issues. Questions that were removed from the questionnaire were questions about the device make/model, mode/output, and manufacture; PSWD device setting parameters, the level of intensity for producing thermal effects, techniques for using SWD, restrictions / contraindications for using CSWD / PSWD, and preference for using CSWD / PSWD over other methods of treatment. New questions added to the questionnaire included a question related to equipment that asked for occurrence of electrical / electronic interference due to the use of any of the electrotherapy modalities included in this study, and four questions related to department issues, which are described below.

3.7.3.1 Departmental issues

Four new questions on departmental issues added to the practices and procedures questionnaire asked information about the number of physiotherapists working in the department, average number of patients per week attending the department, the number of weekly patient who were given electrotherapy, and the date for last electrotherapy audit in the department.

In addition, the pilot study revealed that the question on restrictions and contraindications for using electrotherapy needed modification because the restrictions and contraindications were beings asked for the patients and physiotherapists. Therefore, the title of this question was as the 'Any contraindications for the physiotherapists' safety when using the specific modality' and columns related to patients in this question were deleted. The revised / final version of this questionnaire comprised 22 questions on five themes i.e. device issues (Q1-Q5, Q13, Q18-Q20), user / operator issues (Q7, Q14, Q22), workplace issues (Q8-Q12), treatment issues (Q6) and departmental issues (Q15-Q17, Q21). The final version of practices and procedures questionnaire (Appendix VII) was administered by post to 39 physiotherapy departments that participated in the main study. Data on new added questions was obtained post hoc from seven departments involved in the pilot study by a separate letter and that data are included in the final analyses. Therefore, the final analyses of data on the audit phase of the study includes all 46 departments i.e. 7 in the pilot study and 39 in the main study. However, data on questions that were deleted after pilot study have been excluded from the final analyses.

3.7.4 Risk perception questionnaire

The second survey instrument was entitled as 'risk perception questionnaire' (Appendix IX). This questionnaire was originally validated and used in Sweden

(MacGregor et al., 1994) and thereafter it was applied in a health risk perception study sponsored by the Department of Health in England (Stollery et al., 1999). The adapted questionnaire was shared by the researcher's supervisor with physiotherapist researchers from the Republic of Ireland (Shields et al., 2005).

The adapted risk perception questionnaire comprised four sections. The first section asked for participants' demographic characteristics i.e. gender, the marital status and age; level of academic qualifications; life style habits i.e. smoking, drinking, exercise and diet; the health status, and the awareness and knowledge of environmental and health issues in general. Last three items i.e. health status and the awareness and knowledge of environmental and health issues were asked on a 6 point Likert scale (Appendix VIII).

The second section asked for physiotherapists' 'perception of risk' from 23 items (Appendix VIII). The items included smoking of tobacco and passive exposure to tobacco smoke; alcohol consumption per week up to and over the limits and driving with double the legal limit of alcohol; high fat diet; sedentary lifestyle; exposure to chemical from industry, radon gas, noise, poor air quality and radiation from a single X-ray chest; living near a nuclear power plant, an electricity substation, a mobile phone transmitter (mast) and an overhead power line; radioactive fallout from a nuclear power plant; using a mobile phone; exposure to EMFs in the physiotherapy department and in the home; air and train travel. All items in the second section were ranked on a six point Likert scale i.e. no risk (scale 1), low risk (scale 2), moderate risk (scale 3), high risk (scale 4), very high risk (scale 5) and do not know (scale 6) (Appendix IX).

Third sections asked for 'health consequences' due to exposure to all items except driving with double the legal limit of alcohol included in the second section, as mentioned above. All items in the second section were also ranked on a six point Likert scale i.e. no harm (scale 1), low harm (scale 2), moderate harm (scale 3), sever harm (scale 4), very sever harm (scale 5) and do not know (scale 6) (Appendix IX).

The final (fourth) section asked participants' ability to protect themselves against risks from exposure to 15 items out of 23 items included in the second section. The items in this section were passive exposure to tobacco smoke; exposure to chemicals from industry, radon gas, noise and poor air quality; living near a nuclear power plant, an electricity substation, a mobile phone transmitter (mast) and an overhead power line; radioactive fallout from a nuclear power plant; exposure to EMFs in the physiotherapy department and in the home; air and train travel. All items in the third section were also ranked on a six point Likert scale i.e. never possible (scale 1), rarely possible (scale 2), sometime possible (scale 3), usually possible (scale 4), always possible (scale 5) and do not know (scale 6) (Appendix IX).

There are several scales such as Guttmann scales, semantic differential scales and Likert scales, which are commonly used to measure respondents' attributes or attitudes (DePoy and Gitlin, 1998, p. 199). The researcher in this study used the Likert scales since this type of scale is quick and the most commonly used scale compared to other types of scales as well as it helps in ordering different peoples' attitudes / responses regarding an item (Bowling, 1997, p. 255-256). In addition, the Likert scale response can be understood and analysed easily (Bowling, 2005, p. 406). In Likert scales, even choices lead to either positive or negative responses while the odd choices provide a neutral or middle response to the respondents (DePoy and Gitlin, 1998, p. 200). Likert scales can be between five to seven point ordered response categories (Bowling, 2005, p. 406) but are usually on a five point scale (Bowling, 1997, p. 255). The researcher used a six-point scale that included one option i.e. ‘do not know’, which did not include any rank or rating for the hazard. Therefore, in fact there were five scales for the respondents who had any rating for their attitude towards an item (risk factors / hazards) included in the questionnaire. The ‘do not know’ option was provided to facilitate the respondents who were not in a position to rate their risk perceptions to any of the risk items included in the survey instrument.

This risk perception questionnaire was developed, validated and applied in Sweden to study perception of health risk from exposure to EMFs(MacGregor et al., 1994). This was also used in the UK to study exposed and unexposed peoples’ perception of health risk from exposure to non-ionising radiation (Stollery et al., 1999). Therefore, risk perception questionnaire was relevant to study physiotherapists’ perception of health risk from exposure to EMFs in physiotherapy departments and other known hazards. Therefore, this survey instrument was adapted and applied in the present study.

3.8 Study Participants

The participants in this research study were physiotherapists working in physiotherapy departments in the National Health Service (NHS) hospitals and clinics in Greater London and 12 counties of the Southeast and Southwest of England. The selected physiotherapy departments were located within approximately 50 miles radius of London. In addition, this research involved 584 physiotherapists working, both fulltime and part-time, in the above mentioned 46 physiotherapy departments. Participants’ selection, sampling and contacting with them is described as follows.

3.8.1 Sample selection

A sample frame is defined as a 'listing of units from which the actual sample will be drawn' (Ghauri and Gronhaug, 2002, p. 112). However, finding or creating a sampling frame, which accurately matches with the target population of interest, is not an easy task (Ghauri and Gronhaug, 2002, p. 112). Nevertheless, use of a sampling frame for research of a target population is essential due to cost and time factors that would be involved if the whole population were sampled (Ghauri and Gronhaug, 2002, p. 112).

3.8.2 Sampling methods

Sampling methods can be divided into two categories i.e. probability sampling and non-probably sampling (Zikmund, 2000, p. 362; Ghauri and Gronhaug, 2002, p.113-114). These methods of sampling are described below.

3.8.2.1 Probability sampling

Probability sampling allows for statistical inferences, assessment of the level of sampling error and the chances of inclusion for each unit to be known. The most common types of probability sampling include simple random sampling, systematic random sampling, stratified random sampling, proportional sampling, non-proportional sampling, cluster random sampling and multistage cluster sampling (Tashakkori and Teddlie, 1998, p. 75; Zikmund, 2000, p. 362). It is beyond the scope of this thesis to describe each of the sampling types and their procedures. The researcher used systematic random sampling method based on the total number needed in the sample (in this study number of physiotherapy departments was 46 as per the research funding conditions) and selection of every nth participant in the target population (in this case departments within 50 miles distance from London were (Tashakkori and Teddlie, 1998, p. 75). The other advantages of this sampling method include simple drawing and easy to check sample, assurance of representation of all groups in sample and moderate costs (Zikmund, 2000, p. 362-363).

3.8.2.2 Non-probability sampling

This type of sampling is easy to draw but does not allow for valid inferences about the population, evaluation of the extent of the sampling variation, error of estimation and is therefore unrepresentative of the population.

The most common types of non-probability sampling include purposive sampling, sampling for homogeneity, sampling for heterogeneity, stratified non-random sampling, snowball or chain sampling, sequential sampling and convenience sampling (Tashakkori and Teddlie, 1998, p. 75-76; Zikmund, 2000, p. 362). The description and sampling procedure of non-probability sampling methods are beyond the scope of this thesis.

3.9 Sample Size

According to Neuman (2000), the size of a sample depends upon the population and they have an inverse relationship. For smaller population the sample will require higher percentage of the population and for the large population the sample will require lower percentage of the population such as illustrated in Table 3.1. On this analogy, the sample size for various populations suggested by Neuman (2000) are is shown in Table 3.1.

Table 3.1 Population and sample sizes

Total population	*Sample size*
<1,000	300 (30% of the total population)
10,000	1,000 (10% of the total population)
>150,000	1,500 (1% of the total population)
>10 million	2,500 (0.025% of the total population)

Source: (Neuman, 2000)

However, specific sample size can be determined using formulae, which have been suggested by several researchers. For example, Frankfort-Nachmias and Nachmias (1996, p. 198-199) have suggested the following formula:

$$n = s^2 / (S.E.)^2$$

(Where n = the sample size, s = standard deviation of the variable under study, and S. E. =standard error)

Saunders et al. (2000, 2003) have put forward a formula to calculate actual size of the sample, as follows.

$$n^a = n \times 100 / re\%$$

(Where n^a is the actual sample size required, n is the minimum (or adjusted minimum) sample size and re% is the estimated response rate expressed as a percentage)

The selection of sample size however depends on the degree of accuracy required, degree of variability or diversity in the population and the number of different variables examined simultaneously in data analysis (Neuman, 2000). A formula that provides relationship between sample size, confidence level and width of the band of uncertainty has been suggested by Nasatir (1985), which is as follows:

$N = (0.5\alpha/\Delta)^2$

(Where N = sample size, α = 1.96 for the 95% confidence level, 2.797 for the 99% confidence level, and Δ = width of the band of uncertainty in decimals)

According to Nasatir (1985), the absolute size of the sample is of primary importance and has given following formula for determination of a sample size.

$N = (\sigma\alpha/\Delta)^2$

(Where N = sample size, α = 1.96 for the 95% confidence level, 2.797 for the 99% confidence level, and Δ = width of the band of uncertainty in decimals, σ = estimate of the amount by which the average case differs from the mean of all the cases - usually obtained from the sample itself)

The selection of sample size is also affected by the cost and other limitations (Frankfort-Nachmias and Nachmias, 1996; Neuman, 2000). In addition, according to Nasatir (1985), degree of precision and removal of personal bias by not selecting respondents of choice is very essential in survey research.

3.9.1 Determination of sample size in this research

In order to recruit the prospective physiotherapy departments for this study, a list of physiotherapy departments (N=110) was obtained from the physiotherapy placement office at the Department of Health Studies and Social Care at Brunel University. This list was helpful in providing the contact name of the physiotherapist superintendent / manager, address and the direct line telephone number of each department. Using a systematic random sampling method for determining the sample size, the researcher selected 57 (52%) of the physiotherapy departments from the list of physiotherapy departments (N=110) for recruitment into this study. This number was selected keeping in view the fact that the Health and Safety Executive sponsored this study with a number of conditions such as the limited time to carry out the research and the available funds for questionnaires and travel. The 57 departments were invited to participate in the 'practices and procedures audit' and to agree to a visit by the researcher for the observational parts of this research study. However, only 46 departments responded and agreed to take part in the study.

For the risk perception survey, sample size was determined on the basis of the suggestion by Neuman (2000) that if the total population size is less than 1000, then the sample size should be 300 (30% of the total population). During the practices and procedures survey phase of this study, each of 46 physiotherapy departments reported the total number of physiotherapists working in the department, which helped in ascertaining the total sample size to be N=584 physiotherapists who were working both full-time and part-time in 46 departments participating in this study. Keeping in mind the fact that the total number of physiotherapists in the selected departments was less than 1000, and there was a possibility of non-response and attrition, all of the physiotherapists (N= 584) were selected in order to ensure a minimum sample size of 300.

3.10 Response Rate

Response rate is very important in survey research because if the non-response rate is higher there will be a greater bias effect (Frankfort-Nachmias and Nachmias, 1996; Bowling, 2009, p. 288-289). There is, however, no consensus on what is a low or a high response rate. Similarly, there is no agreement on the cut off levels of poor, adequate, good, very good and excellent response rates. In addition, there are no fixed response rate levels. According to Groves and Couper (1998), a response rate below 60% is sub-optimal. According to Bowling (2009, p. 289), a response of ≥75% is good. According to Babbie (1973, p.165), a response rate of 50%, 60% and 70% is regarded as satisfactory, good and very good respectively. A response rate of ≥60% is however required and considered to be a representative and generalisable to the population from which the respondents are drawn (Armstrong and Ashworth, 2000).

Moreover, there is no standard or universal definition of the response rate (Wiseman and Billington, 1984). There are therefore a several formulae to calculate the response rate. For example, Frankfort-Nachmias and Nachmias (1996, p. 200) suggested a formula for determining the response rate as follows:

$$R = 1 - (n-r)/n$$

(Where R = response rate, n= sample size, and r = responses returned)

Saunders et al. (2000, 2003) have given another formula for calculation of the response rate as follows:

Response rate = total number of responses / total number in sample – (ineligible + unreachable)

The formula given by Saunders et al. (2000) is therefore better than the formula given by Frankfort-Nachmias and Nachmias (1996, p. 200) because it takes into account the ineligible and unreachable respondents.

3.11 Contacting the Research Population

The participating physiotherapy departments were contacted more than once during this study: for recruitment into the study, for completing the 'practices and procedures' audit questionnaire, to arrange and conduct observational visits and to complete the risk perception survey questionnaire. Written reminders were also sent to some of the participating departments during both the recruitment phase and when conducting the pilot and main studies.

All letters to the managers / superintendent physiotherapists were written with a hand written personal salutation. Letters to the physiotherapists participating in the risk perception questionnaire did not include name of any participant. The letters were signed by either the researcher or his supervisor. These issues though uncommon in postal surveys might be helpful in getting the better response (de Chernatony, 1993). The researcher did not offer any incentive to the participants for completing the surveys. However, a prepaid self-addressed reply envelope was send to the every participant.

The selected departments and participants were approached as follows.

3.11.1 Telephone call

First, an introductory telephone call was made to the superintendent physiotherapists or the managers of the selected physiotherapy department/clinics. They were informed about the aims and objectives of this study. If the superintendent physiotherapists or the managers of the departments suggested their willingness to take part in the study, further contact was made as follows otherwise they were dropped from the selected list.

3.11.2 Introductory letter

After the telephone conversation, the willing departments /clinics were sent an introductory letter (Appendix IV). The letter was addressed to the superintendent physiotherapists or the managers of the departments/clinics. The letter introduced the following:

a. The aims and objectives of this study
b. The sponsor of the research i.e. Health and Safety Executive
c. The organisations that gave ethical approval for this study: NHS multi-centre research ethics committee (MREC), Wales and Brunel University.
d. Details of involvement of participants to complete the survey questionnaires
e. A visit, about 30 min long, by the researcher to the individual departments for observation of the electrotherapy equipment and physiotherapists' occupational environment
f. Information that the visit would not involve observation of any patients or physiotherapists during electrotherapy sessions

At the end of the letter, the superintendent physiotherapists or the managers were requested to return the signed consent form should they decide to take part in the study. They were also given contact telephone numbers for the researcher and his supervisor should they wish to discuss further details about the study. This letter was accompanied by a consent form and a copy of the practices and procedures questionnaire, which are described below.

3.11.3 Consent form

The consent form (Appendix V), sent to each of the superintendent physiotherapists or the managers of physiotherapy departments and clinics, informed the participants that data obtained in this study would be used only for research purposes, would remain confidential, and the participants would remain anonymous. After receiving signed consent forms, departments were admitted formally into this study

3.12 Administration of questionnaires

The practices and procedures questionnaire and the risk perception questionnaire were administered separately at different points in time, as described below.

3.12.1 Administration of practices and procedures survey questionnaire

A copy of the practices and procedures questionnaire (Appendix VI) was sent by post with the introductory letter and consent form, described above, to 46 physiotherapy departments / clinics, which included seven departments in a pilot study followed by 39 departments in the main study. The participating superintendent physiotherapists and/or the managers of physiotherapy departments / clinics were requested to complete the practices and procedure questionnaire in consultation / consensus with physiotherapists who used the electrotherapy device most frequently, if possible.

After completion of the practices and procedures survey, risk perception questionnaire were sent to the physiotherapy managers of all departments that took part in the practices and procedures survey for distribution among all physiotherapists working in their departments. Details of administration of this survey instrument are described in the next section.

3.12.2 Administration of risk perception questionnaire

The risk perception questionnaire (Appendix IX) was administered to all the physiotherapists working in all the physiotherapy departments (n=46) that took part in the audit survey and observational visits in this study. This questionnaire was administered at the final stage of this study and it was sent to every physiotherapist in the participating physiotherapy departments /clinic through their superintendent physiotherapist or the manager. A letter (Appendix X) addressed to the managers and superintendent physiotherapists requesting them to distribute the risk perception questionnaire among all physiotherapists in their departments was also attached. In addition, a letter addressed to the individual physiotherapist (Appendix XI) taking part in the risk perception survey was attached to the risk perception questionnaire. The letter informed the participating physiotherapists of the following:

a. Their department had taken part in two earlier phases of this study i.e. the audit (of electrotherapy equipment availability and frequency of use, and the practices and procedures) and the observational visits
b. This study was sponsored by the Health and Safety Executive
c. Their participation in the survey was totally voluntary
d. Completing the risk perception questionnaire would not take longer than 10 minutes and it neither required the participants' names nor the name of their departments / hospitals / clinics
e. The telephone numbers of the researcher(s) in this study were supplied should they (participants) require further information.
f. Request to return the completed survey questionnaires as soon as possible in the addressed and prepaid return envelopes provided

No formal consent from physiotherapists participating in the risk perception survey was obtained. The return of completed survey questionnaires from participating physiotherapists was considered as their consent.

The pilot and main studies are described in the following sections.

3.13 Pilot Study

Prior to the main study, a pilot study on the practices and procedures was undertaken involving seven physiotherapy departments in October 2002. In the pilot study, two things were undertaken first piloting of the practices and procedures questionnaire (Appendix VI) and other was pilot observational visits, using a diary tool (Appendix VIII), to these seven departments. Following pilot study, the practices and procedure instrument was revised as mentioned earlier. The final version of the 'practices and procedures questionnaire' (Appendix VII) was administered to 39 participating departments included in the main study, which is described in the next section.

The risk perception questionnaire had been previously validated (MacGregor et al., 1994; Stollery et al., 1999); however, the researcher pilot tested the adapted version of the questionnaire on four physiotherapists who were members of physiotherapy academic staff at Brunel University. The average time taken by them to complete this questionnaire was 10(±3) minutes and suggested changes were regarding formatting (i.e. font size and using bold to highlight headings) in the questionnaire. This suggested that the adapted risk perception questionnaire was relevant for studying physiotherapists' perception of health risk from exposure to EMFs in their occupational environment. Therefore, the adapted questionnaire was used in the present study, as explained below

3.14 Main Study

The main study was conducted in three phases i.e. survey of practices and procedures and observational visits to the participating departments (N=39) and survey of physiotherapists' perception of health risk from exposure to EMFs in physiotherapy departments and a number of other known hazards, as described below.

In the first phase, data on physiotherapists' practices and procedures in the use of different modalities were studied in 39 departments using the revised practices and procedures audit questionnaire (Appendix VII).

In the second phase, the researcher through semi-structured observational visits to 39 physiotherapy departments investigated the physical features of physiotherapy workplace, particularly in treatment rooms / cubicles used for treatment with therapeutic diathermy modalities, which may raise safety issues for physiotherapists. A dairy (Appendix VIII) was used for data collection/ note taking during these visits to physiotherapy departments.

In the third phase of the study, data on physiotherapists' level of perception of health risk, health consequences of the risk and protection from the risk with respect to different items was collected through the risk perception questionnaire (Appendix IX). The risk perception questionnaire was administered to all (N = 584) physiotherapists who were working, fulltime or part-time, in the 46 physiotherapy departments that participated in the first two phases, i.e. audit of electrotherapy equipment and practices and procedures, and observational visits, of this study.

Both questionnaires accompanied a letter introducing the aims and objectives of the study to the participating departments and sent to the superintendent physiotherapists and/or the managers of the participating physiotherapy departments. The instruments were sent to the participants by Royal Mail. For return of the completed survey questionnaires, prepaid and self-addressed reply envelopes were provided to all the respondents.

Both instruments were administered at different times as follows. First and second phases of this study were conducted from October 2002 to July 2003 while the third (last) phase of the study was conducted between August 2003 and November 2003.

3.15 Data Collection, Coding, Cleaning, and Storage

In all the phases of this study, the data were collected and compiled anonymously. Data collected in different phases of this study were first coded and then cleaned. The cleaned data were then entered on the Statistical Package for Social Sciences (SPSS), version 11.0 for windows, which was upgraded to version 15.0 after some time.

3.16 Ethical Issues

Before conducting this research, ethical approval was obtained from NHS Multicentre Research Ethics Committee, Wales (Research Protocol No. MREC 02/9/04 dated 26th March 2002) (Appendix II) and the Departmental Research Ethics Advisory Committee at the researcher's department i.e. Department of Health Studies and Social Care, Brunel University on 4th March 2002 (Appendix III). In addition, this study was supported by the Chartered Society of Physiotherapists.

In this study, none of the patients and physiotherapists was observed during electrotherapy treatment. As mentioned earlier, all the data were collected, coded, compiled and analysed anonymously and participants' identity and privacy were respected.

3.17 Reliability and Validity of Research

Research methods and products such as the data and outcomes are most commonly judged by two criteria i.e. reliability and validity (Hammersley, 1992, p. 67), which are described below.

3.17.1 Reliability

Reliability of a research method and/or data is defined as "the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions. It provides evidence about validity and ... usefulness of the particular research strategy used" (Hammersley, 1992, p. 67). According to Polgar and Thomas (2008, p. 127), "reliability is the property of reproducibility of the results of a measurement procedure or tool". In other words, reliability of a research instrument, such as a survey questionnaire, is its ability to provide almost identical results when applied repeatedly under similar conditions (Blunch, 2008, p.27-28). When a scale has internal consistency then all its items should show strong correlations (Brace et al., 2009, p. 368).

Reliability can be measured by different means such as test-retest reliability, inter-observer /inter-rater reliability, internal consistency, multiple form reliability, split half reliability, item-item and item-total reliability and Cronbach's alpha (Bowling, 2005, p. 397; Blunch, 2008, p.30-31; Polgar and Thomas, 2008, p. 127). Cronbach's alpha is also known as coefficient alpha and its minimum value of .7 is required to confirm the scale reliability (Brace et al., 2009, p.368). It can be noted that reliability can affect validity of the survey questionnaire and the study design (Bowling, 2005, p. 396).

3.17.2 Generalisation

According to Frankfort-Nachmias and Nachmias (1996), generalisation is the component of research design which considers the degree to which the research findings can be applied to the larger population and different settings. In other words, it is external validity of the research (Hammersley, 1992, p. 66), which is described in the following section.

3.17.3 Validity of research

Validity has been defined by Portney and Watkins (2009, p. 879) as “the degree to which an instrument measures what it is intended to measure”. They have also defined validity as “the degree to which a research design allows for reasonable interpretations from the data, based on controls (internal validity), appropriate definitions (construct validity), appropriate analysis procedures (statistical conclusion validity) and generalisation (external validity)” (Portney and Watkins, 2009, p. 879). According to Polgar and Thomas (2008, p. 128), “validity is concerned with the accuracy of the test procedure”.

For a survey questionnaire, validity is an assessment whether it exactly measures what it aims to measure (Bowling, 2005, 396; Blunch, 2008, p.27). Thus a survey instrument “ should have face, content, concurrent, criterion, construct (convergent and discriminant) and predictive validity” (Bowling, 2005, 396).

According to Peat et al. (2002, p. 105-106), “validity is an estimate of the accuracy of an instrument or the study results” in measuring what it was used to measure. Validity is of two types, which include the internal validity and the external validity that are described as follows.

3.17.3.1 Internal validity

Internal validity of a study, according to Peat et al. (2002, p. 105-106), is the extent to which the study methods and instruments are accurate and repeatable in measuring what they are used and/or expected to measure. According to Bowling (2005, p. 398), internal validity of an instrument is the successful and repeated testing of an instrument in the populations for which it is designed. Thus internal validity, according to Thompson and Panacek (2007) is "the degree to which the findings accurately reflect reality". Internal validity is thus important aspect of the research, which refers to "the entire study, rather than an individual variable" (Thompson and Panacek, 2007).

Internal validity can be influenced by several factors which can be extrinsic and intrinsic factors (Frankfort-Nachmias and Nachmias, 1996; Thompson and Panacek, 2007). The intrinsic factors include: history (events that happened during the study period and affected the population studied), maturation (biological, social or psychological processes, which changed the units or participants studied and changes in the dependent variable due to normal, intrinsic changes over time), experimental mortality (loss of subjects / participants dropout resulting in incomplete information achievement), instrumentation (changes in the measuring instrument before and after testing and "changes in instrument functions between time 1 and time 2 or by a change in how the researcher uses the instrument because of their own increased skill level. With instrumentation problems, a given instrument could give different results, even when the variable itself has not changed"), testing (reactivity of individuals as a result of testing and testing might also be caused by the direct effect of the instrument itself), "the method of assignment of subjects to experimental and control groups could influence the outcome of the study" and interaction of intrinsic factors with selection factors (Frankfort-Nachmias and Nachmias, 1996). Thus controlling effect of extrinsic factors is important as early as the design stages of the study, which can be done by randomisation (to control assignment problem), using statistical techniques at the conclusion stage, use of control groups for elimination of effects of history and maturation avoidance and addition of additional groups of participants to avoid effect of pre-testing (Thompson and Panacek, 2007). According to Frankfort-Nachmias and Nachmias (1996), extrinsic and extrinsic factors that threaten internal validity can be controlled by different methods such as randomization. Randomization controls effects of several factors; however, it does not ensures sample being representative of the population of interest (Frankfort-Nachmias and Nachmias, 1996).

According to Peat et al. (2002, p. 106), internal validity can be measured by face validity (measurement and internal consistency), content validity, criterion validity (predictive utility, concurrent validity and diagnostic validity) and construct validity (criterion-related validity, convergent validity and discriminant validity).

3.17.3.2 External validity

External validity of the research has been defined by several researchers with a little variation; however, generally the external validity means the level of generalisation of the study findings to the population of interest outside of the sample (Frankfort-Nachmias and Nachmias, 1996, p. 113; Peat et al., 2002, p. 105; Bowling, 2005, p. 398; Thompson and Panacek, 2007). Like internal validity, external validity can be affected by a number of external factors such as "the study environment or conditions, or even the investigator's presence, may influence the study subjects or the measurements" (Thompson and Panacek, 2007). This may lead to the Hawthorne effect (subjects respond in a different manner just because they are being observed), the novelty effect (subjects may alter their performance, become more engaged, or change attitudes just because something is new), repeated measurement effect (if study subjects are exposed to a large number of questionnaires, observations, etc., they may become tired of the procedures or are so accustomed to them that their performance is altered) and interaction between history and treatment effect (something unique about the time and place that makes the treatment more (or less) effective, and thus not widely generalisable) (Thompson and Panacek, 2007). In addition, representativeness of the sample is one of the major issues in external validity (Frankfort-Nachmias and Nachmias, 1996). To ensure external validity of a study, research participants should be selected by random sampling methods and the response rate should be high so that the results represent the wider population from which the sample was recruited and other similar populations (Peat et al., 2002, p. 106).

Several methods for assessing different types of validity have been suggested by researchers (Peat et al., 2002, p. 113). For example assessment of external reliability including both face and content validity by several analyses such as experts' judgments, Chronbach's alpha and factor analysis, and assessment of internal validity including criterion and construct validity by a number of analyses such as likelihood ratio, linear or multiple regression and logistic regression (Peat et al., 2002, p. 113). In addition, content validity of a measurement, according to Blunch (2008, p.43), is established when it covers all or most aspects of the concept being measured and it is usually assessed in discussions with experts and colleagues. Construct validity of a measured construct is considered valid when it correlates conceptually with other measured constructs because the constructs could be related on theoretical basis (Blunch, 2008, p.43).

In the present research, the face and content validity of the practices and procedures audit questionnaire were determined, as suggested (Peat et al., 2002, p. 113; Blunch, 2008, p.43), by judgment of experts who were chartered physiotherapists and by Chronbach's alpha >.70 criterion, as suggested (Bowling, 2005, p. 397). In addition, the construct validity was assessed by calculating the construct reliability and discriminant validity as suggested by (Fornell and Larcker, 1981; Farrell, 2010) with a formula given by (Hair et al., 2010, p. 710), as follows.

Construct reliability (CR) = (squared sum of standardised factor loadings (L_i) for a construct) / (squared sum of standardised factor loadings (L_i) for a construct) + (sum of the error variance terms (e_i) for a construct)

3.17.3.3 Sample representativeness

Representativeness of the sample means that the characteristics of the subjects in selected sample must reflect the characteristics of the general population being researched (Frankfort-Nachmias and Nachmias, 1996). Representativeness of the sample is therefore necessary for generalisations of the results to the wider population (Shaughnessy et al., 2009). Generalisation in larger but clearly defined populations can be possible by sampling methods such as probability random sampling (Frankfort-Nachmias and Nachmias, 1996). The reliability and validity of a research can be affected by bias or systematic errors, which are described below.

3.18 Bias in Research

Bias is research, according to Evanoff (2005), refers to "systematic errors that can occur at any one of multiple points during the planning, conduct, analytic, or reporting stages of a research study". Bias in research / data can be due to several reasons such as sample bias, response (set) bias, non-response bias, researchers bias, interviewee bias, interviewer bias, observer / rater bias, question / questionnaire bias, interview bias, courtesy bias (social desirability bias), measurement bias, prestige bias, selection bias, information bias, recall (memory) bias, social desirability bias, and western cultural bias (Fowler, 1988; Neuman, 2000; Saunders et al., 2000; Zikmund, 2000; Saunders et al., 2003; Bowling, 2005). In addition, there is another type of bias which is called as consent bias, which is also known as authorisation bias or volunteer bias (Junghans and Jones, 2007).

Avoidance of bias in research is necessary otherwise the study findings may have limited impact and they cannot be generalised (Evanoff, 2005). Consent bias (also called authorisation bias or volunteer bias) can be avoided by anonymised sample, participant opt-out approach and response rate >60% can be achieved (Junghans and Jones, 2007). Selection bias, which is also known as consent bias (Buckley et al., 2007), can be reduced by random allocation (Bandolier, 2007) as well as by a larger sample (Buckley et al., 2007). Sampling errors (self-selection bias and diagnostic bias) threaten external validity and can be reduced or eliminated by representative sampling (Evanoff, 2005). Measurement errors / bias (such as observer bias, subject bias and instrument bias) can led to spurious results, therefore need to be avoided by blinding or masking for observer bias, by standardised, consistent and repeatable procedures for avoiding instrument bias (Evanoff, 2005).

3.19 Statistical Methods Used for Data Analysis

According to Thompson (2009), "statistics are generally descriptive (describing what is) or inferential (determining the likelihood of a real difference being present in the population)". In this research, the researcher has used both descriptive as well as inferential statistics for the analysis of data.

In any research, data is measured at different measurement scales /levels such as the nominal (mostly categorical), ordinal (categorised in ranked order), interval (divided in units of equal size), or ratio (continuous or discrete) level(Jackson, 2011, p. 60-62; Ledlow and Coppola, 2011, p.48). Among these scales, the interval and the ratio levels can be transformed by addition, subtraction, division and multiplication without altering the actual level and it is analysed with a range of analytical methods (Thompson, 2009; Jackson, 2011, p. 62). In addition, all the above-mentioned measurement levels / scales can be divided in to two categories i.e. discrete and continuous. The discrete category comprises whole numbers /units/ categories and it generally includes data that are mostly nominal or ordinal in the nature while the continuous category includes fractions of numbers and it commonly encompasses data that are usually measured at either continuous ratio or continuous interval levels (Jackson, 2011, p. 63).

In the present study, the researcher analysed data using a number of statistical methods described below. As suggested by Peat et al. (2002, p. 188), the frequencies of categorical variables and the distributions of the continuous variables were examined in the first instance. This was done because the frequency distributions help in identifying errors especially data entry errors

(Thompson, 2009). Before undertaking further analyses, data from some variables measured in ratio level especially with smaller numbers were merged together to form new variables with ordinal level data (Thompson, 2009) so as to maintain the statistical power and to avoid unwanted effects on final statistical results, as suggested (Peat et al., 2002, p. 188-189).

According to Thompson (2009), “descriptive statistics are numbers that summarise the data with the purpose of describing what occurred in the sample” and can be used to compare samples in different studies. Descriptive statistics such as mode, median and mean (average) measure central tendency but do not inform about the distribution of and variability in data, which can be better measured with the range and the standard deviation (Thompson, 2009)

For determining baseline comparisons for continuous variables, the researcher used descriptive statistics such as the range, mean, standard deviation and 95% confidence internals were calculated for each normally distributed variable and median and inter-quartile range were calculated for each skewed variable, as suggested (Peat et al., 2002, p. 189-195).

To determine relationships (correlations) between variables, the researcher used Pearson's R, which can be used as both descriptive statistics and inferential statistics (Thompson, 2009).

For multiple continuous variables, the researcher used multivariate methods of analysis such as multiple regressions when there was at least one outcome variable; and factor analysis when there was no outcome variable, as suggested (Peat et al., 2002, p. 189-195). In addition, factor analysis was undertaken to determine construct validity of the survey instruments (Portney and Watkins, 2009, p. 108), to detect relationships among variables and to reduce the number of variables (Portney and Watkins, 2009, p. 713-714), which were included in both of the survey questionnaires used in this study.

To determine the significance level, a value of $p \leq 0.05$ was considered significant throughout the analyses. In addition, acceptable level Type I error / alpha (α) was .05 and the power level (Type II error or β) level of .80 (80%) was accepted for interpretation of statistical inference (Hair et al., 2010, p. 9-10).

The reliability, external validity and internal consistency of survey questionnaires were determined by calculating Cronbach's alpha (α) (Peat et al., 2002, p. 109 & 124; Bernard, 2006, p. 332 & 335; Portney and Watkins, 2009, p. 606), which was regarded acceptable if it was ≥.70 as suggested (Bowling, 2005, p. 397). The content validity of the practices and procedures instrument was determined by expert judgements (Bowling, 2005, p. 398), which were made by a panel of chartered physiotherapists.

3.20 Multivariate Statistical Techniques used for Inferential Data Analysis

For inferential data analysis, multivariate statistical techniques used by the researcher include factor analysis (i.e. exploratory and confirmatory factor analyses), multiple linear regression and structural equation modelling. A review of these inferential statistical techniques is given below.

3.20.1 Factor analysis

Factor analysis is a multivariate statistical technique that is used to determine interrelationships (correlations) between variables and to find whether data comprising several variables can be reduced to a few factors or components that are a groups of highly correlated variables representing underlying dimensions within the data (Hair et al., 2010. p.92 & 94). Factor analysis can be undertaken in two forms i.e. exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). EFA is most commonly used when the aim is only an exploratory research to identify latent factors and CFA is used to confirm theoretical or conceptual hypothesis about interrelationships between a set of observed variables and latent factors (Hair et al., 2010. p.94-95). In other words, EFA is used to generate hypotheses about underlying latent processes thus it helps in theory generation and CFA is used to test the underlying latent processes, thus it assists in theory testing (Tabachnick and Fidell, 2007, p.609-610). Before proceeding with EFA and CFA, the data have to meet a number of assumptions such as normality, linearity, absence of outliers, absence of multicollinearity and singularity, homoscedasticity and the homogeneity as well as conceptual linkages between the variables (Tabachnick and Fidell, 2007, p.613-615; Hair et al., 2010, p.103-105). In addition, factor analysis (FA) requires the presence of correlations between the variables; however, the correlations should be neither equal nor too low (i. e. <.30) (Tabachnick and Fidell, 2007, p.614; Hair et al., 2010, p.103-104). In this regard, the statistically significant Bartlett's test of Sphericity (p <.05) confirms the appropriateness of entire correlation matrix in the data required for running an EFA (Tabachnick and Fidell, 2007, p.614; Hair et al., 2010, p.105). Moreover, anti-image correlation matrix with partial correlations < .70 and the 'measuring of sampling adequacy' >.50 also indicate the presence of the appropriate correlations between the variables necessary for conducting the factor analysis (Tabachnick and Fidell, 2007, p.614; Hair et al., 2010, p. 105). Nevertheless, better factor extraction requires a higher (for example >.60) shared variance (known as communality in the EFA) between the analysed variables (Hair et al., 2010, p. 111). Variable communalities less than .50 provide less explanation for the variance and therefore may be problematic (Hair et al., 2010, p. 119). Tabachnick and Fidel (2007, p.613) suggested a minimum sample size of 300 cases for factor analysis. In this research, the sample size was >390 which is regarded as a good-very good sample size for FA; hence, the data was suitable and used for both EFA and CFA.

Factor analysis (FA) is different from multiple regression (MR) where the former is an interdependence technique and the latter is a dependence technique (Hair et al., 2010, p.99). Therefore, there are no dependent or criterion variables in FA and all the measured variables are simultaneously considered in the analysis; hence, there is no prediction in FA but there is identification of underlying structure or dimensions (factors or constructs) representing measured variables (Hair et al., 2010, p.99). FA thus helps to create a smaller number of new variables that were not directly measured but represent the concept or dimension underlying the measured variables.

3.20.1.1 Exploratory factor analysis

The researcher used EFA to identify latent factors from 60 measured variables representing different types of risk factors. This included 23 variables for perception of health risk, 22 variables for perception of health consequences and 15 variables for protection against risk. The objective was to reduce the number of variables from 60 variables to a few unmeasured distinct categories of health risks defined as latent factors or dimensions. The EFA requires at least five variables for a factor and at least five observations for each variables included in the analysis (Hair et al., 2010, p. 102). In this research study, there were 390 observations for 60 variables, which showed a ratio 1:6.5 i.e. 6.5 cases for each variable analysed. In addition, EFA requires a number of assumptions as follows.

i. Sample size: Tabachnick and Fidel (2007, p.613) suggested a minimum sample size of 300 cases for factor analysis. In this research, the sample size was 390, which is regarded as a good-very good sample size for FA; hence, the data was suitable and used for the EFA.

ii. Missing data: Missing value by case and by variable were estimated and imputed by multiple imputation method as mentioned earlier. However, 'do not know score' were treated as missing value by selecting 'exclude cases listwise' for EFA.

iii. Normality: In factor analysis presence of normality, especially multivariate normality is essential, because it enhances the factor solution (Tabachnick and Fidell, 2007, p.613). Normality was assessed by skewness and kurtosis and this assumption was met as described earlier.

iv. Linearity: Liner relationship between variables is measured by their correlations with each other, and the latter is essential for factor loadings; hence, the factor analysis is degraded when there is no linearity between variables (Tabachnick and Fidell, 2007, p.613). Linearity between pairs of variables was assessed with scatterplots and the assumption was met.

v. Absence of outliers among cases: Outlier cases on both the individual variables and a set of variables are known as univariate and multivariate outliers respectively and they have greater impact on factor solution (Tabachnick and Fidell, 2007, p.614). Hence, both univariate and multivariate outliers were identified and deleted as described earlier.

vi. Absence of outliers among variables: According to Tabachnick and Fidel (2007, p.615), an outlier variable is the one that has low SMCs with all other variables and low correlations with all important factors and all such variables should be excluded from factor analyses. All outlier variables were deleted during the EFA and only variables with substantial communalities and loadings on factors were retained in the final factor solution.

vii. Absence of multicollinearity and singularity: presence of singularity or extreme multicollinearity between variables can create problem in factor analysis and estimating factor scores either in EFA or CFA, hence all such variables have to be identified and deleted (Tabachnick and Fidell, 2007, p.614). These assumptions were checked and met as described earlier.

viii. Factorability of R: size of correlations between variables depends on the sample size; therefore, factor analysis is undertaken if factor matrix shows correlation ≥.30 otherwise it is abandoned (Tabachnick and Fidell, 2007, p.614). Factorability of R was met by checking Bartlett's test of Sphericity (significant at p =.05), significant correlations between variables, the anti-image correlation matrix (with small values) and Kaiser's measure of sampling adequacy values ≥.60 as suggested (Tabachnick and Fidell, 2007, p.614).

In EFA, there are two methods of factor extraction i.e. component analysis and common factor analysis (Hair et al., 2010, p.105-108). The researcher used common factor analysis because this method is appropriate in determining latent dimensions, especially when common variance is desired and elimination of error and specific (unique) variance is needed (Hair et al., 2010, p.108). For extracting latent factors in the EFA, several criteria have been suggested (Hair et al., 2010, p.108-111) and the researcher applied the most commonly used criteria as follows.

i. Latent root criterion: all factor with Eigen values greater than 1.0

ii. Percentage of variance extracted ≥ 40%

iii. Scree test criterion: retention of all factors before inflection point on the scree plot (graph)

In addition, the type of rotation axis and factor loadings determines the extraction of latent factors in EFA. Rotation of factors is defined as ‘a process by which the solution (matrices produced and interpreted) is made more interpretable without changing its underlying mathematical properties’ (Tabachnick and Fidell, 2007, p.609). There are two types of rotation i.e. orthogonal rotation where all factor are thought to be uncorrelated and oblique rotation where all factors are thought to be correlated (Tabachnick and Fidell, 2007, p.609). Oblique rotation is therefore used for correlated variables (Hair et al., 2010, p. 116). The researcher therefore used oblique rotation using the Oblimin method because risk perceptions are regarded as correlated with each other (Lee et al., 2008). In EFA, factor loadings mean correlations between the observed (measured) variables and the latent (unmeasured) factors (Tabachnick and Fidell, 2007, p.609; Hair et al., 2010, p. 116). In this regard, Hair et al. (2010, p.117) have suggested a minimum .30 factor loading for identifying a significant factor (p =.05) for a sample size of 350. Given the sample size of 390 in this study, the researcher applied factor loadings ≥.30 as significant for extracting factors. All extracted factors were labelled on the basis of the underlying dimension that was identified on the basis of the nature of variables loaded on each factor (Hair et al., 2010, p.120).

In EFA, the final stage is validation of the extracted factor because the validation identifies the extent of generalisation of the findings to the population and determines the possible impact of each case and each respondent on the overall results (Hair et al., 2010, p.122). Validation thus confirms the results and assesses their reproducibility (Hair et al., 2010, p.122). This can be achieved by a number of methods such as the CFA. The researcher used the CFA to validate the factor models extracted in the EFA. The CFA is performed using structural equation modelling (Tabachnick and Fidell, 2007, p.609), which is briefly described below.

3.20.2 Structural equation modelling

According to Tabachnick and Fidel (2007, p.676), structural equation modelling (SEM) 'is a collection of statistical techniques that allow a set of relationships between one or more IVs, either continuous or discrete, and one or more DVs, either continuous or discrete, to be examined". In SEM, both the IVs and the DVs can be either measured variables or latent factors (unmeasured variables) (Tabachnick and Fidell, 2007, p.676). Thus, SEM provides factor analysis, canonical correlation and multiple regression in one technique, which assesses model fit to the data and the contribution of IV(s) to the dependent variable(s) (Tabachnick and Fidell, 2007, p.26). In addition, SEM is more advantageous than the regression because of estimation of the residual error in the former (Tabachnick and Fidell, 2007, p.26). SEM requires path diagrams indicating hypothesised set of relationships between independent and dependent variables and latent factors, which collectively is known as a model (Tabachnick and Fidell, 2007, p.677).

In SEM, according to Tabachnick and Fidel (2007, p.677), there are a number of conventions as follows.

i. Measured variables are also called as observed or manifest variables or indicators and they are represented by squares or rectangles in path diagrams

ii. Factors are also called as unobserved or latent variables or constructs and they are represented by circles or ovals in path diagrams

iii. Each factor is composed of two or more measured variables.

iv. In path diagram, relationships between two variables in indicated by lines with either one or two arrow heads. A line with one arrow head shows direct relationship whereas a line with two arrow heads shows covariance or no direct (or unanalysed) relationship between two variables.

v. Dependent variable is the variable with the arrow pointing towards it

vi. Independent variable is the variable with the arrow pointing away from it

vii. Absence of line between variables implies no hypothesised direct relationship

viii. All dependent variables both measured and unmeasured have errors, which are labelled as ‘E’ (i.e. error) pointing towards measured variable and ‘D’ (i.e. disturbance) pointing towards unmeasured variable (latent factor)

ix. In SEM, a model consists two parts. The part of the SEM model that comprises measured variables and latent factors and relationships between measured variables and latent factors is called the ‘measurement model’ while the part of SEM model that shows hypothesised relationship(s) between latent factors in the model is known as the ‘structural model’.

x. SEM / CFA is based on covariance between variables while EFA is based on correlations between variables

SEM has a number of advantages such as estimation of error between variable; thus, accounting for the reliability of measurement as well as examination of complex and multidimensional relationships simultaneously (Tabachnick and Fidell, 2007, p.679). SEM helps in model specification, which can involve estimation, evaluation and possibly modification from confirmatory perspectives. Thus SEM is used for testing models, testing hypotheses about model, modification of existing models and testing a number of related models (Tabachnick and Fidell, 2007, p.679). SEM can be run on several software packages such as the AMOS (Analysis of Moment Structures), EQS (Structural Equation Modeling Software), SAS CALIS (Statistical Analysis Software Covariance Analysis of Linear Structural Equations) and LISREL (Linear Structural Relations) (Tabachnick and Fidell, 2007, p.773; Blunch, 2008; Hair et al., 2010). There are several types of SEM and CFA is a special type of SEM (Tabachnick and Fidell, 2007, p.676). CFA is described in the following section.

3.20.2.1 Confirmatory factor analysis

Confirmatory factor analysis (CFA) is a factor analysis techniques that is used to test 'a theory about latent processes' (Tabachnick and Fidell, 2007, p.609) such as 'specific hypotheses about structures and relations between the latent variables that underlie the data' (Field, 2009, p.783). CFA assesses the contribution of each variable (item) included in the scale (construct or factor) and tests how well the scale represents the underlying dimension (Hair et al., 2010, p. 20 & 693)..

Like an EFA, CFA requires fulfilment of a number of assumptions as follows.

3.20.2.1.1 Assumptions for CFA/SEM

Like any other multivariate statistical technique, CFA and SEM require following assumptions.

3.20.2.1.1.1 Sample size

CFA / SEM requires a large sample size (Tabachnick and Fidell, 2007, p.682); however, no minimum sample size has been suggested. For SEM, the sample size determination has been suggested on the basis of the number of parameters (degree of freedom) and the effect size (MacCallum et al., 1996) and a minimum number of five cases per measured variable have been suggested (Brown, 2006, p.413). For confirmatory factor analyses conducted in this research, the minimum sample size was 306 cases and the maximum number of measured variables analysed was 11, which means there were about 28 cases per variable.

3.20.2.1.1.2 Missing data

SEM cannot run in the presence of missing data; hence, it is important to address missing values by either deleting or imputing (Tabachnick and Fidell, 2007, p.683). As mentioned earlier, missing values were imputed by a multiple imputation method. However, there were ‘do not know’ scores that were treated as missing values; these were however not imputed because these were valid scores reported by the participants. Therefore, all cases with ‘do not know’ scores for any of the variables included in CFA models were deleted before running CFA for testing model fitting to the given data.

3.20.2.1.1.3 Multivariate normality and outliers

Multivariate outliers can be identified by determining each variable’s Mahalanobis distance greater than the critical values of chi-square (X^2) at a desired α level usually .001 with degree of freedom that equals to the number of IVs (Tabachnick and Fidell, 2007 p.166). To fulfil the multivariate normality requirement for SEM / CFA (Tabachnick and Fidell, 2007, p.683), all univariate and multivariate outliers were identified in two stages. First, for all variables in the data before running exploratory factor analyses and second, for all variables that were included in CFA models before running the model confirmation in SEM.

3.20.2.1.1.4 Linearity

To meet the linearity requirement of SEM, linear relationships between variables were checked, and met, by inspection of scatter plots, as suggested by Tabachnick and Fidell (2007, p.683).

3.20.2.1.1.5 Absence of multicollinearity and singularity

In SEM, covariance matrices need to be inverted and that cannot be achieved if there is the presence of multicollinearity and singularity, which may lead to a SEM program abortion or provide a warning message for the presence of singularity (Tabachnick and Fidell, 2007, p.683). The researcher observed no such issue during running CFA; hence, it was assumed that there were no multicollinearity and singularity issues among the variables included in the CFA models.

3.20.2.1.1.6 Residuals in covariance matrices

According to Tabachnick and Fidell (2007, p.684), residuals in covariance matrices should be small and centered around zero after estimation of a CFA model. Covariance matrices obtained in estimating CFA models were examined by the researcher and no large residuals were observed, which confirmed meeting this assumption for SEM.

3.20.2.1.2 Stages in CFA / SEM

There are three stages in SEM i.e. specification of a model, estimation of the model and evaluation of the model fit.

3.20.2.1.2.1 Model specification

There are several methods of model specification in SEM such as the Bentler-Weeks method in which all (observed and latent) variables are either DVs or IVs and the estimated parameters include the regression coefficients, variances and covariances of the IV(s) in the model (Tabachnick and Fidell, 2007, p.688). In addition, residual errors of variables are measured, which are denoted as ‘e’ (errors) for observed variables and ‘D’ (disturbances) for latent variables (Tabachnick and Fidell, 2007, p.688).

3.20.2.1.2.2 Model estimation

In SEM, model estimation can be performed using a number of methods, for example Maximum Likelihood method, that generate a number of matrices such as regressions, variances, correlations, covariances and residual matrices (Tabachnick and Fidell, 2007, p.690-694).

3.20.2.1.2.3 Model fit evaluation

In CFA / SEM, a model can be declared fit on the basis of several criteria (Schermelleh-Engel et al., 2003; von Eye et al., 2003; Hair et al., 2010). Most commonly reported indicators of model fit are described as follows.

3.20.2.1.2.3.1 Chi Square

In SEM, a non-significant chi square (χ^2) is required to obtain model fit against the given data; however, χ^2 values are sensitive to the sample size thus a large sample size can result in significant χ^2 (Tabachnick and Fidell, 2007 p. 695, 715). Therefore, another criteria related to χ^2 has been suggested for model fit i.e. ratio of the χ^2 to the degree of freedom (DF), labelled as CMIN/DF (minimum Chi square / degree of freedom) (Byrne, 2010, p. 75-77), which has to be less than 2 (Tabachnick and Fidell, 2007, p715).

3.20.2.1.2.3.2 Comparative fit indices

3.20.2.1.2.3.2.1 Normid Fit Index (NFI)

Under Normid Fit Index (NFI) or Bentler-Bonett index, the estimated model is assessed by comparison of χ^2 values of the hypothesised and the independent models and an NFI value >.95 indicates a good model fit (Tabachnick and Fidell, 2007, p716; Byrne, 2010, p. 78). However, NFI values are underestimated by small sample size (Byrne, 2010, p. 78) ; hence, another fit index known as NNFI is used instead, which is described below.

3.20.2.1.2.3.2.2 Non-Normid Fit Index (NNFI)

Non-Normid Fit Index is also known as Tucker-Lewis Coefficient Index (TLI) (Hair et al., 2010). This fit index takes into account the degree of freedom and adjusts the NFI. An NNFI value ranges between 0 and 1 and a value higher than .90 shows the model fitting the data (Tabachnick and Fidell, 2007, p716). Its value near to .95 indicates good fit (Byrne, 2010, p. 79). However, its' value can be low due to its sensitivity to the small sample size and this issue can be solved by another index called incremental fit index (Tabachnick and Fidell, 2007, p716).

3.20.2.1.2.3.2.3 Incremental Fit Index

Incremental Fit Index (IFI) takes into account the degree of freedom to adjust the issue of large variation in the values of NNFI and an IFI value of >.90 shows good model fit (Tabachnick and Fidell, 2007, p716).

3.20.2.1.2.3.2.4 Comparative Fit Index

Comparative fit index (CFI) evaluates model fit by taking into account non-central χ^2 distribution and non-centrality parameters ι_i that equals zero (0) when the model is fit and a CFI value of >.95 indicates a good model fit and is reliable for a small sample size (Tabachnick and Fidell, 2007, p717; Byrne, 2010, p.78; Hair et al., 2010, p. 684).

3.20.2.1.2.3.3 Root mean square error of approximation (RMSEA)

This index compares the lack of fit in a model (for example a hypothesised model) compared to a saturated (a perfect) model that has a RMSEA value of 0.00 and the p-value >.50 (Byrne, 2010, p.80) A RMSEA value of ≤.06 shows a good model fit; however, when the sample size is small the RMSEA can reject a true model (Tabachnick and Fidell, 2007, p.717; Hair et al., 2010, p. 684).

3.20.2.1.2.3.4 Indices of proportion of variance accounted for

According to Tabachnick and Fidell (2007, p.718-719), two fit indices i.e. Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) that take into account a weighted proportion of variance in the sample covariance accounted for by the estimated population covariance matrix. The GFI is equivalent to R^2 in multiple regression and it is sensitive to the number of parameters in the estimated model while the AGFI takes into account the degree of parsimony (fewer parameters) and adjusts for the number of estimated parameters in a model. GFI and AGFI values range between 0.00 to 1.00 and a value of ≥.80 indicate a good model fit to the data (Tabachnick and Fidell, 2007, p. 718-719; Byrne, 2010, p. 77).

3.20.2.1.2.3.5 Degree of parsimony fit indices

According to Tabachnick and Fidell (2007, p.719-720), a number of fit indices have been developed that take into account the degree of parsimony (number of parameters) in a model such as Parsimony Goodness of Fit Index (PGFI), Akaike Information Criterion (AIC) and Consistent Akaike Information Criterion (CAIC). Higher PGFI values (i.e. nearer to 1) and lower values of AIC and CAIC (i.e.

smaller values compared to other models) indicate good fit of the estimated model and the AIC and CAIC are especially good for small sample size and nested models (i.e. a model is a subset of another model) (Tabachnick and Fidell, 2007, p. 719-721; Byrne, 2010, p. 82).

3.20.2.1.2.3.6 Residual based fit indices

Fit indices based on residuals i.e. average differences between the sample variances and covariances and the estimated population variances and covariances include the Root Mean Square Residual (RMR) and the Standardised Root Mean Square Residual (SRMR). Values of RMR and SRMR range from 0 to 1 and their values $\leq$.05 indicate a good model fit (Tabachnick and Fidell, 2007, p. 720; Byrne, 2010, pp. 77).

Given the large number of fit indices for estimating model goodness, the selection of the indices depends on the researchers' choice; however, CFI and RMSEA are the most widely reported model fit indices (Tabachnick and Fidell, 2007, p. 720). The researcher has however evaluated all CFA/SEM models by χ^2, CMIN/DF, NFI, NNFI (TLI), IFI, CFI, RMSEA, GFI, AGFI and PNFI criteria.

3.20.2.1.3 Reliability and proportion of variance

In CFA / SEM, reliability of a measured variable is determined by its squared multiple correlation (SMC) and the proportion of variance (POV) of a measured variable is determined by its variance accounted for by the latent factor on which it is loaded; thus, the POV is conceptually analogous to the communality of a measured variable in the EFA (Tabachnick and Fidell, 2007, p.728). However, if the SMC value of a variable is higher i.e. between .99 and .9999, then there is multicollinearity issue, which means the variable is highly correlated with other variables while if the SMC value is 1 then there is singularity problem, which means the variable is perfectly correlated with other variables; hence, deletion of the variable may be required (Tabachnick and Fidell, 2007, p.88-91).

3.20.2.1.4 Model modification

Modifications are made in the models to improve model fit, particularly in exploratory research, and to test hypotheses, especially in theoretical work, which can be undertaken by chi-square difference tests, Lagrange multiplier (LM) tests and Wald tests (Tabachnick and Fidell, 2007, p. 721). In χ^2 difference test, two models are estimated and difference in the χ^2 is estimated; however, this techniques is less preferable due to it being time consuming, higher sensitivity of χ^2 to the sample size as well as requirements of normality of data whereas the LM test assesses the impact of addition of one or more parameters in the model and it is useful when the sample size is small and the Wald test checks the impact of deletion of a parameter on the model fitness (Tabachnick and Fidell, 2007, p. 721). Nevertheless, all the three tests cannot be performed in single SEM software package for example AMOS, SAS CALIS and LISERAL, which do not provide the LM test and Wald test (Tabachnick and Fidell, 2007, p. 779). Moreover, model modifications have to be based on theoretical basis rather than on statistical basis.

After identification of latent factors (constructs) in EFA and CFA / SEM, the researcher created summated variables for the latent factors and then ran multiple regression to find out the significant predictors of the latent factors. A brief description of multiple regression is given in the following section.

3.20.3 Multiple Regression

Regression is a statistical technique that is used to determine the relationship between a DV and a set of IVs (Tabachnick and Fidell, 2007, p. 117). There are several types of regression such as simple regression (SR), multiple regression (MR), and logistic regression (LR). Among various types of regression, MR is equally popular and widely used in several academic disciplines for examples heath studies, business studies and social sciences (Tabachnick and Fidell, 2007, , p. 122). There are several types of MR such as standard MR, stepwise (or statistical) MR and sequential (or hierarchical) MR, which differ from each other in the way the IV(s) are entered in the regression equation (Tabachnick and Fidell, 2007, p.118), which is given below:

$$Y' = A + B_1 X_1 + B_2 X_2 + \cdots + B_K X_K$$

Where Y' is the predicted value of the DV, A is the Y intercept (the value of Y when all the X values are zero), the X_s represent the various IVs (of which there are k), and β_s are the coefficients assigned to each of the IVs (Tabachnick and Fidell, 2007, p.118).

Regression is usually performed for prediction purposes (Tabachnick and Fidell, 2007, p.118). The researcher used sequential (or hierarchical) MR to determine predictors of perception of risk, perception of health consequences and perception of protection against risk as well as their latent factors i.e. unmeasured variables. The researcher preferred sequential (or hierarchical) MR over the other types of regression. The advantages included the researcher's control over the process of regression and entry of IVs in the prediction equation on the basis of theory or logic as well as the test ability to precise hypotheses regarding the proportion of prediction of variance by one or more IVs (Tabachnick and Fidell, 2007, p. 144).

Before running multiple regression for the purpose stated above, the researcher fulfilled following assumptions required for MR.

a) Missing data: Missing data was determined both by case and by variables and then imputed as described earlier in this chapter.

b) Cases to Independent variables ratio: A minimum required sample size was met as calculated by $N \geq 104+m$ (where m is the number of IVs) for testing individual predictors, assuming a medium size relationship between IVs and the dependent variable, $\alpha = .05$, $\beta = .20$ (Tabachnick and Fidell, 2007, p. 123).

c) Absence of outliers: all outliers on both the independent and dependent variables were checked by boxplots and z-scores (i.e. scores higher than +2.5 and lower than -2.5) for univariate outliers and by the Mahalanobis distance as a χ^2 critical value with degree of freedom (number of IVs) at $\alpha = .001$) for multivariate outliers (Tabachnick and Fidell, 2007, p.124). Subsequently all outliers were deleted.

d) Absence of multicollinearity and singularity: In order to avoid both logistical and statistical problems, multicollinearity (which is defined as a very high correlation i.e. $r \geq .90$ between IVs) and singularity (which means one of the variables is a combination of two or more other variables thus causing some variables to be redundant by inflating the size of error term; hence, the analysis may be weakened, but not invalidated) were checked by screening the data for very high squared multiple correlations (SMCs) (default levels .99-.9999) and very low tolerance values i.e. 1-SMC (default level .01-.0001) (Tabachnick and Fidell, 2007, p. 88-91 & 124-127). In other words, SMCs ≥ 1 indicate singularity and SMCs near to

1 indicate multicollinearity and all variables showing either or both of these issues were deleted, as suggested by Tabachnick and Fidell (2007, p. 614).

e) Normality, linearity and homoscedasticity of residuals: As suggested by Tabachnick and Fidell (2007, p.124-125), these assumptions were checked by examining scatterplots of residuals between predicted dependent variable(s) and the errors of prediction, which showed a straight line relationship; hence, the assumptions were met.

f) Independence of errors of prediction: This was checked, as suggested by Tabachnick and Fidell (2007, p.128) with Durbin-Watson statistics, which determine autocorrelation of errors over the sequences of cases and was found insignificant, hence this assumption was met.

3.21 Process of Data Analysis

The process of data collection and analyses is shown in Figure 3.1, which shows that three types of data were collected using three methods. Data collected in practices and procedures audit and observational visits was combined and analysed using frequencies and descriptive statistics in Statistical Package for Social Sciences (SPSS) 15.0 for windows and Predictive Analytics Software (PASW) Statistics 18 (trial version) for windows.

Data collected in the risk perception survey was analysed using descriptive statistics and multivariate statistical techniques as summarised below. Descriptive statistics including frequencies were run in SPSS. This was followed by missing values analysis, scale reliabilities and data normality testing. Then summated scales of perception of risk, perception of health consequences and perception of protection against risk were created and then predictors of perception of risk, perception of health consequences and perception of protection against risk were identified running the sequential multiple linear regression (SMLR). The regression pathways were confirmed by structural equation modelling (SEM).

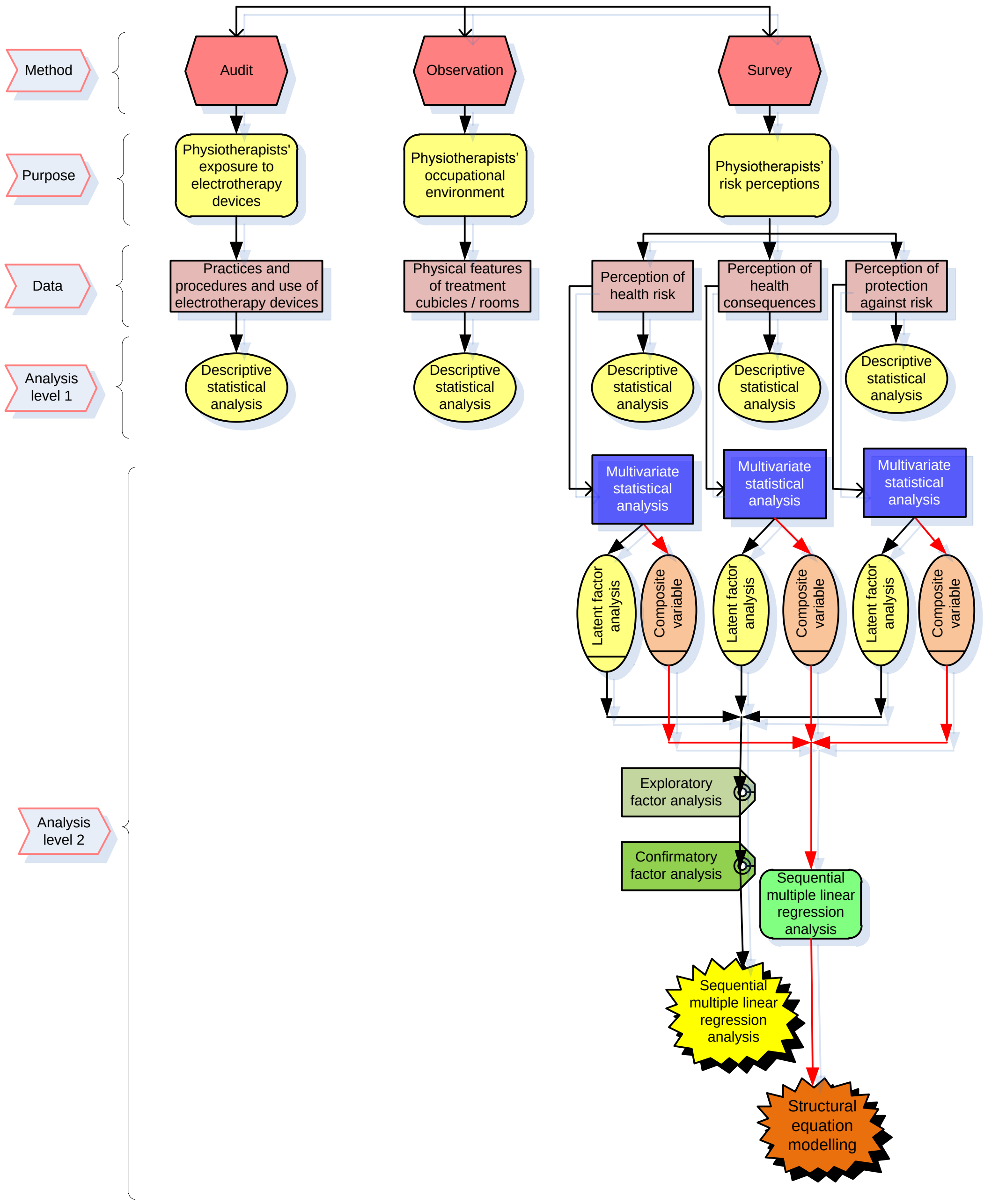

Figure 3.1 Flow chart of the process of data collection and analyses

For identifying the latent dimensions (factors / constructs) of perception of risk, perception of health consequences and perception of protection against risk, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) of risk perception survey data were conducted. After identification and confirmation of latent factors, summated variables of all latent factors were created. Finally, predictors of latent variables were identified running the sequential multiple linear regression (SMLR). PASW Statistics 18 was used for missing values analysis, scale reliabilities, data normalisation for multivariate analysis, EFA and SMLR while Analysis of Moment Structures (AMOS) 18 for window was used for CFA/SEM.

3.22 Summary

Methodological details for conducting this research were provided in this chapter. This study was conducted using a cross sectional study design that involved a sample of 46 physiotherapy departments (7 in pilot study and 39 in the main study) and 584 physiotherapists working in these departments. Data was collected in three phases by three research methods. First, an audit of electrotherapy equipment, and practices and procedures was conducted in 46 physiotherapy departments using an in-house developed practices and procedures questionnaire. This was followed by semi-structured observational visits using a diary tool in the same departments to identify specific physical features of physiotherapists' work environment workplace particularly in treatment rooms / cubicles used for treatment with therapeutic diathermy modalities in a sample of NHS hospitals and clinics that may raise safety issues for physiotherapists. Finally, an adapted and previously validated questionnaire on risk perception was administered to 584 physiotherapists working in all physiotherapy departments (n=46) mentioned above. Data obtained in the practices and procedures audit and observational visits was analysed using frequencies and descriptive statistics. Data obtained in the risk perception survey was analysed using various analytical tests that included frequencies, descriptive statistics and multivariate data analysis including exploratory and confirmatory factor analyses. Risk perception data was also analysed using multiple linear regression and structural equation modelling. Results of this study are presented in the next chapter.

4 RESULTS

In this chapter, results of this study are presented in the following order. The first section gives response rates obtained during different phases of the research i.e. the practices and procedures audit, observational visits and risk perception survey. The second section provides details of the reliability and validity of two survey instruments, which are the practices and procedures questionnaire and risk perception questionnaire. The third section contains results of the practices and procedure survey on five interrelated themes i.e. device, physiotherapist / operator, treatment, occupational environment (workplace) and departmental issues addressed in the survey. The fourth section gives findings of observational visits to physiotherapy departments. The fifth section shows results of physiotherapists' perception of health risk, perception of health consequences and perception of protection of health from risk. Finally, a summary of this chapter along with an outline of the subsequent chapter on discussion are given.

4.1 Response Rate

In this section, the researcher presents response rates obtained during three different phases of this research i.e. practices and procedures study of physiotherapy departments, observational visits to physiotherapy departments and the survey of physiotherapists' perception of risk.

4.1.1 Practices and procedures audit survey

The practices and procedures audit of physiotherapy departments was conducted in the first phase of this research from October 2002 to April 2003. The recruitment rate was 81% (i.e. 46/57 departments). The response rate was 100% as all departments (n =46 - including 7 departments involved in the pilot study and

39 departments in the main study) that agreed they took part in this phase of the study

4.1.2 Observational visits

Observational visits to physiotherapy departments were carried out in the second phase of this study from Dec 2002 to June 2003. The response rate in this phase of the study was same as in the first phase i.e. 100% (n=46), which included all departments involved in the pilot study and the main study, as mentioned above

4.1.3 Risk perception survey

The survey of physiotherapists' perception of risk was undertaken during the third (last) phase of this research from June through to November 2003. In this survey, all physiotherapists (n=584) working in 46 physiotherapy departments, which took part in the first two phases of this research, were involved and the response rate achieved was 66.8% (i.e. 390 out of 584 physiotherapists returned the completed survey questionnaires).

4.2 Reliability and Validity of Survey Instruments

As mentioned earlier in the chapter 3 on methodology, the researcher applied two survey instruments in this research. The first instrument entitled the practices and procedures questionnaire was designed in house while the other instrument entitled the risk perception questionnaire was adapted with a few amendments made to it. The researcher therefore recognises that it is essential that the results of the reliability and validity of the two questionnaires be reported here.

4.2.1 Reliability

The reliability of survey questionnaires was assessed by determining Cronbach's alpha and the results are presented below.

4.2.1.1 Practices and procedures questionnaire

The reliability of the practices and procedure questionnaire was determined by the Cronbach's alpha, which was .798 that was calculated by running the reliability statistics with the Scale Analysis on the SPSS for all the items in the instrument. During the running of the reliability statistics, all items related to the microwave diathermy (n=14) were automatically removed from the analysis since they had zero variance. Consequently, 113 items out of total 127 items were automatically included in determining the scale reliability of this questionnaire.

The output for the 'Item-total Statistics within the Scale Analysis' revealed through the 'Cronbach's alpha if item deleted' that the reliability of the practices and procedures questionnaire could be enhanced from .798 to .898 if one item i.e. 'number of patients per week visiting the department' was deleted. However, none of the items was excluded during the final analysis because the internal consistency of this questionnaire was already high (i.e. Cronbach's alpha = .798).

4.2.1.2 Risk perception questionnaire

The reliability of the risk perception questionnaire was determined by the Cronbach's alpha that was found .884, which was calculated by running the reliability statistics in the SPSS for all items (n=82) that comprised this questionnaire.

The 'Cronbach's alpha if item deleted' option in the Item-Total Statistics with the Scale: Reliability analysis showed that the Cronbach's alpha; hence, the reliability of the risk perception questionnaire, could be improved further by deleting some of the variables and/or items that contribute very little or none towards the overall reliability of the instruments. The researcher therefore undertook a number of iterations of running the Scale Statistics by deleting (removing) the variables/items having none or little contribution towards the overall reliability of the instruments until a high score of Cronbach's alpha were found. The highest score of Cronbach's alpha could be obtained for the risk perception questionnaire was .951 for 70 items, out of total 82 items, by deleting 12 socio-demographic variables / items given below. However, none of the following items was removed or excluded from the final analysis because the instrument internal reliability was already very high (i.e. Cronbach's alpha = .884).

1) How long have you been qualified?
2) How many cigarettes do you smoke in a typical day?
3) How many units of alcohol do you drink in a typical week?
4) On average how many days a week do you drink alcohol?
5) How often do you undertake vigorous exercise (for more than 30 minutes at a time?
6) How often do you undertake mild exercise?
7) Do you have special diet for health reasons?
8) Do you believe that you eat the right amount of food for you?
9) Do you believe you currently have a balanced diet?
10) What is your weight?
11) What is your height?
12) Body mass index?

4.2.2 Validity

The validity of the two survey questionnaires was assessed by determining Cronbach's alpha as follows.

4.2.2.1 Practices and procedures questionnaire

The internal validity of the practices and procedures questionnaire was assessed by determining the Cronbach's alpha that was found .798, which was determined by running the reliability of all 113 items included in the P&P questionnaire excluding all items (n = 14) related to the microwave diathermy since this type of electrotherapy devices was not available in the surveyed physiotherapy departments. The 'Cronbach's alpha if item deleted' option in the 'Item-Total statistics within the Scale: reliability analysis' showed that the overall Cronbach's alpha could be increased by deleting some of the items such as the 'number of patients visiting the physiotherapy department per week'. The researcher therefore deleted this item and the Cronbach's alpha score of .898 was found which the researcher set as the final the limit of Cronbach's alpha for this questionnaire.

4.2.2.2 Risk perception questionnaire

The internal validity of the risk perception questionnaire was determined by assessing Cronbach's alpha, which was found .884 for all 82 items included in this questionnaire. The 'Cronbach's alpha if item deleted' option in the 'Item-Total statistics within the Scale: reliability analysis' showed that the overall Cronbach's alpha can be increased by deleting some of the items, which had no or lowest contribution towards the overall reliability. The researcher thus repeatedly ran the Scale: reliability analysis until a highest Cronbach's alpha score of .951 was found for the risk perception instrument, which was achieved by deleting 12 socio-demographic variables / items mentioned in the reliability section above.

4.3 Results of Practices and Procedures Survey

Results of the survey of practices and procedures in physiotherapy departments are divided in to five themes i.e. device issues, physiotherapists (operator) issues, treatment issues, occupational environment (workplace) issues and departmental issues, which are presented in the following sub-sections.

4.3.1 Device issues

Results of issues related to electrotherapy devices include information regarding a number of items as follows.

4.3.1.1 Availability of devices

The availability and non-availability of devices of nine electrotherapy modalities in surveyed departments is shown in Table 4.1 and Figure 4.1, which reveal that devices of microwave diathermy were not available whereas devices of therapeutic ultrasound were available in all surveyed departments. The order of frequency of available modalities by number of departments was ultrasound (n=46, 100%) > Interferential (n=44, 95.7%) > PSWD (n=43, 93.5%) > TENS (n=38, 82.6%) > Laser (n=23, 50%) > CSWD (n=14, 30.4%) >H-wave (n=3, 6.5%).

Table 4.1 Availability of electrotherapy devices

	Available		*Not available*	
	N	%	n	%
Ultrasound	46	100	0	0
Interferential	44	95.7	2	4.3
PSWD	43	93.5	3	6.5
Biofeedback	39	84.8	7	15.2
TENS	38	82.6	8	17.4
Laser	23	50	23	50
CSWD	14	30.4	32	69.6
H-wave	3	6.5	43	93.5
MWD	0	0	46	100

PSWD = pulsed shortwave diathermy, TENS = transcutaneous electrical nerve stimulation, CSWD = continuous shortwave diathermy, MWD = microwave diathermy

4.3.1.2 Number of devices available

The number of devices of each of the eight modalities of electrotherapy available in the surveyed physiotherapy departments is given in Figure 4.1. The number of devices available varied between modalities and between departments. The highest number of available devices in a department was 88 for TENS, 14 for Ultrasound, 8 for Biofeedback, 6 for PSWD, 5 for Interferential, 3 for CSWD and 2 devices each for Laser and H-wave.

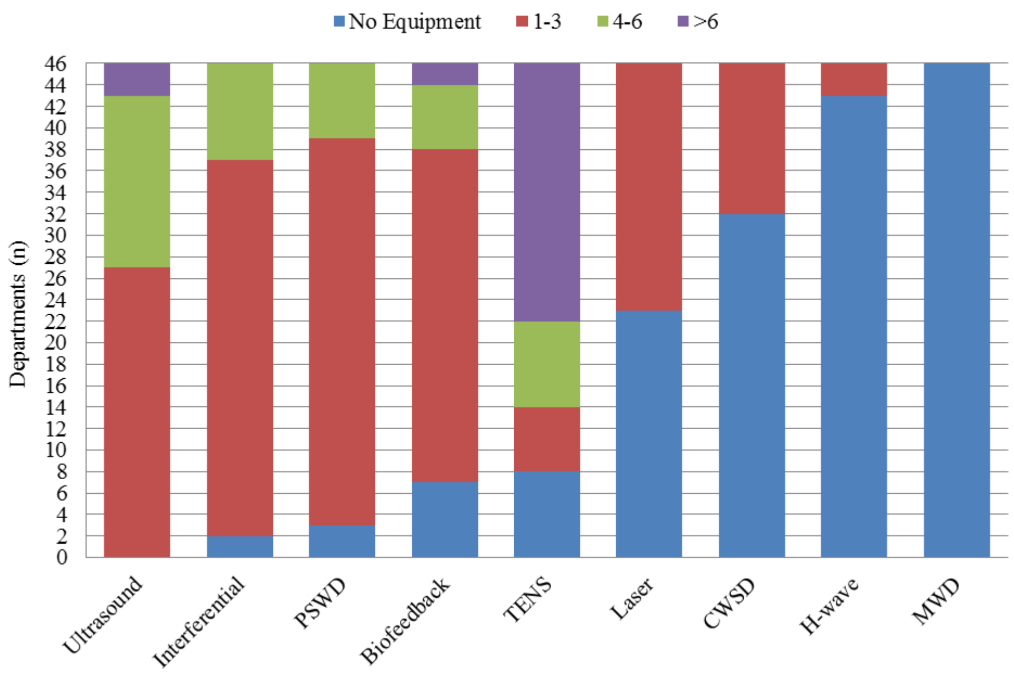

Figure 4.1 Number of electrotherapy devices available in physiotherapy departments

4.3.1.3 Use and non-use of devices

Figure 4.2 shows use and no-use of electrotherapy modalities in departments where the equipment was available. Both the use and the non-use varied between modalities and between departments. The order of use reported was ultrasound (n=37) > interferential (n=35)> PSWD (n=32) > Biofeedback (n=30) > TENS (n=28)> Laser (n=7)> CSWD (n=4) > H-wave (n=1). In some departments, devices were not used despite availability, which was reported for CSWD, PSWD, laser and biofeedback by 64.3% (n=9), 9.3% (n=4), 4.3% (n=1) and 2.6% (n=1) of 14, 43, 23 and 39 departments where these types of devices were available. The non-use was not reported for ultrasound, interferential, TENS and H-wave by the departments that had the equipment available. A number of departments provided no information on usage of the eight modalities, as shown in Figure 4.2.

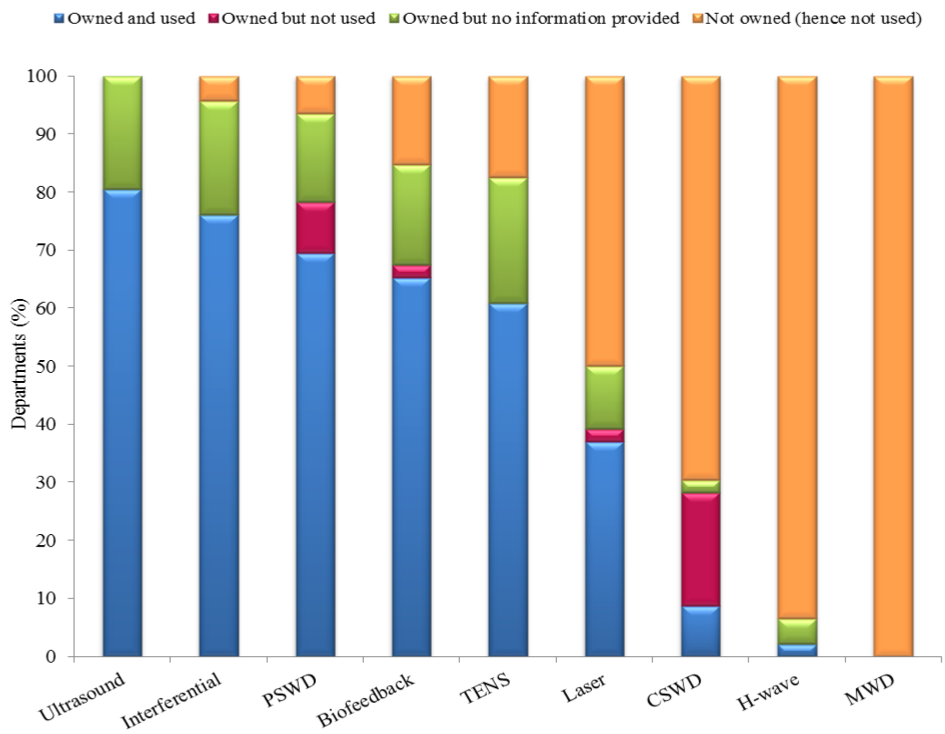

Figure 4.2 Use of electrotherapy devices in physiotherapy departments

The frequency of use of PSWD and CSWD on a five points Liker Scale (i.e. 4-5 days / week (very commonly), 2-3 days / week (commonly), one day / week (rarely), less than one day / week (very rarely) and never (never)) showed that the use of PSWD was more common than the use of CSWD. Of the 43 departments where PSWD devices were available, the frequency of use was reported as 4-5 days / week in 15 (35%) departments, 2-3 days / week in 7 (16%) departments, 1 day / week in 2 (5%) departments, <1 day / week in 15 (35%) departments and 'never' in 4 (9%) departments. Of the 14 departments that had CSWD devices, the frequency of use was reported as 2-3 days / week by 1 (7%) department, <1 day / week by 4 (29%) departments and 'never' by 9 (64%) departments.

4.3.1.4 Order of device usage in departments where these equipment were used

The ranking of the order of use of electrotherapy modalities reported by departments on a nine point Liker scale from most commonly used (rank first) to least used (rank ninth) is shown in Figure 4.3. The greatest number of departments ranked the use of ultrasound, TENS and Interferential as first choice, the use of PSWD and Biofeedback as second choice and the use of CSWD as the sixth choice. An equal number of departments ranked the use of Laser as first and second choices. All departments that used the H-wave reported its use as 7th choice. A few departments also reported the last (9th) choice to use PSWD.

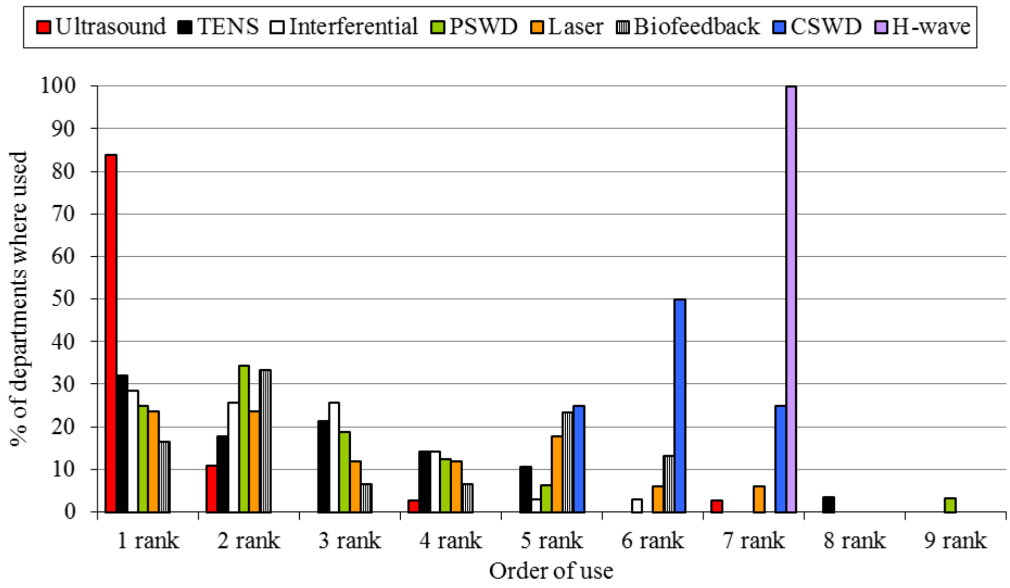

Figure 4.3 Order of electrotherapy equipment usage in physiotherapy departments (% of departments where these equipment were used)

4.3.1.5 Frequency of device maintenance

The frequency of maintenance of devices is presented in Table 4.2, which shows that the electrotherapy devices were most commonly maintained and checked every six months.

Table 4.2 Frequency of electrotherapy device maintenance

	US	*IFT*	*PSWD*	*BFD*	*TENS*	*Laser*	*CSWD*	*H-wave*	*MWD*
	(n)	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*
No Equipment	0	2	3	7	8	23	32	43	46
4-6 months	35	33	32	28	22	20	9	2	
Annually	8	8	8	8	7	2	3	0	
Biannually	1	1	1	0	2	1	0	0	
When broken/if faulty	1	1	1	1	2	0	1	1	
Information not provided	1	1	1	2	4	0	1	0	
Never	0	0	0	0	1	0	0	0	

US = ultrasound, IFT = interferential, PSWD = pulsed shortwave diathermy, BFD =biofeedback, TENS = transcutaneous electrical nerve stimulation, CSWD = continuous shortwave diathermy, MWD = microwave diathermy

4.3.1.6 Responsibility of device maintenance

The responsibility of maintaining electrotherapy devices is shown in Table 4.3

Table 4.3 Responsibility of electrotherapy device maintenance

	US	*IFT*	*PSWD*	*BFD*	*TENS*	*Laser*	*CSWD*	*H-wave*	*MWD*
	(n)	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*
In house facility	38	37	36	32	31	18	13	2	
Contractor	7	6	6	6	6	5	1	1	
No equipment	0	2	3	7	8	23	32	43	46
Information not provide	1	1	1	1	1	0	0	0	

US = ultrasound, IFT = interferential, PSWD = pulsed shortwave diathermy, BFD =biofeedback, TENS = transcutaneous electrical nerve stimulation, CSWD = continuous shortwave diathermy, MWD = microwave diathermy

In the majority of departments, the responsibility of device maintenance was given to an in-house facility such as the biomedical engineering department within the hospital (Table 4.3). In a few departments, an external contractor also maintained the devices (Table 4.3).

4.3.1.7 Types of electrodes used for shortwave diathermy application

The types of applicators or electrodes used for any mode of shortwave diathermy are shown is Table 4.4. Most common type of electrodes used was reported to be ‘circuplode / monode’ in 65.2% (n=30), which was followed by the ‘rigid metal disks’ (disk electrodes) in 10.9% (n=5) departments. The types of electrodes used for pulsed and continuous SWD (Table 4.4) suggested that the majority of departments (65.2%, n=30) used ‘inductive mode’ of SWD application. In addition, the ‘capacitive mode’ was used in six (13%) departments and ‘both inductive and capacitive modes’ were used in only one department (2.2% of total surveyed departments).

Table 4.4 Types of electrodes used for shortwave diathermy application

Type of applicators/electrodes	*n*	*%*
No device of SWD (both CWD and PSWD)	3	6.5
Monode / Circuplode	30	65.2
Flexible electrode	1	2.2
Rigid electrode	5	10.9
Monode / circpulode and Rigid	2	4.3
SWD not used despite availability of equipment	4	8.7
Information not provided	1	2.2

4.3.1.8 Availability of device user manual

The availability of the device user manual of electrotherapy modalities available within the departments is shown in Table 4.5. User manuals of different types of electrotherapy devices were available in the majority of departments. In some departments, the user manuals of some electrotherapy equipment were not available (Table 4.5).

Table 4.5 Availability of electrotherapy equipment manual

	US	*IFT*	*PSWD*	*BFD*	*TENS*	*Laser*	*CSWD*	*H-wave*	*MWD*
	(n)	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*	*(n)*
No equipment		2	3	7	8	23	32	43	46
Manual available	40	39	36	34	25	21	12	3	
Manual not available	5	4	5	3	3	1	2		
Information not provided	1	1	2	2	3	1			
Patients use at home so do not know					7				

US = ultrasound, IFT = interferential, PSWD = pulsed shortwave diathermy, BFD =biofeedback, TENS = transcutaneous electrical nerve stimulation, CSWD = continuous shortwave diathermy, MWD = microwave diathermy

4.3.1.9 Electromagnetic interference

Occurrence of electromagnetic interference of SWD devices with other equipment was reported in 35% (n=16) of departments (Table 4.6).

Table 4.6 Electromagnetic interference caused by shortwave diathermy equipment

	Count	%
No SWD (both CSWD and PSWD) equipment	3	6.5%
No / don't know	14	30.4%
Yes	16	34.8%
SWD not used despite availability of equipment	4	8.7%
Information not asked	1	2.2%
Information not provided	8	17.4%

4.3.2 User / operator (Physiotherapist) issues

Results of issues related to device operators (physiotherapists) are as follows.

4.3.2.1 Training

Training or instruction to physiotherapists in the safe use of various electrotherapy modalities was reported in the majority of departments as shown in Table. 4.7. Three departments (6.5%) reported no training to staff and the same number of departments did not provided information on this issue.

Table 4.7 Training or instruction to physiotherapists for safe use of electrotherapy devices

	Yes		*No*		*Information not provided*		*No equipment*	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Ultrasound	43	93.5	3	6.5				
Interferential	41	89.1	3	6.5			2	4.3
PSWD	40	87.0	2	4.3	1	2.2	3	6.5
TENS	36	78.3			2	4.3	8	17.4
Biofeedback	34	73.9	2	4.3	3	6.5	7	15.2
Laser	21	45.7	2	4.3			23	50.0
CSWD	14	30.4					32	69.6
H-wave	3	6.5					43	93.5
MWD							46	100

PSWD = pulsed shortwave diathermy, TENS = transcutaneous electrical nerve stimulation, CSWD = continuous shortwave diathermy, MWD = microwave diathermy

4.3.2.2 Operator distance from device

Operator / physiotherapist’s distance from electrotherapy device when in use reported by departments is shown in Table 4.8. In the majority of departments, the distance was ≤1 meter (m) for Ultrasound, Biofeedback, Interferential, TENS and Laser devices and the distance was ≥ 2 m for devices of PSWD, CSWD and H-wave modalities.

Table 4.8 Physiotherapist's distance from electrotherapy device when in use

	Ultrasound		*Biofeedback*		*Interferential*		*TENS*		*PSWD*		*CSWD*		*Laser*		*H-wave*		*MWD*	
Distance from device	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
<1 m	42	91.3	22	47.8	13	28.3	21	45.6					19	41.3				
1-2 m	2	4.3	4	8.7	8	17.4			11	24	1	2.2						
2.1- 4 m	1	2.2	2	4.3	9	19.6			10	21.7	3	6.5						
> 4 m			1	2.2	7	15.2			3	6.5								
Varies							1	2.2										
Physiotherapist leaves the cubicle / room			1	2.2	3	6.5			13	28.3	1	2.2			2	4.3		
Not known / patients use at home							7	15.2										
Not used despite equipment availability			1	2.2					4	8.7	9	19.6	1	2.2				
No equipment			7	15.2	2	4.3	8	17.4	3	6.5	32	69.6	23	50	43	93.5	46	100
Information not provided	1	2.2	8	17.4	4	8.7	9	19.6	2	4.3			3	6.5	1	2.2		

PSWD = pulsed shortwave diathermy, TENS = transcutaneous electrical nerve stimulation, CSWD = continuous shortwave diathermy, MWD = microwave diathermy

4.3.2.3 Contraindications for physiotherapists

Contraindications for physiotherapists using shortwave diathermy, both pulsed and continuous modes, reported by the departments are given in Table 4.9. Pregnancy, cardiac pacemakers and malignancy (past or present) were top three medical conditions where use of both PSWD and CSWD by physiotherapists was reported as contraindicated. Fever and skin conditions were not reported as contraindications for physiotherapists using CSWD.

Table 4.9 shows contraindications or precautions for the safety of an individual physiotherapist's when using a specific electrotherapy modality. The percentages of physiotherapy departments are shown where the responder answered that a physiotherapist should use (Yes) or not use (No) the equipment if s/he had any of the conditions. The most important responses included a "yes" response for not using the CSWD, PSWD and interferential machines in 23.9%, 71.7% and 26.1% of departments respectively if the physiotherapist was pregnant. Similarly, 47.8% responded that a physiotherapist should not be using PSWD equipment if s/he had had a malignancy (past or present). In addition 23.9%, 65.2%, 30.4% and 30.4% of departments responded that CSWD, PSWD, interferential and TENS equipment respectively should not be used by the physiotherapist if s/he had a cardiac pacemaker. 23.9% of departments also responded that the physiotherapist should not use interferential or ultrasound equipment if s/he had an infection or TB (active (Table 4.9).

Table 4.9 Contraindication / precautions for physiotherapist's safety when using the specific electrotherapy modality

Condition	*CSWD*		*PSWD*		*Interferential*		*Biofeedback*		*Ultrasound*		*TENS*		*Laser*		*H-wave*		*MWD*	
	Yes (%)	*No (%)*	*Yes (%)*	*No (%)*	*Yes (%)*	*No (%)*	*Yes (%)*	*No (%)*	*Yes (%)*	*No (%)*	*Yes (%)*	*No (%)*	*Yes (%)*	*No (%)*	*Yes (%)*	*No (%)*	*Yes (%)*	*No (%)*
Infection / TB	8.7	13	30.4	43.5	23.9	56.5	8.7	54.3	23.9	54.3	13	54.3	13	19.6	2.2	2.2	N.A.	N.A.
Pregnancy	23.9	2.2	71.7	4.3	26.1	54.3	4.3	58.7	21.7	56.5	15.2	54.3	13	19.6	2.2	2.2	N.A.	N.A.
Skin conditions	6.5	19.6	10.9	65.2	21.7	58.7	6.5	56.5	15.2	63	15.2	54.3	6.5	26.1	2.2	4.3	N.A.	N.A.
Anticoagulants	4.3	21.7	6.5	69.6	10.9	69.6	4.3	63	2.2	76.1	2.2	67.4	4.3	32.6	2.2	4.3	N.A.	N.A.
DVT	6.5	19.6	17.4	56.5	17.4	63	4.3	58.7	17.4	60.9	10.9	58.7	4.3	28.3	2.2	4.3	N.A.	N.A.
Malignancy*	15.2	8.7	47.8	26.1	21.7	58.7	6.5	56.5	21.7	56.5	15.2	54.3	13	19.6	2.2	2.2	N.A.	N.A.
Metal in tissues	8.7	15.2	21.7	54.3	17.4	60.9	2.2	60.9	17.4	60.9	4.3	65.2	4.3	65.2	2.2	2.2	N.A.	N.A.
Cardiac pacemaker	23.9	2.2	65.2	10.9	30.4	50	8.7	54.3	17.4	60.9	30.4	39.1	8.7	23.9	2.2	4.3	N.A.	N.A.
Fever	6.5	17.4	19.6	54.3	10.9	65.2	8.7	52.2	15.2	60.9	8.7	58.7	6.5	23.9	2.2	2.2	N.A.	N.A.
Menstruation	4.3	21.7	10.9	65.2	4.3	76.1	4.3	63	2.2	76.1	4.3	65.2	4.3	32.6	2.2	2.2	N.A.	N.A.
Epilepsy	10.9	15.2	19.6	54.3	15.2	65.2	8.7	54.3	8.7	69.6	13	56.5	10.9	21.7	2.2	4.3	N.A.	N.A.
Cardiac arrhythmia	8.7	17.4	15.2	60.9	10.9	69.6	8.7	54.3	6.5	71.7	13	56.6	4.3	28.3	2.2	4.3	N.A.	N.A.

* Past or present, CSWD = continuous shortwave diathermy, PSWD = pulsed shortwave diathermy, BFD =biofeedback, TENS = transcutaneous electrical nerve stimulation, MWD = microwave diathermy, N.A. =Not available

4.3.3 Occupational environment / workplace issues

4.3.3.1 Size of treatment cubicles/rooms

Table 4.10 indicates the size of treatment cubicles in square metres (m^2) used for each type of electrotherapy equipment. The size of electrotherapy cubicles varied from 1 m^2 to 24 m^2.

4.3.3.2 Metallic objects within treatment cubicles / rooms

Presence of metallic objects near to electrotherapy device with in treatment cubicle is shown in Table 4.11. In the majority of departments, metallic objects were present in the treatment cubicles used for electrotherapy with Interferential, ultrasound, biofeedback and TENS. However, metallic objects were not present within the treatment areas used for PSWD and CSWD.

4.3.3.3 Nature of treatment plinth

Treatment plinths were made of metal, wood and mixed metal and wood, which were used for different electrotherapy modalities as shown in Table 4.12. In most of the departments, treatment plinths contained metal. However, in a few departments wooden plinths were used for electrotherapy with PSWD and CSWD.

4.3.3.4 Number of people in a treatment cubicle/room

Number of people in the treatment cubicle / room varied from only patient to patient and physiotherapists. This practice varied between departments and between modes of electrotherapy as presented in Table 4.13.

Table 4.10 Size of treatment cubicle

Modality		*No equipment*	$<2m^2$	$2\text{-}4\ m^2$	$4.1\text{-}6\ m^2$	$> 6\ m^2$	*Not used despite availability of equipment*	*Patient uses at home so do not know*	*Information not provided*
CSWD	Count	32		1	2	2	9		
	%	69.6		2.2	4.3	4.3	19.6		
PSWD	Count	3	1	20	9	7	4		2
	%	6.5	2.2	43.5	19.6	15.2	8.7		4.3
Interferential	Count	2	2	23	7	11			1
	%	4.3	4.3	50	15.2	23.9			2.2
TENS	Count	8	1	20	5	4		7	1
	%	17.4	2.2	43.5	10.9	8.7		15.2	2.2
Biofeedback	Count	7	1	23	6	6	1		2
	%	15.2	2.2	50	13	13	2.2		4.3
Ultrasound	Count		1	26	7	11			1
	%		2.2	56.5	15.2	23.9			2.2
Laser	Count	23		14	4	4	1		
	%	50		30.4	8.7	8.7	2.2		
H-wave	Count	43		1	1	1			
	%	93.5		2.2	2.2	2.2			
MWD	Count	46							
	%	100							

Table 4.11 Metallic surfaces near to electrotherapy devices

		No	*Yes*	*Patient uses at home so do not know*	*Not used despite availability of equipment*	*Information not provided*	*No equipment*
Interferential	Count	9	31			4	2
	%	19.6	67.4			8.7	4.3
Ultrasound	Count	9	34			3	
	%	19.6	73.9			6.5	
Biofeedback	Count	7	24		1	7	7
	%	15.2	52.2		2.2	15.2	15.2
TENS	Count	5	21	7		5	8
	%	10.9	45.7	15.2		10.9	17.4
CSWD	Count	4	1		9		32
	%	8.7	2.2		19.6		69.6
PSWD	Count	13	24		4	2	3
	%	28.3	52.2		8.7	4.3	6.5
Laser	Count	2	15		1	5	23
	%	4.3	32.6		2.2	10.9	50
H-wave	Count		2			1	43
	%		4.3			2.2	93.5
MWD	Count						46
	%						100

Table 4.12 The nature of treatment plinth used for electrotherapy

	CSWD	*PSWD*	*IFT*	*BFD*	*US*	*TENS*	*Laser*	*H wave*	*MWD*
	n, %	*n, %*	*n, %*	*n, %*	*n, %*	*n, %*	*n, %*	*n, %*	*n, %*
No equipment	32, 69.6%	3, 6.5%	2, 4.3%	7, 15.2%		8, 17.4%	23, 50.0%	43, 93.5%	46, 100%
Wood	4,8.7%	6, 13.0%							
Metal		17, 37.0%	29, 63.0%	24, 52.2%	31, 67.4%	21, 45.7%	13, 28.3%	1, 2.2%	
Metal and Wood	1, 2.2%	15, 32.6%	15, 32.6%	11, 23.9%	15, 32.6%	7, 15.2%	9, 19.6%	2, 4.3%	
Not used despite availability of equipment	9, 19.6%	4, 8.7%		1, 2.2%			1, 2.2%		
Patient uses at home so do not know						7, 15.2%			
Information not provided		1, 2.2%		3, 6.5%		3, 6.5%			

US = ultrasound, IFT = interferential, BFD =Biofeedback

Table 4.13 Number of people in a treatment cubicle / room during electrotherapy

	CSWD	*PSWD*	*IFT*	*BFD*	*US*	*TENS*	*Laser*	*H wave*	*MWD*
	n, %	*n, %*	*n, %*	*n, %*	*n, %*	*n, %*	*n, %*	*n, %*	*n, %*
No equipment	32, 69.6%	3, 6.5%	2, 4.3%	7, 15.2%		8, 17.4%	23, 50%	43, 93.5%	46, 100%
Patient and Physiotherapist		12, 26.1%	30, 65.2%	32, 69.6%	42, 91.3%	22, 47.8%	19, 41.3%	1, 2.2%	
2 then 1 (physiotherapist leaves the room)	4, 8.7%	23, 50%	9, 19.6%	1, 2.2%		3, 6.5%		2, 4.3%	
Varies	1, 2.2%	2, 4.3%	2, 4.3%	1, 2.2%	2, 4.3%	2 , 4.3%	1, 2.2%		
Not used despite availability of equipment	9, 19.6%	4, 8.7%		1, 2.2%			1, 2.2%		
Patient uses at home so do not know						7, 15.2%			
Information not provided		2, 4.3%	3, 6.5%	4, 8.7%	2, 4.3%	4, 8.7%	2, 4.3%		

US = ultrasound, IFT = interferential, BFD =Biofeedback

4.3.4 Treatment issues

4.3.4.1 Treatment time

The average treatment time for each type of electrotherapy modality is given in Table 4.14, which indicates that the average treatment time varied from 2 minutes for ultrasound and Laser to more than 10 minutes for CSWD, PSWD, interferential, biofeedback, TENS and H-wave. There was a variable average treatment time reported for use of interferential and Laser in 2.2%, for biofeedback in 19.5%, for ultrasound in 6.5%, and for TENS in 15.2% of departments (Table 4.14).

Table 4.14 Average treatment time for electrotherapy modalities

Average treatment time	*CSWD*	*PSWD*	*Interferential*	*Biofeedback*	*Ultrasound*	*TENS*	*Laser*	*H-wave*	*MWD*
	%	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*
0. 01-2 (minutes = min)							6.5		
2.1-6 min				6.5	87	2.2	30.4		
6.1-10 min	4.3	21.7	21.7	17.4	2.2	2.2	2.2	2.2	
>10 min	6.5	60.9	69.6	26.1		37		2.2	
Varies			2.2	15.2	6.5	15.2	6.5		
Not used despite availability of equipment	19.6	8.7		2.2			2.2		
No equipment	69.6	6.5	4.3	15.2		17.4	50	93.5	100
Information not provided /asked		2.2	2.2	17.4	4.3	10.9	2.2	2.2	
Patient uses at home so do not know						15.2			

4.3.5 Departmental issues

4.3.5.1 Number of physiotherapists per department

The number of physiotherapists working in physiotherapy departments ranged between 3 and 34 physiotherapists (mean = 12.7, SD = 6.2). There were 1-5 physiotherapists in 6.5% (n=3) departments, 6-10 physiotherapists in 34.8% (n=16), 11-20 physiotherapists were in 52.2% (n=24) and 21-34 physiotherapists in 6.5% (n=3).

4.3.5.2 Number of patients per week visiting the department

Number of patients per week visiting the department ranged from 44 to 1200. The mean number was 417.7 (SD = 260.5), median was 416.5 and mode was 450 patients per week per department. Up to 300 patients per week visiting the department was reported by 39.1 (n=18) departments, 301-600 patients per week visited 39.1 (n=18) departments and 601-1200 patients visited 21.7% (n=10) departments weekly.

4.3.5.3 Percentage of patients per week receiving electrotherapy

Percentage of patients per week per department receiving electrotherapy ranged from 0.33% to 50%. Average percentage of patients per week per department receiving electrotherapy was 19.6% (SD =14.9) and the median and mode were 20% each. Up to 10% of patients per week per department received electrotherapy in 32.6% (n=15) departments, 10.1-20% patients per week per department in 19.6% (n=9) departments, 20.1-30% patients per week per department in 23.9% (n=11) departments and 30.1-50% patients per week per department received electrotherapy in 15.2% (n=7) departments. Remaining departments (n=4, 8.7%) did not provide information on this issue. About 39% departments reported giving electrotherapy to less than 15% of total patients per week visiting the department.

In about 15% (n=7) of the departments, electrotherapy was given to more than 30% to 50% of patients per week (Table 4.15).

Table 4.15 Percentage of weekly patients receiving electrotherapy

	Frequency	*Per cent*	*Valid Per cent*	*Cumulative Per cent*
< 15%	18	39.1	39.1	39.1
15-30%	17	37.0	37.0	76.1
> 30% up to 50%	7	15.2	15.2	91.3
Information not provided	4	8.7	8.7	100.0

4.3.5.4 Electrotherapy audit in the department

Half of surveyed departments (n=23, 50%) reported that no electrotherapy audit was conducted in the department. Ten departments (21.7%) reported that an electrotherapy audit took place in the department; five departments (10.9%) reported 'did not know' and eight departments (17.4%) provided no information about this issue.

4.4 Observational Visits to Physiotherapy Departments

During observational visits to physiotherapy departments, issues studied were as follows.

4.4.1.1 Device issues

This included evidence of maintenance and calibration and electrical safety tests (Table 4.2). All available equipment of eight electrotherapy modalities in each department was checked for signs of periodic maintenance as well as calibration and electrical safety tests. In most of the departments, majority of the devices had small stickers which showed date of the last safety check, which usually was an electrical safety check and it varied by type of the equipment and by the department. The safety test stickers were mostly signed. It was difficult to ascertain whether the electrical safety tests also included calibration tests.

4.4.1.2 Workplace issues

Physical environment for electrotherapy within each physiotherapy department was observed which included measurement of size of a few treatment cubicles usually the cubicles or the rooms commonly used for administration of PSWD and CSWD (Table 4.10). In addition, the presence of large metallic objects such as filling cabinets, radiators and other objects was noted (Table 4.11). Moreover, the nature of treatment plinth was checked whether it was made of only wood, only metal or mixed wooden and metal (Table 4.12). Furthermore, the nature of partition between treatment cubicles and rooms was noted (Table 4.16), which revealed that in the majority of departments cubicles were separated generally by curtains and walls. However, in a few departments, the treatment cubicles used for therapy with PSWD, CSWDD and laser had walls on all four sides. In one department, PSWD was administered in a room that was built specially build with shielding material.

Table 4.16 Nature of partition between treatment cubicles (departments = count, %)

	BFD	*PSWD*	*Laser*	*IFT*	*US*	*TENS*	*CSWD*	*H –wave*	*MWD*
	n (%)	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*n (%)*
No equipment	7(15.2%)	3 (6.5%)	23 (50%)	2 (4.3%)		8(17.4%)	32 (69.6%)	43 (93.5%)	46 (100%)
Wall	3 (6.5%)	2 (4.3%)	2 (4.3%)						
Curtains	13 (28.3%)	11 (23.9%)	5 (10.9%)	16 (34.8%)	17 (37%)	15 (32.6%)	1(2.2%)	1(2.2%)	
Curtains & wall	18 (39.1%)	22 (47.8%)	13 (28.3%)	26 (56.5%)	27 (58.7%)	13 (28.3%)	4 (8.7%)	2 (4.3%)	
Curtains & wood / plywood	2 (4.3%)	2 (4.3%)	1 (2.2%)	2(4.3%)	2 (4.3%)	2(4.3%)			
Special walls		1 (2.2%)							
Patient uses at home so do not know						7 (15.2%)			
Not used despite availability of equipment	1 (2.2%)	4 (8.7%)	1 (2.2%)				9 (19.6%)		
Information not provided	2 (4.3%)	1 (2.2%)	1 (2.2%)			1 (2.2%)			

BFD =Biofeedback, IFT = interferential, US = ultrasound

4.5 Risk Perception Survey

4.5.1 Screening and cleaning of data

Prior to any statistical analysis, data were screened and cleaned as follows.

4.5.2 Missing data identification and handling

Missing data were identified for each variable as well as for each case. Missing data results (Table 4.17) show that data was missing for 70 variables and there was no missing data for the remaining variables (n=14). Variables without missing data were gender and a number of variables of perception of risk scale.

The highest missing data by variable was 2.1 % (n=8) for Q3b (How long have been you been qualified for the job you are presently doing?) and the lowest missing data were 0.3% (n=1) for a number of variables (Table 4.17). Variables with missing data included all types of variables including demographics. Missing data were imputed by multiple imputation method using WinMice V0.1 software (van Buuren and Oudshoorn, 2010). Thus, none of the variables with missing data were deleted or excluded at this stage.

Table 4.17 Missing value statistics by variable

	Valid values	*Missing values*			*Valid values*	*Missing values*	
*Variable**	*Count*	*Count*	*per cent*	*Variable**	*Count*	*Count*	*per cent*
q3b	382	8	2.1	q9b	388	2	0.5
q6b	383	7	1.8	rp_9	388	2	0.5
Weight (q7e)	383	7	1.8	rp_13	388	2	0.5
BMI	383	7	1.8	rp_17	388	2	0.5
par11	383	7	1.8	rp_18	388	2	0.5
par4	384	6	1.5	rp_19	388	2	0.5
par8	384	6	1.5	rp_20	388	2	0.5
par10	384	6	1.5	hc1	388	2	0.5
par14	384	6	1.5	hc2	388	2	0.5

Table continued on next page

Table 4.17 (Missing value statistics by variable) continue

	Valid values	*Missing values*			*Valid values*	*Missing values*	
*Variable**	*Count*	*Count*	*per cent*	*Variable**	*Count*	*Count*	*per cent*
par15	384	6	1.5	hc6	388	2	0.5
par1	385	5	1.3	hc11	388	2	0.5
par2	385	5	1.3	hc12	388	2	0.5
par3	385	5	1.3	hc13	388	2	0.5
par5	385	5	1.3	hc20	388	2	0.5
par9	385	5	1.3	hc21	388	2	0.5
par12	385	5	1.3	hc22	388	2	0.5
par13	385	5	1.3	ms_2	389	1	0.3
hc3	386	4	1	q5	389	1	0.3
hc16	386	4	1	q5_a	389	1	0.3
hc17	386	4	1	q6a	389	1	0.3
par6	386	4	1	q9a	389	1	0.3
par7	386	4	1	q10a	389	1	0.3
q7c	387	3	0.8	q10_b	389	1	0.3
Height (q7d)	387	3	0.8	rp_4	389	1	0.3
hc4	387	3	0.8	rp_8	389	1	0.3
hc5	387	3	0.8	rp_10	389	1	0.3
hc7	387	3	0.8	rp_15	389	1	0.3
hc8	387	3	0.8	gender_1	390	0	0
hc9	387	3	0.8	rp_1	390	0	0
hc10	387	3	0.8	rp_2	390	0	0
hc14	387	3	0.8	rp_3	390	0	0
hc15	387	3	0.8	rp_5	390	0	0
hc18	387	3	0.8	rp_6	390	0	0
hc19	387	3	0.8	rp_7	390	0	0
educ_3a	388	2	0.5	rp_11	390	0	0
q4	388	2	0.5	rp_12	390	0	0
q4_a	388	2	0.5	rp_14	390	0	0
q5_b	388	2	0.5	rp_16	390	0	0
q7a	388	2	0.5	rp_21	390	0	0
q7b	388	2	0.5	rp_22	390	0	0
q8_age	388	2	0.5	rp_23	390	0	0
q9b	388	2	0.5				

* Variables are sorted by missing patterns

Missing data by case was determined and the results are presented in Table 4.18 that shows that maximum and minimum data missing per case was 46.3% (n = 38 variables) and 1.2% (n = 1 variable) respectively. Overall, seven cases (participants) were with > 10% missing data; however, none of the cases was excluded or deleted at this stage.

Table 4.18 Missing value statistics by case

	Missing values			*Missing values*	
*Case ID**	*Count*	*per cent*	*Case ID**	*Count*	*per cent*
156	38	46.3	64	1	1.2
162	22	26.8	70	1	1.2
139	16	19.5	121	1	1.2
182	15	18.3	163	1	1.2
38	15	18.3	40	1	1.2
133	11	13.4	69	1	1.2
330	11	13.4	88	1	1.2
344	8	9.8	117	1	1.2
280	8	9.8	204	1	1.2
191	5	6.1	229	1	1.2
50	4	4.9	375	1	1.2
379	4	4.9	81	1	1.2
7	3	3.7	51	1	1.2
32	3	3.7	116	1	1.2
314	3	3.7	129	1	1.2
152	2	2.4	148	1	1.2
62	2	2.4	157	1	1.2
57	2	2.4	177	1	1.2
21	2	2.4	194	1	1.2
273	2	2.4	203	1	1.2
337	2	2.4	207	1	1.2
382	2	2.4	277	1	1.2
287	2	2.4	323	1	1.2
100	2	2.4	353	1	1.2
310	2	2.4	360	1	1.2
20	1	1.2	361	1	1.2
23	1	1.2			

*Cases are sorted by missing patterns

4.5.3 Descriptive statistics of demographic variables

After handling missing values, frequencies and descriptive statistics for each of the demographic variables were determined as shown in Table 4.19. Results of demographic characteristics show that the majority of respondents were female (79.5%), aged between 21and 35 years (73.7%), married or cohabiting (54%) and educated up to a master's degree (69.2%).

Table 4.19 Frequencies of participants' demographics, lifestyle and health status

Variable	*Category*	*Frequency*	*per cent*
Gender (q1)			
	Male	80	20.5
	Female	310	79.5
Age group (q8)			
	21-25 yrs	102	26.2
	26-30 yrs	113	29.0
	31-35 yrs	72	18.5
	36-40 yrs	32	8.2
	41-45 yrs	35	9.0
	46-50 yrs	11	2.8
	51-55 yrs	14	3.6
	56-60 yrs	9	2.3
	61-65 yrs	2	0.5
Marital Status (q2)			
	Single	168	43.1
	Married	144	36.9
	Separated	5	1.3
	Divorced	5	1.3
	Widowed	2	0.5
	Cohabiting	66	16.9
Education highest level achieved (q3a)			
	Diploma	79	20.3
	University Graduate	39	10.0
	Master's Degree (MA, MSc)	270	69.2
	Higher Degree (PhD, MD)	2	0.5

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Table 4.19 continues from previous page

Variable	*Category*	*Frequency*	*per cent*
Smoking (q4)			
	Yes	17	4.4
	No	373	95.6
Alcohol consumption (q5)			
	Yes	357	91.5
	No	33	8.5
Special diet for health reasons (q7a)			
	Yes	17	4.4
	No	373	95.6
Eating right amount of food (q7b)			
	Always	53	13.6
	Usually	301	77.2
	Sometimes	35	9.0
	Never	1	0.3
Currently having balanced diet (q7c)			
	Always	82	21.0
	Usually	272	69.7
	Sometimes	34	8.7
	Never	2	0.5
Body Mass Index*			
	BMI ≤ 18.49 (underweight)	10	2.6
	BMI 18.5-24.9 (normal)	295	75.6
	BMI 25-29.9 (over weight)	72	18.5
	BMI ≥30 (obese)	13	3.3
Vigorous exercise taken (for more than 30 minutes) each week (q6a)			
	6-7 days/week	22	5.7
	4-5 days/week	64	16.6
	2-3 days/week	167	43.4
	Once a week	99	25.7
	Never	33	8.6
Mild exercise taken (for more than 20 minutes) each week (q6b)			
	6-7 days/week	113	29.8
	4-5 days/week	96	25.3
	2-3 days/week	109	28.8
	Once a week	48	12.7
	Never	13	3.4

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Table 4.19 continues from previous page

Variable	*Category*	*Frequency*	*per cent*
Current state of health (q9a)			
	Very poor	0	0
	Poor	0	0
	Average	9	2.3
	Good	59	15.1
	Very good	207	53.1
	Excellent	115	29.5
Value placed on good health (q9b)			
	None (no value)	0	0
	Low value	0	0
	Moderate value	1	0.3
	High value	15	3.8
	High plus value	103	26.4
	Very high value	271	69.5
Awareness of environmental and health issues (q10a)			
	Not aware (No awareness)	0	0
	Little awareness	6	1.5
	Moderate awareness	29	7.4
	Good awareness	139	35.6
	High awareness	182	46.7
	Very high awareness	34	8.7
Knowledge of environmental and health issues (q10b)			
	No Knowledge	0	0
	Little knowledge	11	2.8
	Moderate knowledge	52	13.3
	Good knowledge	195	50.0
	High knowledge	116	29.7
	Very high knowledge	16	4.1

*Created by researcher from the height and weight data provided by the participants. BMI classification is based on WHO criteria (World Health Organisation, 2000)

Results of self-reported health and lifestyle status showed that respondents were mainly non-smokers (95.6%) but consumed alcohol (91.8%). Findings show that 4.4% of participants had special dietary requirements mainly due to health reasons.

Usually eating right amount of food and having currently a balanced diet was reported by 77.2% and 69.7% participants respectively. On average, participants reported their current health status as very good (53.1%), placed very high value on good health (69.5%) and reported high awareness (46.7%) and knowledge of environmental and health issues (50%).

Descriptive statistics of demographics, health and social status (Table 4.20) showed the mean 'time since qualification' was 9.2 (±8.8) years. Participants had mean height of 1.7 (±0.1) m, mean weight 65.9 (±11.3) kg and mean BMI 22.9 (±2.94). BMI of 21.8% (n=85) physiotherapists was higher than the normal BMI limits (25-29.9). Findings show that mean number of cigarettes smoked was about 8 (±6.4) cigarettes / day. Mean alcohol consumption was about 7.5 (±6.4) units / week and about 3 (±1.5) days / week. The skewness and kurtosis inform about the symmetry of data distribution and flatness/peakedness of data, respectively (Jackson, 2011, p. 112). The researcher calculated z-scores for the values of skewness and kurtosis for all the variables given in Table 4.20 and found that except skewness value of cigarette smoking (q4a) and kurtosis values for height (q7d), cigarette smoking (q4a) and alcohol consumption (q5b), the z-scores for all items were >3.29 ($P < .001$) for both the skewness and kurtosis. This suggested deviation from normal distribution (Field, 2009, p. 139). However, skewness and kurtosis values are sensitive to the sample sizes and tend to become significant when the sample size is > 200 (Field, 2009, p. 139). Therefore, given the sample size of 390 in the present study, the data distribution was considered normal for all variables given in Table 4.20.

Table 4.20 Descriptive statistics of participants' demographic and lifestyle characteristics

	Mean		*Std. Deviation*	*Skewness*		*Kurtosis*	
	Statistic	*Std. Error*	*Statistic*	*Statistic*	*Std. Error*	*Statistic*	*Std. Error*
Time since qualification (years) (q3b)	9.2	0.4	8.8	1.5	0.1	1.8	0.2
Height (m) (q7d)	1.7	0.0	0.1	0.5	0.1	0.2	0.2
Weight (kg) (q7e)	65.9	0.6	11.3	0.9	0.1	0.7	0.2
Body Mass Index	22.9	0.1	2.9	1.1	0.1	2.3	0.2
Cigarettes smoked / day (number) (q4a)	7.79	1.47	6.40	0.80	0.52	-0.77	1.01
Alcohol consumed (units / week) (q5a)	7.48	0.34	6.42	2.05	0.13	5.82	0.26
Alcohol consumption (days / week) (q5b)	2.72	0.08	1.46	0.94	0.13	0.62	0.26

4.5.4 Descriptive statistics of perception of health risk items

Descriptive statistics of rating of 23 risk items included in the perception of health risk (RP) scale are presented in Table 4.21. Results show that the highest mean ranking of 4.8 (±0.59) was for driving with twice the legal limit of alcohol (item rp_20) while the lowest mean ranking of 1.8 (±0.62) was for exposure to EMFs in the home for example from hair dryers and hi fi systems (item rp_15).

For all items but three included in the perception of health risk, participants selected 'do not know' option (shown as missing (n) in Table 4.21), which was highest (n=147, 37.7%) for exposure to radon gas (item rp_17).

Among seven items about health risks from EMFs, the highest average rating of 2.99 (±0.97) was found for living near to a mobile phone transmitter (item rp_11) while EMFs in the physiotherapy department (item rp_14) was ranked fifth out of seven (in high to low order) and its mean rating was 2.44.

Table 4.21 also presents the mean ratings of health risks by gender of participants, which shows that overall female physiotherapists reported higher risk ratings for all items compared to male physiotherapists.

However, when the mean rankings of perception of health risk were sorted (ordered) from highest mean rank to lowest mean rank, it was found that the ordered ranking of the mean ratings by male and female physiotherapists were same for 11 out of 23 health risk items. These items were driving with twice the legal limit of alcohol, smoking, radioactive fallout from a nuclear power plant, high fat diet, exposure to chemicals released by industry, passive smoking, living near an electricity substation, living near an overhead power line, exposure to noise, EMFs from home microwave oven and EMFs from hair dryers and hi fi systems. This probably suggests that male and female physiotherapists perceive same level of health risk from these hazards.

The ordered ranking of the mean ratings by male physiotherapists was found higher than female physiotherapists' mean ratings for six items, which included leading a sedentary lifestyle, exposure to poor air quality, exposure to radon gas, living near a mobile phone transmitter, air travel and train travel. This finding suggests that male physiotherapists perceive higher level of health risk from these hazards compared to female physiotherapists. Conversely, the ordered ranking of the mean ratings by female physiotherapists was higher than male physiotherapists' mean ratings for six items. These items were alcohol consumption per week over the limit as well as up to the limit of 21 units for men and 14 units for women, living near a nuclear power plant, living near an electricity substation, EMFs in physiotherapy departments and exposure to radiations from a single chest X-ray. This finding probably suggests that female physiotherapists perceive higher health consequences from these risk factors compared to male physiotherapists.

Table 4.21 Descriptive statistics of perception of health risk items

Risk item	*Code*	*Analysis (n)*	*Missing (n)*	*Combined*		*Male*		*Female*	
				Mean	*Std. Deviation*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*
Smoking of tobacco	rp_1	390	0	4.64	0.64	4.54	0.71	4.67	0.62
Passive exposure to tobacco smoke	rp_2	390	0	3.80	0.79	3.55	0.83	3.86	0.76
Alcohol consumption per week over 21 units for men and 14 units for women	rp_3	387	3	4.01	0.75	3.78	0.75	4.07	0.75
Alcohol consumption per week up to 21 units for men and 14 units for women	rp_4	386	4	2.99	0.90	2.67	0.89	3.08	0.88
High fat diet	rp_5	389	1	4.20	0.68	4.01	0.67	4.25	0.67
Sedentary lifestyle	rp_6	389	1	4.02	0.79	3.88	0.82	4.06	0.79
Exposure to chemicals released by industry	rp_7	381	9	4.02	0.91	3.85	0.98	4.06	0.89
Living near a nuclear power plant	rp_8	377	13	3.55	1.11	3.14	1.11	3.66	1.09
Living near an electricity sub-station	rp_9	368	22	2.97	1.05	2.57	0.98	3.07	1.04
Radioactive fallout from a nuclear power plant	rp_10	380	10	4.40	1.02	4.35	1.10	4.42	1.00
Living near a mobile phone transmitter	rp_11	354	36	2.99	0.97	2.70	1.02	3.06	0.94

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Table 4.12 continues from previous page

				Combined		*Male*		*Female*	
	Code	*Analysis (n)*	*Missing (n)*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*
Living near an overhead power line	rp_12	368	22	2.67	0.96	2.51	1.00	2.71	0.94
Using a mobile phone	rp_13	378	12	2.52	0.75	2.29	0.82	2.58	0.72
Exposure to EMFs in the physiotherapy department	rp_14	383	7	2.44	0.78	2.10	0.80	2.52	0.75
Exposure to EMFs in the home e.g. hair dryers, hi fi systems	rp_15	382	8	1.82	0.62	1.63	0.56	1.87	0.62
Other sources of EMFs in the home e.g. microwave	rp_16	383	7	2.22	0.71	2.00	0.68	2.28	0.71
Exposure to radon Gas	rp_17	243	147	3.31	1.11	3.19	1.16	3.33	1.10
Exposure to noise	rp_18	388	2	2.56	0.77	2.37	0.66	2.61	0.79
Exposure to poor air quality	rp_19	389	1	3.37	0.78	3.25	0.82	3.40	0.77
Driving with twice the legal limit of alcohol	rp_20	387	3	4.78	0.59	4.65	0.68	4.81	0.56
Air travel	rp_21	390	0	2.28	0.58	2.19	0.51	2.30	0.60
Train travel	rp_22	389	1	2.28	0.57	2.19	0.53	2.30	0.58
Exposure to radiation from a single chest X-ray	rp_23	388	2	2.28	0.73	2.16	0.77	2.31	0.72

4.5.5 Descriptive statistics of perception of health consequences items

Descriptive statistics for 22 risk items included in the perception of health consequences (harm) are presented in Table 4.22. Results show that the highest mean ranking was 4.5 (±0.62) for smoking of tobacco (item hc1) and the lowest mean ranking was 1.7 (±0.69) for exposure to EMFs in the home e.g. hair dryers and hi fi systems (item hc15). For all items but five included in the perception of health consequences (HC), participants selected 'do not know' option (this is shown as missing values (n) in Table 4.22), which was highest (n=153, 39.2%) for exposure to radon gas (item hc17). Among seven items about health consequences from EMFs, the highest average rating was found for living near an electricity substation (item hc9) while EMFs in the physiotherapy department (item hc14) was ranked fifth out of seven (in high to low order).

Table 4.22 provides the mean ratings of health consequences by gender of participants, which shows that female physiotherapists reported higher risk ratings for all items except EMFs from home microwave oven (item hc16), exposure to noise (item hc18), air travel (item hc20), train travel (item hc21), which were rated higher by male physiotherapists.

Sorting (ordering) of the mean ratings of protection against risk items from highest rank to lowest rank revealed that male and female physiotherapists' ranking of health consequences were the same for only 9 out of 22 risk items. These items were smoking, radioactive fallout from a nuclear power plant, high fat diet, driving with twice the legal limit of alcohol, smoking, radioactive fallout from a nuclear power plant, high fat diet, alcohol consumption per week up to 21 units for men and 14 units for women, and EMFs from hair dryers and hi fi systems. This finding probably suggests that male and female physiotherapists perceive same level of health consequences from these items. However, the ordered ranking of the mean ratings by male physiotherapists was higher than female physiotherapists' mean ratings for five items, which included exposure to chemicals released by industry, leading a sedentary lifestyle, exposure to radon gas, exposure to poor air quality, exposure to radiation from a single chest X-ray. This perhaps suggests that male physiotherapists perceive higher level of health consequences from these items compared to female physiotherapists. On the other hand, the ordered ranking of the mean ratings by female physiotherapists was higher than male physiotherapists' mean ratings for eight items. These items were alcohol consumption per week over 21 units for men and 14 units for women, passive smoking, living near a nuclear plant, living near an electricity substation, living near a mobile phone transmitter, living near an overhead power line, using a mobile phone, and exposure to EMFs in physiotherapy department. This finding suggests that female physiotherapists perceive higher level of health consequences from these hazards compared to male physiotherapists.

Table 4.22 Descriptive statistics of perception of health consequences items

				Combined		*Male*		*Female*	
Risk item	*Code*	*Analysis (n)*	*Missing (n)*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*
Smoking of tobacco	hc1	390	0	4.50	0.62	4.43	0.61	4.52	0.62
Passive exposure to tobacco smoke	hc2	390	0	3.62	0.87	3.51	0.97	3.65	0.85
Alcohol consumption per week over 21 units for men and 14 units for women	hc3	388	2	3.96	0.78	3.68	0.90	4.03	0.74
Alcohol consumption per week up to 21 units for men and 14 units for women	hc4	387	3	2.96	0.97	2.76	1.10	3.01	0.93
High fat diet	hc5	390	0	3.93	0.77	3.75	0.82	3.98	0.75
Sedentary lifestyle	hc6	390	0	3.59	0.83	3.52	0.97	3.61	0.79
Exposure to chemicals released by industry	hc7	384	6	3.84	0.88	3.83	1.03	3.84	0.84
Living near a nuclear power plant	hc8	377	13	3.32	1.12	2.95	1.22	3.41	1.08
Living near an electricity sub-station	hc9	364	26	2.70	1.04	2.46	1.09	2.76	1.03
Radioactive fallout from a nuclear power plant	hc10	380	10	4.39	0.98	4.32	1.09	4.41	0.95
Living near a mobile phone transmitter	hc11	356	34	2.68	0.94	2.42	1.08	2.74	0.90

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Table 4.22 continues from previous page

				Combined		Male		Female	
	Code	*Analysis (n)*	*Missing (n)*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*
Living near an overhead power line	hc12	366	24	2.44	0.98	2.38	1.14	2.45	0.94
Using a mobile phone	hc13	372	18	2.32	0.83	2.18	0.98	2.35	0.79
Exposure to EMFs in the physiotherapy department	hc14	376	14	2.22	0.78	2.07	0.80	2.26	0.78
Exposure to EMFs in the home e.g. hair dryers, hi fi systems	hc15	373	17	1.74	0.69	1.71	0.70	1.75	0.69
Other sources of EMFs in the home e.g. microwave	hc16	378	12	2.08	0.73	2.08	0.82	2.08	0.71
Exposure to radon Gas	hc17	237	153	3.36	1.08	3.20	1.22	3.38	1.04
Exposure to noise	hc18	386	4	2.50	0.77	2.50	0.79	2.50	0.77
Exposure to poor air quality	hc19	390	0	3.19	0.81	3.13	0.91	3.20	0.79
Air travel	hc20	388	2	2.39	1.13	2.51	1.31	2.36	1.09
Train travel	hc21	388	2	2.27	1.06	2.33	1.17	2.25	1.04
Exposure to radiation from a single chest X-ray	hc22	387	3	2.11	0.79	2.12	0.87	2.11	0.77

4.5.6 Descriptive statistics of perception of protection against health risk items

Results of the descriptive statistics of ranking for 15 items included in the perception of protection against risk (PAR) are given in Table 4.23. Results reveal that the highest mean ranking was 3.7 (±1.2) for living near a nuclear power plant (item par3) and the lowest mean ranking was 2.2 (±1.22) for radioactive fallout from a nuclear power plant (item par5).

For all items but one included in the protection against risk, participants selected 'do not know' option (shown as missing (n) in Table 4.23, which was highest (n=173, 44.4%) for exposure to radon gas (item par11). Among six items about protection against risk from EMFs, the average rating in high to low order was highest (first) for exposure to EMFs in the physiotherapy department (item par8) while living near an overhead power line (item par7) was ranked the lowest (in high to low order).

In addition, Table 4.23 shows the mean ratings of protection against risk by gender of participants, which reveals that male physiotherapists reported higher rating for protection from risk for all items except living near a mobile phone transmitter (item par6), EMFs from home microwave oven (item par8) and EMFs from home appliances i.e. hair dryers and hi fi systems (item par9), which were rated higher by female physiotherapists. When the mean ranking of protection against risk items were sorted (ordered) from highest rank to lowest rank, it showed that male and female physiotherapists' overall ranking of protection against health risk was the same for 6 out of 15 risk items. These items were living near a nuclear power plant, exposure to EMFs in physiotherapy department, air travel, exposure to chemical released by industry, exposure to poor air quality, radioactive fallout from a nuclear power plant. The ordered mean rankings also revealed that the mean ratings by female physiotherapists were higher than male physiotherapists' mean ratings for four items. These items were living near an electricity sub-station, exposure to EMFs from home microwave oven, living near a mobile phone transmitter and exposure to EMFs from hair dryers and hi fi systems. This finding might suggest that female physiotherapists compared to male physiotherapists perceive higher possibility of protection against health risk from these risk factors. In other words, this means that male physiotherapists perceive that there is low possibility of protection against risk from these hazards.

Conversely, the ordered ranking of the mean ratings by male physiotherapists was higher than female physiotherapists' mean ratings for five items, which included passive smoking, train travel, exposure to noise, living near an overhead power line and exposure to radon gas. This finding might suggest that male physiotherapists compared to female physiotherapists perceive higher possibility of protection against health risk from these risk factors. This might also suggest that female physiotherapists perceive that there is low possibility of protection against risk from these hazards.

Table 4.23 Descriptive statistics of perception of protection against health risk items

				Combined		Male		Female	
Risk item	*Code*	*Analysis (n)*	*Missing (n)*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*
Passive exposure to tobacco smoke	par1	390	0	3.51	0.72	3.61	0.82	3.49	0.70
Exposure to chemicals released by industry	par2	377	13	2.77	1.00	2.81	1.11	2.75	0.99
Living near a nuclear power plant	par3	372	18	3.65	1.20	3.66	1.40	3.64	1.15
Living near an electricity sub-station	par4	370	20	3.59	1.16	3.61	1.33	3.58	1.13
Radioactive fallout from a nuclear power plant	par5	361	29	2.19	1.22	2.26	1.31	2.16	1.20
Living near a mobile phone transmitter	par6	372	18	3.24	1.11	3.11	1.17	3.27	1.11
Living near an overhead power line	par7	376	14	3.17	1.16	3.27	1.27	3.14	1.14
Exposure to EMFs in the physiotherapy department	par8	383	7	3.61	0.97	3.65	0.96	3.60	0.99
Exposure to EMFs in the home e.g. hair dryers, hi fi systems	par9	375	15	3.21	1.21	3.21	1.31	3.21	1.20
Other sources of EMFs in the home e.g. microwave	par10	376	14	3.38	1.13	3.37	1.24	3.38	1.11
Exposure to radon Gas	par11	217	173	3.01	1.22	3.37	1.34	2.84	1.15
Exposure to noise	par12	386	4	3.24	0.89	3.38	0.99	3.20	0.87
Exposure to poor air quality	par13	386	4	2.59	0.83	2.66	0.98	2.56	0.80
Air travel	par14	384	6	3.47	1.33	3.54	1.37	3.45	1.33
Train travel	par15	382	8	3.39	1.34	3.47	1.36	3.36	1.36

The descriptive statistics for all items of RP, HC and PAR scales were calculated by excluding ‘score of 6’ assigned to ‘do not know’ response, which was treated as missing values that are reported in Tables 4.21, 4.22 and 4.23. The descriptive statistics show that ‘do not know’ scores for rp_17, hc17 and par 11 were frequently reported by 147 (35%), 153 (39%) and 173 (44%) participants respectively. It is imperative to state that all these three items were about ‘exposure to radon gas’. After calculating descriptive statistics, these three items, due to widely reported ‘do not know’ scores, were deleted; hence, excluded from subsequent analyses. As the ‘do not know’ scores were genuinely reported scores by the study participant, hence they cannot be treated as ‘information not provided’ (missing data), which might be imputed. These score were thus not imputed but they were treated as missing values, and subsequently deleted by selecting the ‘exclude cases listwise’ option for missing values available in SPSS for multivariate analyses such as multiple regressions and exploratory factor analysis. For model fitting using structural equation modelling (SEM), all cases with ‘do not know’ scores were deleted before running the model because the SEM do not provide the ‘exclude cases listwise’ option for missing values.

4.5.7 Creation of summated (composite) variables

Scores of all items (measured variables) except ‘exposure to radon gas’ included in the perception of health risks, perception of health consequences and protection against health risk were summated to create summated variables one each for the RP, HC and PAR.

4.5.7.1 Descriptive statistics of summated variables

Descriptive statistics of summated variables of RP, HC and PAR are presented in Table 4.24. When summated means of RP, HC and PAR were divided by the total number items i.e .23 for RP, 22 for HC and 15 for PAR constructs, then the average mean ranking was 3.1 for summated RP, was 2.9 for HC and 3 for PAR, which means that this sample of physiotherapists perceived moderate health risk, moderate harm and sometime possibility of protection from health hazards included in the survey questionnaire used in this study.

The researcher calculated Z scores for skewness and kurtosis of the three variables given in Table 4.24 as suggested by Field (2009, p. 139) and found that the z-scores were >3.29 ($p < .001$) for summated PAR and < 3.29 ($p < .001$) for summated RP and summated HC variables, which suggested that data for summated for PAR was not normally distributed. However, as explained earlier that the kurtosis and skewness become significant due to large sample size (Field, 2009, p. 139) such as 390 in the present study, the data for these variables (Table 4.24) was considered as normally distributed.

Table 4.24 Descriptive statistics of summated RP, HC and PAR variables

	Perception of health risk (RP) (summated)	*Perception of health consequences (HC) (summated)*	*Protection against health risk (PAR)(summated)*
Mean	71.60	63.51	45.31
Std. Error of Mean	0.54	0.57	0.48
Median	72.00	63.00	46.00
Std. Deviation	10.58	11.19	9.47
Skewness	0.06	0.37	-0.62
Std. Error of Skewness	0.12	0.12	0.12
Kurtosis	0.03	0.08	0.90
Std. Error of Kurtosis	0.25	0.25	0.25

4.5.7.2 Reliability of summated variables

Running scale reliability statistics in SPSS, reliability of summated variables of RP, HC and PAR was determined by Cronbach's α coefficient, which was observed as .880 (standardised α = .879), .889 (standardised α = .892) and .786

(standardised α = .783) respectively. The grand mean ranking of the RP, HC and PAR variables was 3.22, 2.97 and 3.21 respectively.

4.5.7.3 Outliers, normality and homogeneity of variance in summated variables

After creating, RP, HC and PAR summated variables were checked for outliers, normality and homogeneity of variance as follows.

4.5.7.3.1 Outliers

4.5.7.3.1.1 Univariate outliers

Univariate outliers were identified by box plots and z-scores > ±2.5 value. Figure 4.4a shows the first box plot revealing a number of univariate outliers present on three summated variables. Figure 4.4b is the last box plots that were observed after fourth stage of univariate outliers' identification and subsequent deletion. In addition, Z scores were also calculated for all the three summated variables to identify scores > ±2.5 score. As a result, 2, 8 and 13 univariate outliers were identified for summated RP, HC and PAR variables, respectively (Table 4.25). As such, 23 univariate outliers were deleted for three summated variables.

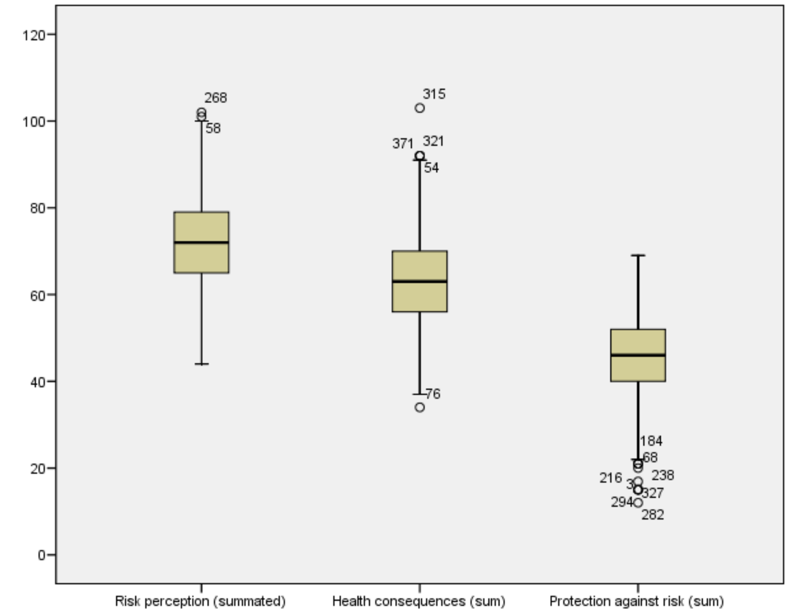


Figure 4.4a First stage box plot showing univariate outliers

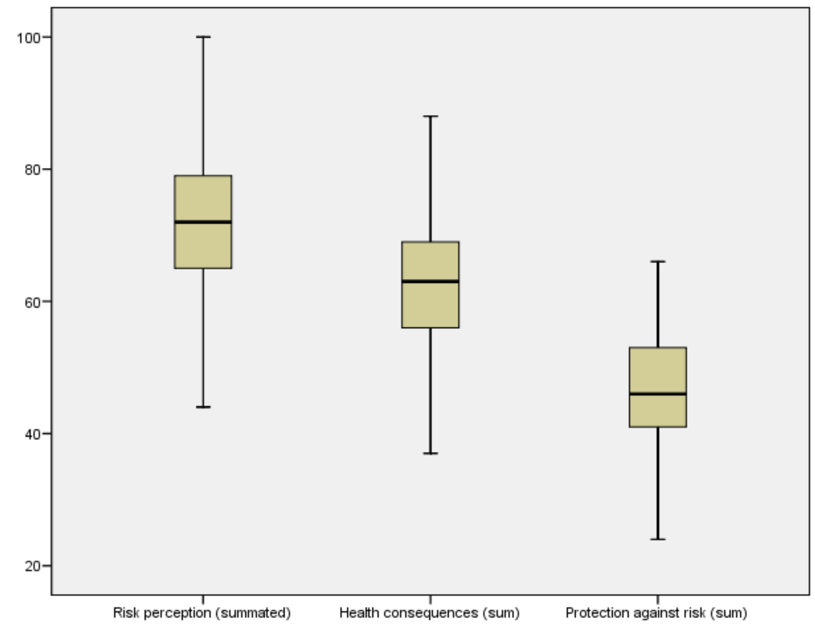


Figure 4.4b Last stage box plots showing no univariate outliers

4.5.7.3.1.2 Multivariate outliers

Multivariate outliers were identified by calculating Mahalanobis distance (D^2) for three (df =3) summated RP, HC and PAR variables. Any case with a D^2 value greater than the critical value of chi square (χ^2) = 16.277 at p = .001 for df = 3 was considered a multivariate outlier. The process of identification of multivariatie outliers was conducted in a number of iterations. In the fourth step, D^2 observed was minimum 0.026 and maximum 12.341, which means the maximum D^2 was lower than the upper limit of χ^2 critical value i.e. 16.27, p=0.001 for df=3. It therefore confirmed that there were no further multivariate outliers for three summated variables entered in the Mahalanobis test.

As a result of above-mentioned methods 23 univariate and 9 multivariate outliers were identified in four steps. The results of both univariate and multivariate outlier cases are presented in Table 4.25, which shows that cases number 54, 315 and 282 were univariate as well as multivariate outliers. Consequently, 29 outliers were deleted in total; thus, leaving the final sample size of 361 cases.

Table 4.25 Univariate and multivariate outliers on summated variables

Univariate outliers						*Multivariate outliers*		
Perception of risk (RP)		*Perception of health consequences (HC)*		*Protection against risk (PAR)*		*RP, HC and PAR variables (df=3)*		
Case ID	*Std* z score*	*Case ID*	*Std* z score*	*Case ID*	*Std.* z score*	*Case ID*	*Mahalanobis distance (D2)*	*D2/Df*
268	2.87	371	2.55	113	-3.61	73	23.669	7.9
58	2.78	315	3.53	282	-3.52	360	19.611	6.5
		234	2.68	294	-3.2	157	19.361	6.5
		337	2.68	238	-3.2	314	19.235	6.4
		321	2.55	216	-3.2	53	18.187	6.1
		54	2.55	3	-3.0	54	18.070	6.0
		41	2.5	158	-2.91	315	17.350	5.8
		76	-2.64	357	-2.79	388	16.356	5.5
				68	-2.67	282	16.336	5.4
				327	-2.57			
				184	-2.57			
				143	-2.56			
				141	-2.56			

*Std.= Standardised

4.5.7.3.2 Normality

Normality of summated RP, HC and PAR variables was determined by Kolmogorov-Smirnov (K-S) Test and Shapiro-Wilk (S-W) Test by running the explore statistics in SPSS (Table 4.26a). For summated RP variable, the both tests were not significant which confirmed normality of data for this variable. For summated HC variable, both tests were significant that showed that the data for this variable was not normalised. Whereas in the case of summated PAR variable, K-S test was significant and S-W test was not significant, which means further analyses were required. Therefore, when the data for these three variables were split by gender in two groups, the results showed that the both normality tests were not significant except for female category for HC variable (Table 4.26b). Overall, significance values > .05 for both K-S and S-W tests confirmed normality of data.

Table 4.26a Tests of normality of summated RP, HC and PAR variables

	Kolmogorov-Smirnov[(a)] Test			*Shapiro-Wilk Test*		
	Statistic	*df*	*Sig.*	*Statistic*	*df*	*Sig.*
Risk perception (summated RP)	.037	361	.200	.997	361	.647
Health consequences (summated HC)	.052	361	.020	.990	361	.014
Protection against risk (summated PAR)	.051	361	.026	.994	361	.142

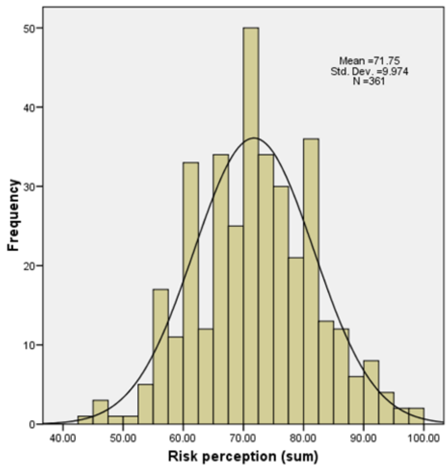
a Lilliefors Significance Correction

Table 4.26b Tests of normality of summated RP, HC and PAR variables (by gender)

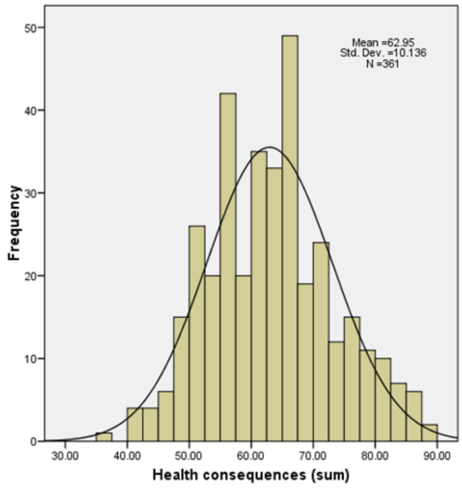
Variable	*Gender*	*Kolmogorov-Smirnov*[(a)] *Test*			*Shapiro-Wilk Test*		
		Statistic	*df*	*Sig.*	*Statistic*	*df*	*Sig.*
Risk perception (summated RP)	Male	.100	74	.065	.983	74	.407
	Female	.046	287	.200	.996	287	.731
Health consequences (summated HC)	Male	.077	74	.200	.979	74	.243
	Female	.057	287	.027	.989	287	.023
Protection against risk (summated PAR)	Male	.055	74	.200	.988	74	.721
	Female	.053	287	.052	.993	287	.178

a Lilliefors Significance Correction

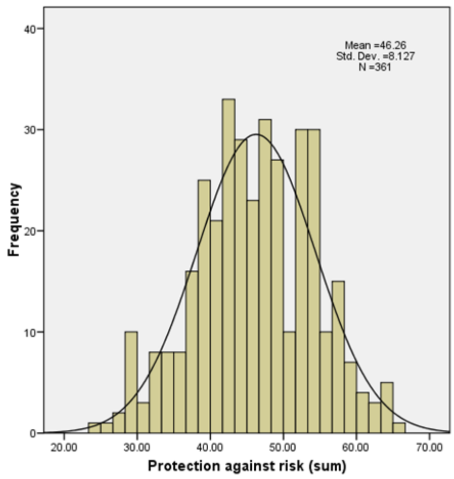
The normality of data distribution was also checked by histograms of summated RP, HC and PAR variables (Figures 4.5a, b, c), which showed bell-shaped symmetrical distribution. Thus, they confirmed normality of the data.



Figures 4.5a. Histogram of summated RP variable



Figures 4.5b. Histogram of summated HC variable



Figures 4.5c Histogram of summated PAR variable

In addition, Probability-Probability (PP) plots (Figure 4.6a,c,e) and Qunatile-Quantile plots (Figure 4.6b,d,f) of summated RP, HC and PAR variables were produced, which also confirmed presence of data normality by revealing the observed values falling on a straight diagonal line.

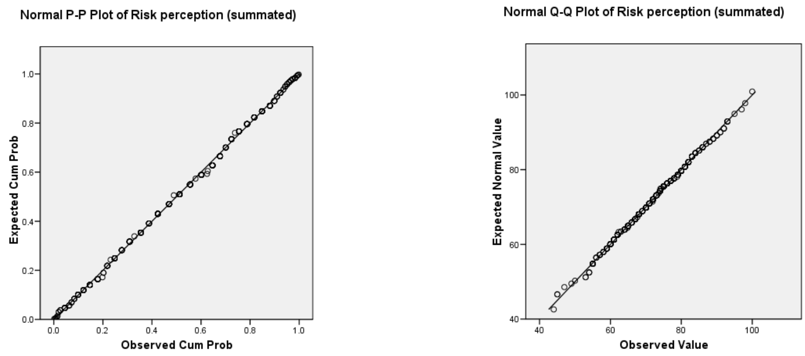


Figure 4.6(a-b) Probability-Probability (PP) plot and Quantile-Quantile (QQ) plot of summated RP variable

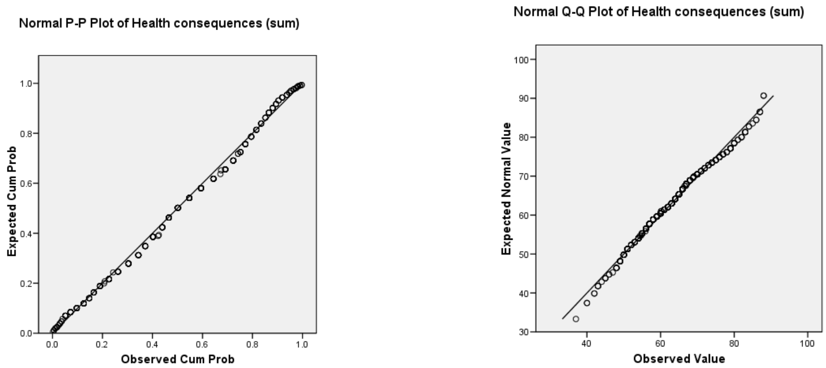


Figure 4.6(c-d) PP and QQ plots of summated HC variable

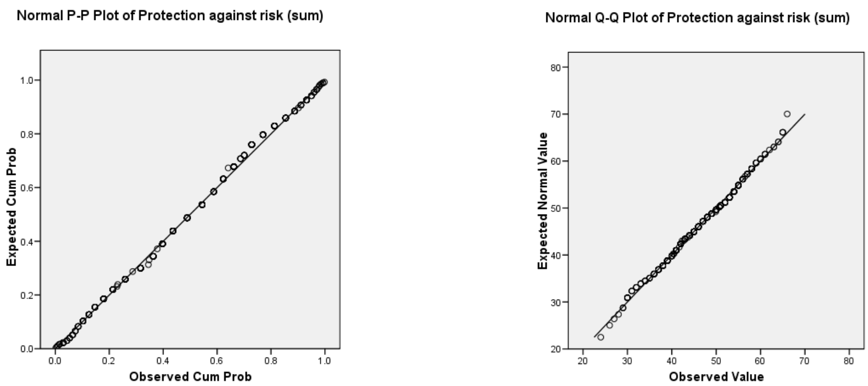
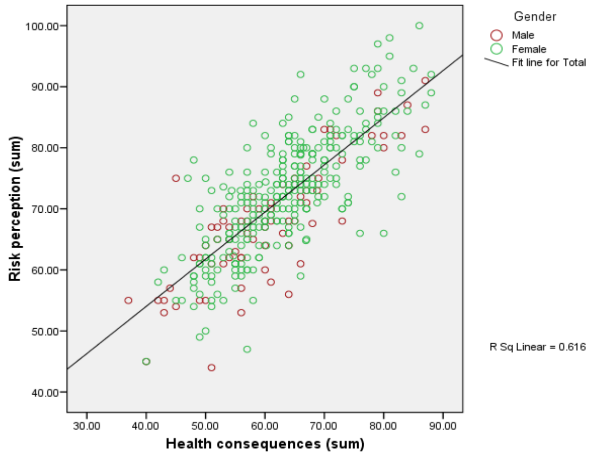


Figure 4.6(e-f) PP and QQ plots of summated PAR variable

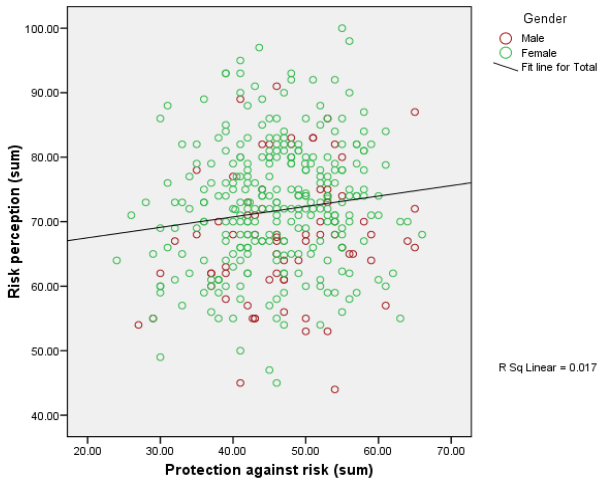
4.5.7.3.3 Linearity

4.5.7.3.3.1 Bivariate linearity

Bivariate linearity between summated variables of RP, HC and PAR was determined by scatter plots. In the first instance, summated RP variable was treated as a dependent variable (DV) while summated HC and summated PAR variables were treated as independent variables (IVs). Thereafter, summated HC variable was entered as a DV and summated PAR variable was entered as an IV. Scatter plots (Figure 4.7a and 4.7b) revealed positive linear association between RP and HC variables and between RP and PAR variables with R^2 linear = 0.616 and 0.017, respectively, which also confirmed presence of bivariate linearity between the variables. Scatter plot (Figure 4.6c) of HC and PAR variables showed R^2 linear = 0.006, which once again confirmed a lack of significant bivariate linearity between the two variables.



Figures 4.7a. Bivariate linearity between summated RP and HC variables



Figures 4.7b Bivariate linearity between summated RP and PAR variables

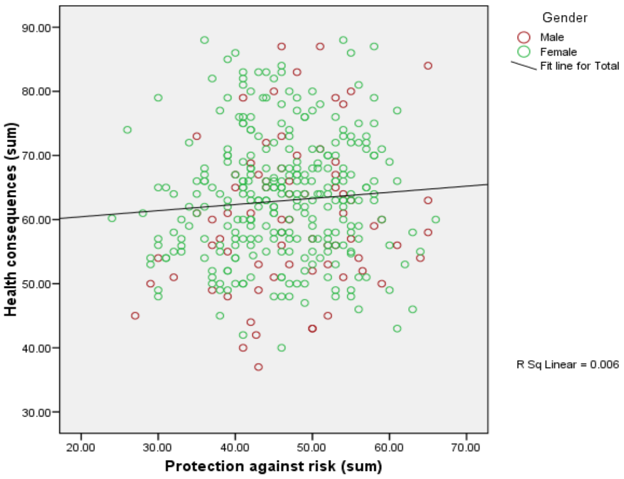


Figure 4.7c. Bivariate linearity between summated HC and PAR variables

4.5.7.3.4 Homogeneity of variance (Homoscedasticity)

Homogeneity of variance between summated RP, HC and PAR variables was determined by Levene's test. Results are presented in Table 4.27. No test statistics were significant, which confirmed presence of homogeneity of variance between the variables.

Table 4.27 Test of homogeneity of variance in summated RP, HC and PAR variables

		Levene Statistic	*df1*	*df2*	*Sig.*
Risk perception (summated RP)	Based on Mean	.008	1	359	.931
	Based on Median	.009	1	359	.925
	Based on Median and with adjusted df	.009	1	358.09	.925
	Based on trimmed mean	.007	1	359	.932
Health consequences (summated HC)	Based on Mean	2.803	1	359	.095
	Based on Median	2.620	1	359	.106
	Based on Median and with adjusted df	2.620	1	349.79	.106
	Based on trimmed mean	2.702	1	359	.101
Protection against risk (summated PAR)	Based on Mean	.123	1	359	.726
	Based on Median	.097	1	359	.756
	Based on Median and with adjusted df	.097	1	357.24	.756
	Based on trimmed mean	.121	1	359	.729

4.5.7.4 Descriptive statistics of summated variables after deletion of outliers

Descriptive statistics of summated RP, HC and PAR variables after deletion of outliers are presented in Table 4.28. The mean scores observed were 3.22 (moderate risk) for perception of health risk, 2.79 (moderate harm) for perception of health consequences and 3.24 (protection sometimes possible) for perception of protection against risk. The variance was lowest in perception of health risk and highest in perception of protection against risk. Values of both Skewness and Kurtosis for all the three summated variables were less than 3.29 at $p < .001$ (Field, 2009, p. 139); thus, normality of data was confirmed.

Table 4.28 Descriptive statistics of summated RP, HC and PAR variables

		Risk perception (summated RP)	*Health consequences (summated HC)*	*Protection against risk (summated PAR)*
Minimum	Statistic	1.96	1.82	1.86
Maximum	Statistic	4.35	4.61	4.5
Mean	Statistic	3.22	2.98	3.24
	Std. Error	0.02	0.02	0.03
Std. Deviation	Statistic	0.4	0.47	0.51
Variance	Statistic	0.16	0.22	0.26
Skewness	Statistic	0.07	0.39	-0.11
	Std. Error	0.13	0.13	0.13
Kurtosis	Statistic	-0.06	0.01	-0.36
	Std. Error	0.26	0.26	0.26

4.5.7.5 Pattern of ‘Do not know’ score (shown as missing values)

Summary of 'do not know’ score treated as missing value for all items included in the 'perception of risk', 'perception of health consequences' and 'protection against risk' constructs are presented in Table 4.29 and Figure 4.8.

Table 2.29 Measured variables with ‘Do not know’ scores shown as missing values

	Missing		*Valid*			*Missing*		*Valid*	
Variable Code	*N*	*%*	*N*	*%*	*Variable Code*	*N*	*%*	*N*	*%*
par11	173	44.4	217	55.6	rp_16	7	1.8	383	98.2
hc17	153	39.2	237	60.8	rp_14	7	1.8	383	98.2
rp_17	147	37.7	243	62.3	par14	6	1.5	384	98.5
rp_11	36	9.2	354	90.8	hc7	6	1.5	384	98.5
hc11	34	8.7	356	91.3	par13	4	1	386	99
par5	29	7.4	361	92.6	par12	4	1	386	99
hc9	26	6.7	364	93.3	hc18	4	1	386	99
hc12	24	6.2	366	93.8	rp_4	4	1	386	99
rp_12	22	5.6	368	94.4	hc22	3	.8	387	99.2
rp_9	22	5.6	368	94.4	hc4	3	.8	387	99.2
par4	20	5.1	370	94.9	rp_20	3	.8	387	99.2
par6	18	4.6	372	95.4	rp_3	3	.8	387	99.2
par3	18	4.6	372	95.4	hc21	2	.5	388	99.5
hc13	18	4.6	372	95.4	hc20	2	.5	388	99.5
hc15	17	4.4	373	95.6	hc3	2	.5	388	99.5
par9	15	3.8	375	96.2	rp_23	2	.5	388	99.5
par10	14	3.6	376	96.4	rp_18	2	.5	388	99.5
par7	14	3.6	376	96.4	rp_22	1	.3	389	99.7
hc14	14	3.6	376	96.4	rp_19	1	.3	389	99.7
par2	13	3.3	377	96.7	rp_6	1	.3	389	99.7
hc8	13	3.3	377	96.7	rp_5	1	.3	389	99.7
rp_8	13	3.3	377	96.7	par1	0	.0	390	100
hc16	12	3.1	378	96.9	hc19	0	.0	390	100
rp_13	12	3.1	378	96.9	hc6	0	.0	390	100
hc10	10	2.6	380	97.4	hc5	0	.0	390	100
rp_10	10	2.6	380	97.4	hc2	0	.0	390	100
rp_7	9	2.3	381	97.7	hc1	0	.0	390	100
par15	8	2.1	382	97.9	rp_21	0	.0	390	100
rp_15	8	2.1	382	97.9	rp_2	0	.0	390	100
par8	7	1.8	383	98.2	rp_1	0	.0	390	100

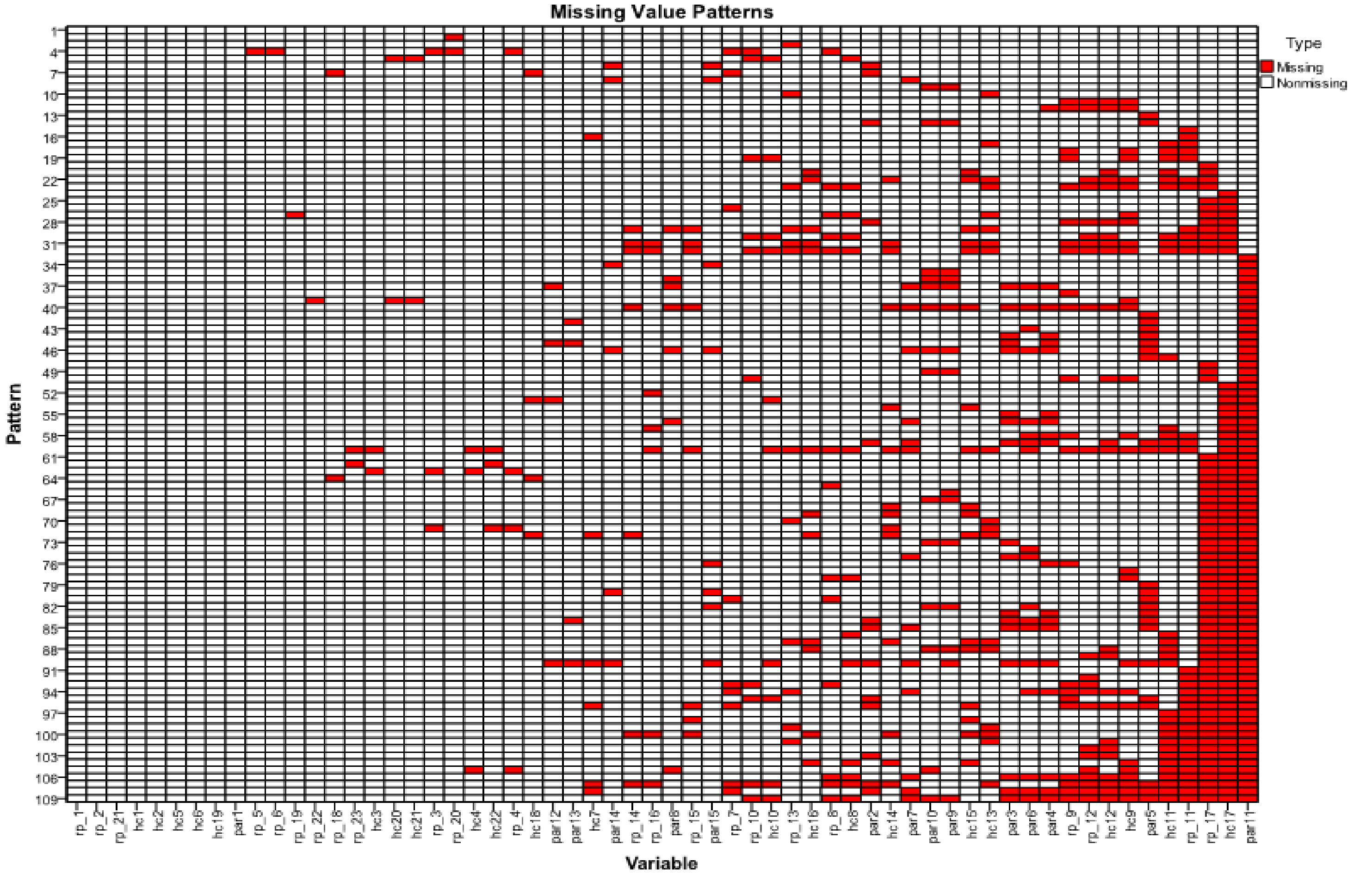


Figure 4.8 Total ‘do not know’ score shown as missing values for all measured RP, HC and PAR items

Results revealed that 'do not know' was reported overall for 51 (85%) of variables by 217 (55.6%) of respondents (cases) (Figure 4.9). Thus, deleting all of the cases with 'do not know' would have reduced the sample size from 390 to 173 (44.4%). In addition, the total of missing values coded as 'do not know' was 4.3% (Figure 4.9). Therefore, deleting all participants with "do not know" would not be necessary but all individual variables with missing value ≥10% would be deleted. Hence, three variables i.e. par 11, hc17 and rp_17 variables were deleted (excluded from further analyses) due to missing values (i.e. 'do not know' scores) of 44.4%, 39.2% and 37.7%, respectively (Table 2.29).

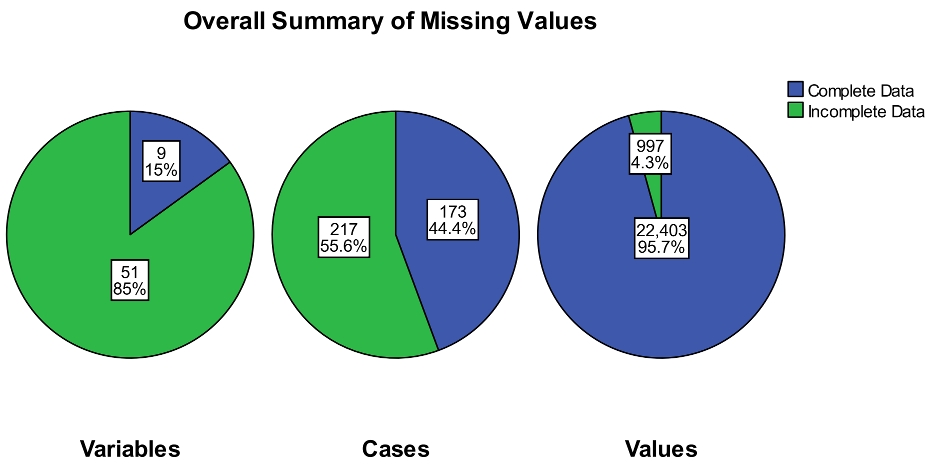


Figure 4.9 Overall summary of 'do not know' score shown as missing values

4.5.7.6 Correlations between socio-demographic and summated variables

Bivariate Pearson correlations between socio-demographic variables and summated RP, HC and PAR variables were run and results are presented in Table 4.30. Summated variable of RP was significantly and positively correlated with summated variables of HC and PAR. There was however no significant correlation between summated HC and summated PAR variables. Summated RP variable was also significantly and positively correlated with gender, alcohol consumption, and awareness of EHI and knowledge of EHI. Summated HC variable was also significantly and positively correlated with gender, awareness of EHI, and knowledge of EHI. Summated PAR variable was not significantly correlated with any demographic variables but the highest education level to which it was significantly and negatively correlated.

Table 4.30 Correlations between demographic and summated perception of health risk, perception of health consequences and perception of protection against risk variables

	Variable name	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
1	Risk perception	1													
2	Health consequences	.78**	1												
3	Protection against risk	.13*	.08	1											
4	Gender	.20**	.12*	-.06	1										
5	Marital Status	.03	.03	.04	.02	1									
6	Education (highest level)	-.02	.01	-.13*	-.13*	.00	1								
7	Time since qualification	.06	.00	.07	.15**	.05	-.72**	1							
8	Cigarette smoking	.06	.04	-.03	.11*	.04	-.04	.05	1						
9	Alcohol consumption (yes/no)	.13*	.09	-.06	.03	.04	.05	.03	.00	1					
10	Alcohol consumption (days / week)	.11*	.08	-.06	.01	.05	.04	.05	-.05	.99**	1				
11	Vigorous exercise (days/week)	.02	.04	-.05	.12*	-.03	-.15**	.25**	-.12*	.08	.08	1			
12	Mild exercise (days/week)	-.04	-.05	-.08	.01	.1	-.01	.06	.00	.04	.05	.27**	1		
13	Eating right amount of food	.01	.01	.05	.01	.11*	-.01	-.03	.01	-.02	-.02	.08	.17**	1	
14	Balanced diet	.00	.01	.04	-.11*	.02	.08	-.05	-.07	.02	.02	.18**	.19**	.45**	1

* Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed),

Table 4.30 continues

	Variable name	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
15	Age	.07	.00	.02	.06	.04	-.62**	.91**	.00	.08	.1	.24**	.06	-.01	-.05
16	Current state of health	.00	-.04	.02	.08	-.03	-.07	.05	.09	-.18**	-.18**	-.12*	-.13*	-.20**	-.24**
17	Value placed on good health	-.02	-.02	.09	.07	.06	.04	.01	.13*	-.02	-.03	-.17**	-.16**	-.26**	-.30**
18	Awareness of EHI	.20**	.18**	.04	.04	-.03	-.14**	.26**	-.01	.02	.02	.07	-.15**	-.08	-.11*
19	Knowledge of EHI	.16**	.18**	.03	.04	-.02	-.12*	.18**	.01	.06	.05	.00	-.15**	-.1	-.16**

Table continued

Table 4.30 continued

	Variable name	*15*	*16*	*17*	*18*	*19*
15	Age	1				
16	Current state of health	.00	1			
17	Value placed on good health	.00	.29**	1		
18	Awareness of EHI	.26**	.13*	.24**	1	
19	Knowledge of EHI	.21**	.08	.19**	.76**	1

* Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed), EHI = environment and health issues.

4.6 Perception of Health Risk

In this section, results of inferential analyses i.e. multiple regression and structural equation modelling of summated variable of perception of health risk are presented and then results of exploratory factor analysis, confirmatory factor analysis and multiple regression of latent constructs of perception of health risk are presented.

4.6.1 Multiple regression summated perception of health risk variable

Assumptions for multiple regression were met before running the sequential multiple linear regression for summated variable of 'perception of health risk' entered as a DV while summated variables of 'perception of health consequences' and 'perception of protection against risk' were entered as IVs. In addition, gender was entered as an IV. Moreover, a new summated variable i.e. 'awareness and knowledge of EHI' entered in the regression. The new summated variable was created by merging scores of 'awareness of EHI' and 'knowledge of EHI' because they were highly correlated (i.e. r =.76), which might be a source of multicollinearity between them.

Running sequential linear multiple regression using the Enter method, a significant model of perception of health risks emerged with F (4, 356) = 155.024, p <.000. The final model explained 63.1 % of the variance (Adjusted R^2 = .631, R^2 = .635), which included 54.2% of the variance accounted for by the 'perception of health consequences' variable. Gender and summated awareness and knowledge of EHI variable explained 4.1% and 3.4%, respectively, of the variance in the criterion variable i.e. summated perception of health risk.

Table 4.31 shows information for each of the explanatory variables, which significantly predicted perception of health risks. The last (4th) step showed that ‘perception of health consequences’ was the most important and significant predictor of ‘perception of health risk’ (while controlling for the other predictors). Results revealed that for a change of 1 SD (standard deviation) in the ‘perception of health consequences’, the outcome variable i.e. ‘perception of health risk’ increased by .76 SD. In the last step, awareness and knowledge of EHI was not significant while all other variables were significant predictors of the ‘perception of health risk’. Gender was significant predictor of ‘perception of health risk’ in all steps.

Table 4.31 Results of multiple regression with predictors of perception of health risk

Variable	*B*	*SEB**	*β*	*Sig.*	R^2	ΔR^2
Step 1					.041	.041
(Constant)	62.81	2.35		.000		
Gender	4.98	1.28	.20	.000		
Step 2					.075	.034
(Constant)	52.71	3.62		.000		
Gender	4.80	1.26	.19	.000		
Awareness and Knowledge of EHI	1.20	0.33	.18	.000		
Step 3					.094	.019
(Constant)	44.79	4.61		.000		
Gender	5.02	1.25	.20	.000		
Awareness and Knowledge of EHI	1.16	0.33	.18	.000		
Protection against risk (sum)	0.17	0.06	.14	.007		
Step 4					.635	.542
(Constant)	13.02	3.24		.000		
Gender	2.76	0.80	.11	.001		
Awareness and Knowledge of EHI	0.27	0.21	.04	.199		
Protection against risk (summated)	0.10	0.04	.08	.014		
Health consequences (summated)	0.75	0.03	.76	.000		

a Dependent Variable: perception of health risk, *SEB = Standardised Error of B

The histogram and P-P plot of residuals of multiple regression of summated RP variable (Figure 4.10) confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.11) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

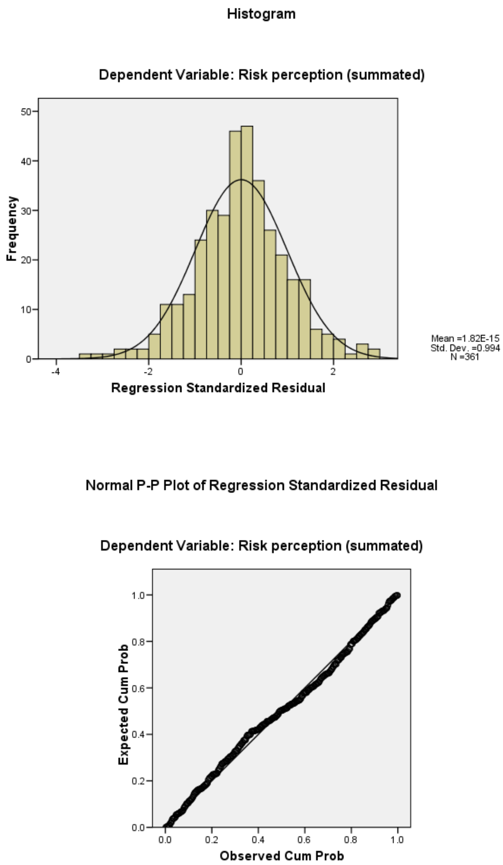


Figure 4.10 Histogram and normal P-P plot of normally distributed residuals of summated perception of health risk

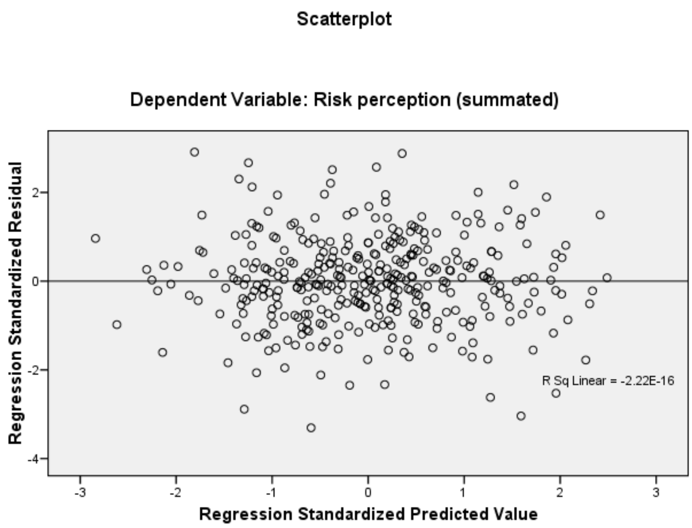


Figure 4.11 Scatterplot of ZRESID against ZPRED of multiple regression of summated perception of health risk

4.6.2 Structural equation model summated ‘perception of health risk’ variable

A hypothesised model of perception of health risk was run with structural equation modelling (SEM). Assumptions of SEM such as multivariate normality and linearity were met before running the model. Figure 4.12 represents the model showing ‘Perception of health risk’ as a dependent variable and gender and three summated variables i.e. ‘perception of health consequences’, awareness and knowledge of EH (summated), and ‘perception of protection against risk’ as IVs.

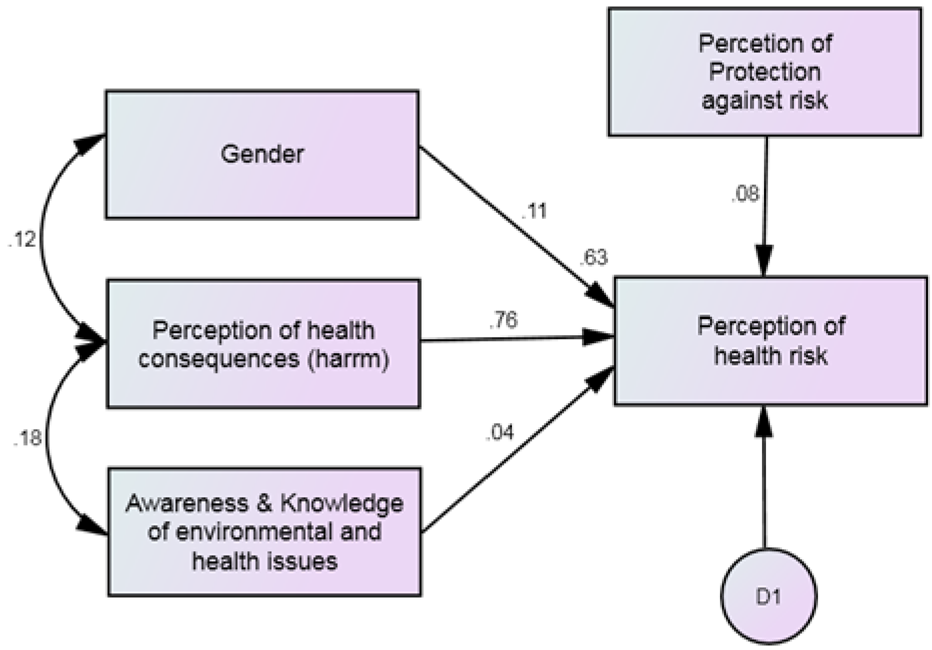


Figure 4.12 Hypothesised structural equation model of perception of health risk

For the outcome variable i.e. perception of health risk, standardised regression weight of the predictor variables observed were .761 for ‘perception of health consequences’, .08 for ‘protection against risk’, .112 for gender and .042 for ‘awareness and knowledge of EHI’. All regressors were significant ($p < .05$) except the ‘awareness and knowledge of EHI’. The structural model (Figure 4.12) revealed that 63% variance in the ‘perception of health risk’ was explained by the four explanatory variables. In addition, there were significant covariance between gender and ‘perception of health consequences’ and between ‘awareness and knowledge of EHI’ and ‘perception of health consequences’, which might suggest that gender and awareness and knowledge of EHI also explained ‘perception of health risk’ indirectly i.e. through ‘perception of health consequences’.

For the structural equation model of ‘perception of health risk’, summary of goodness of fit statistics (Table 4.32) shows support for model fit with the data with Chi-square (χ^2) (4, N =361) = 5.01, P > .05 and the values for model fit indices were > .90 for GFI, NFI, TLI, CFI, RFI and AGFI, < .40 for PNFI, and < .026 (p > .05) for RMSEA.

Due to the high RMR value, modification indices obtained for the hypothesised model were consulted, which suggested dropping out ‘perception of protection against risk’. Therefore, a post-hoc model without the ‘protection against risk variable’ was run (Figure 4.13). Regression weights for all the IVs were similar to those obtained in the hypothesised model. However, the goodness of fit statistics was different (Table 4.32). The noteworthy differences were a lower value of RMR and a higher value for the upper limit of RMSEA in the post hoc model compared to the hypothesised model. In addition, the value for TLI was greater than the upper cut-off value of 1. Because of the limitations of RMSEA and TLI values, the post hoc model was rejected and the hypothesised model was selected as the final model.

Overall, the hypothesised model (Figure 4.12) showed that 63% variance in the ‘perception of health risk’ was significantly explained by gender, ‘perception of health consequences’ and ‘perception of protection against risk’ while the impact of ‘awareness and knowledge of EHI’ was not significant.

Table 4.32 Goodness of fit statistics for structural model of perception of health risk

Goodness of Fit Statistics	*Hypothesised model*	*Post hoc model*
Chi-square (χ^2)		
Chi-square (χ^2)	5.008 (p=.286)	.596 (p =.440)
Degrees of freedom (df)	4	1
Absolute Fit Measures		
Goodness of Fit Index (GFI)	.995	.999
Root mean square error of approximation (RMSEA)	.026	.000
90 % confidence interval for RMSEA (Low; high)	.000; .088 (p =.660)	.000; .127 (p=.613)
Root mean square residual (RMR)	1.995	.139
Normed Chi-square (=χ^2/df)	1.252	.596
Incremental Fit Indices		
Normed fit index (NFI)	.987	.998
Tucker-Lewis coefficient (TLI) *	.993	1.007
Comparative fit index (CFI)	.997	1.000
Relative fit index (RFI)	.968	.990
Parsimony fit Indices		
Adjusted goodness of fit index (AGFI)	.980	.992
Parsimony normed fit index (PNFI)	.395	.166

*Also known as the Bentler-Bonett non-normed fit index (NNFI) (Hair et al., 2010)

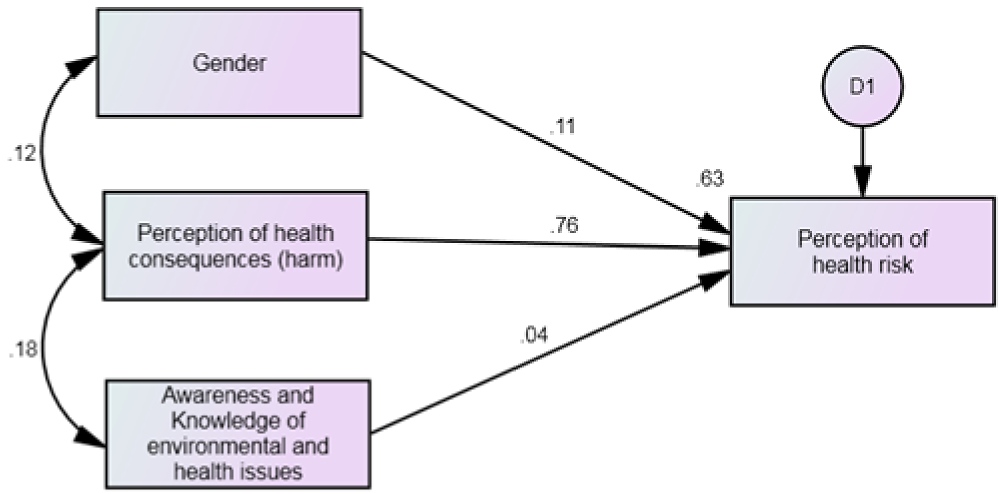


Figure 4.13 Post hoc structural model of perception of health risk

4.6.3 Exploratory factor analysis of perception of health risk items

Exploratory factor analysis was carried out to reduce the dimensions and find out latent factors (constructs) for the ‘perception of health risk’ from 22 risk factors. Multiple criteria for extraction of latent factors were applied as follows:

a) Communalities greater than 0.30
b) Loadings greater than 0.30 on each factor
c) Multiple Sampling Adequacy (MSA) greater than 0.50
d) Kaiser latent root criterion of Eigen values greater than 1
e) Scree plots
f) Minimum variance extracted = 40%

It is reiterated that before finding out latent factors, ‘exposure to radon gas’ (rp_17) variable was excluded because 37.7 % (n=147) of total (n=390) participants answered ‘do not know’ for this variable. For the remaining variables, the ‘do not know’ answer was treated as a missing value in all subsequent analyses but the score was not replaced by imputation because it was a valid answer provided by the respondents. Therefore, while running the EFA in SPSS the option of ‘exclude cases listwise’ was used for handling ‘do not know’ as missing values. Consequently, there were 323 valid cases that were analysed in the EFA.

The process of latent factor extraction was as follows: all measured variables (n=22) regarding the ‘perception of health risk’ except ‘exposure to radon gas’ (rp_17) were entered on SPSS in the data reduction analysis option available for running an EFA. A principal axis factor analysis of the ‘perception of health risk’ was conducted on 22 variables using oblique rotation with Oblimin Kaisar normalisation method. Prior to factor extraction, both univariate and multivariate outliers were identified and deleted as described earlier.

The correlation matrix of items loaded in the final factor solution showed that they were positively and significantly correlated with each other ($p<.05$) except item rp1, which was not correlated with rp_7, rp_8, rp_9 and rp_15. In addition, rp_3 was not correlated with rp_8 while rp_5 was not correlated with rp_15. The highest significant correlation ($r = .65$) was observed between the rp_15 and rp_16 variables. The two variables had significantly higher correlations (i.e. $r = .55$ and $r =.48$ respectively) with rp14. Another high correlation ($r =.57$) was observed between the rp_3 and rp_4 variables. There were however no very high correlations (i.e. $r \geq .9$) between loaded variables that might have caused a multicollinearity problem. In addition, the determinant of the correlation matrix was 0.067, which was greater than the requisite value of 0.0001. It was therefore confirmed that there was no multicollinearity between the loaded variables.

Table 4.33 provides extracted latent factors, Eigen values and the variance as well the loadings, communalities and MSA for all measured variables that were loaded on the extracted latent factors. Anti-mage matrices showed observed MSA that were minimum .665 and maximum .852. Thus, all MSA were greater than the required standard of MSA of .50, which confirmed that the sample was adequate for running factor analyses. Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy statistic observed was.739, which also confirmed sampling adequacy for the analysis. Bartlett’s test of Sphericity with χ^2 (45) = 859.5 ($p < .001$) showed that correlations between variables were statistically significant and large enough for the factor analysis. Communalities extracted were between .23 and .76 (Table 4.33). Communalities of all variables except rp1 were greater than the minimum required communality of .30 for the sample size of this study. Eigen values for each factor in the data were run and three factors were observed on the basis of Kaiser's Eigen values greater than 1 criterion. Another criterion of extracting the number of factors, Scree plot (Figure 4.14) showed inflexion that also justified retention of a three factor solution for the 'perception of health risk'.

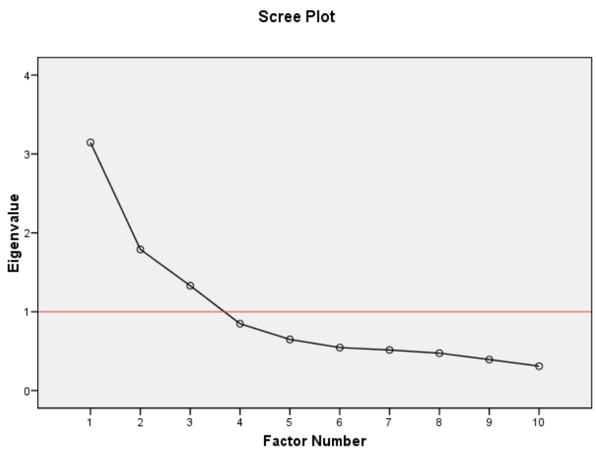


Figure 4.14 Scree plot of extraction of latent factors in exploratory factor analysis of perception of health risk

Total variance extracted by three factors was 48.4% (Table 4.33). Factor 1 explained 26.8% of the variance and the other two factors accounted for the remaining 21.6% of the variance. Therefore, the three-factor solution was accepted because the total variance extracted in the model was greater than the minimum requirement of 40% variance extraction.

Results revealed that in the final solution, ten variables were retained and the 'pattern matrix' showed extraction of three factors, which was achieved in 6 iterations. Factor 1 comprised three variables i.e. rp15, rp16 and rp14. Factor 2 consisted four items i.e. rp3, rp4, rp5 and rp1. Factor 3 included three variables i.e. rp8, rp7 and rp10 (Table 4.33).

Table 4.33. Results of exploratory factor analysis of perception of health risk

Dimension/Factor (items/indicator variables)	*Factor loading*	*Eigen value*	*Variance explained (%)*	*Communality extracted (h^2)*	*Measures of Sampling Adequacy*	*Reliability (Cronbach's α)*
F1=EMF risks		3.15	26.78			.78
rp15:EMFs in home I (e.g. hair dryers and hi fi systems)	.86			.76	.74	
rp16:EMFs in home II (e.g. home microwave)	.84			.56	.70	
rp14: EMFs in Physiotherapy department	.72			.44	.85	
F2=Lifestyle risks		1.29	12.88			.69
rp3: Alcohol consumption up to the legal limit	.90			.74	.67	
rp4:Alcohol consumption over the legal limit	.68			.37	.68	
rp5:Obesity	.53			.29	.77	
rp1: Tobacco Smoking	.45			.23	.71	
F3= Chemical and Nuclear risks		1.33	8.73			.72
rp8:Nuclear power plant	.64			.58	.77	
rp7: Industrial chemicals	.68			.49	.76	
rp10:Radioactive fallout from nuclear power plant	.73			.39	.76	
Total			48.39			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy .74						
Bartlett's Test of Sphericity:						
Approx. Chi-Square	859.146					
Degrees of freedom (df)	45					
Significance (p value)	.000					
Extraction method	Principal axis factoring					
Rotation method	Oblimin with Kaiser normalisation					
Factor loadings	>.40					

The nature of variables loaded on the same factor suggested that factor 1 represented EMF risks, factor 2 represented lifestyle risks and factor 3 represented chemical and nuclear risks. The highest and lowest variable loadings on factor 1 were .90 and .56 by rp15 and rp14, respectively. On factor 2, rp3 and rp1 were loaded as the highest and the lowest with .86 and .48 loading, respectively. The maximum and minimum loadings on factor 3 were .71 and .63 by items rp8 and rp10, respectively.

The 'factor correlation matrix' revealed that all three factors were correlated with each other. Correlation between factor 1 (EMF risks) and factor 2 (lifestyle risks) was .271, between factor 1 (EMF risks) and factor 3 (chemical and nuclear risks) was .368 and between factor 2 (lifestyle risks) and factor 3 (chemical and nuclear risks) was .191.

The reliability of each latent factor was determined by calculating the Cronbach's alpha coefficient which was .78 for factor 1, .69 for factor 2 and .72 for factor 3 (Table 4.33).

4.6.4 Confirmatory factor analysis of perception of health risk items

Using AMOS statistical package, CFA was conducted on three latent factors of perception of health risk items, identified in EFA, as presented in a hypothesised model (Figure 4.15). In the model, big circles represented latent variables (also known as factors, constructs or unobserved variables) and rectangles represented measured variables (also called indicators, observed or manifest variables). Double headed arrows represented covariance between two variables while and single headed arrows showed a unidirectional hypothesised direct relationship between two variables. In the latter case, arrow points to the dependent variable while the variable on the other end is an independent variable.

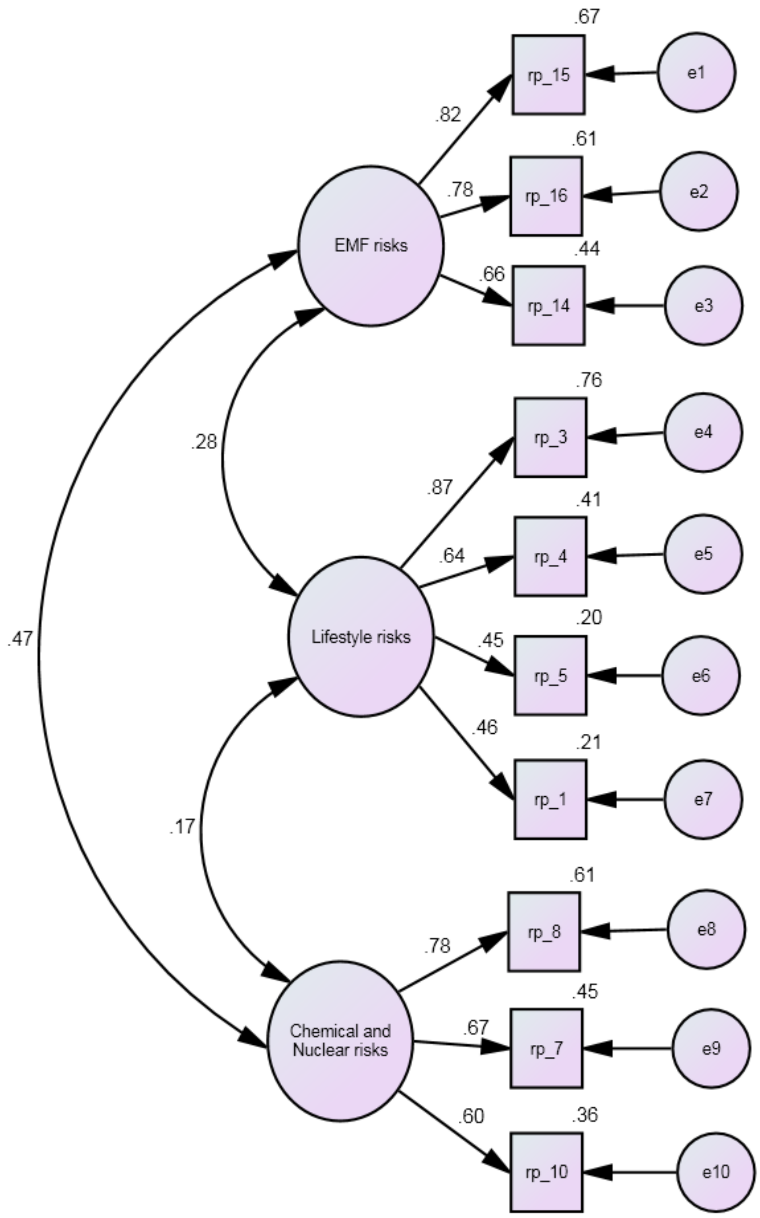


Figure 4.15 Hypothesised measurement (CFA) model of perception of health risk

[rp15 = EMFs in home I (e.g. hair dryers and hi fi systems), rp16 =EMFs in home II (e.g. home microwaves), rp14 = EMFs in Physiotherapy department, rp3 = Alcohol consumption up to the legal limit, rp4 =Alcohol consumption over the legal limit, rp5 =Obesity, rp1= Tobacco Smoking, rp8 =Nuclear power plant, rp7= Industrial chemicals, rp10 =Radioactive fallout from nuclear power plant]

No direct effect between measured variables was hypothesised. Three measured variables i.e. EMFs in home I e.g. hair dryers and hi fi systems (rp15), EMFs in home II e.g. home microwaves (rp16) and EMFs in Physiotherapy department (rp14) served as indicators of the latent factor 1, which represented EMF risks. Latent factor 2 representing lifestyle risks was indicated by four measured variables i.e. alcohol consumption up to legal limit (rp3) and over the legal limit (rp4), obesity (rp5) and tobacco smoking (rp1). Third latent factor representing chemical and nuclear risks was manifested by three measured variables i.e. living near a nuclear power plant (rp8), chemicals released by industry (rp7) and radioactive fallout from a nuclear power plant (rp10).

The assumption of multivariate normality and linearity were evaluated through SPSS. In addition, all cases with 'do not know' score (now as missing values) for any of 11 measured variables included in the model were deleted and a separate file was saved to run the structural equation modelling using AMOS because the latter do not run in the presence of missing values. The 'Maximum Likelihood Estimation method' was employed for estimating hypothesised measurement (CFA) model of 'perception of health risk'. All three latent factors along with their respective indicator (measured) variables were retained in the hypothesised model. Results of the significant regression estimates along with average variance and correlations between the latent variables and their indicator variables included in the measurement model are presented in Table 4.34. Henceforth, latent factors will be referred to as the latent constructs or scales according to the terminology used in the SEM.

As found in the EFA, CFA results of the hypothesised measurement model showed that all the three constructs were correlated with each other (Table 4.34).

Table 4.34 Standardised regression estimates, average variance extracted and construct reliabilities and correlations of CFA model of perception of health risk

	Standardised regression estimates					
Measured variables / indicators	*EMF risks*	*Lifestyle risks*	*Chemical and nuclear risks*	*c.r.*	*Sig (p)*	*SMCs*
EMFs in home I (e.g. hair dryers and hi fi systems) (rp15)	0.82			0.67	a	
EMFs in home II (e.g. home microwave) (rp16)	0.78			0.61	12.48	< .001
EMFs in Physiotherapy department (rp14)	0.66			0.44	10.87	< .001
Alcohol consumption up to legal limit (rp3)		0.87		0.76	a	
Alcohol consumption over the legal limit (rp4)		0.64		0.41	9.10	< .001
Obesity (rp5)		0.45		0.20	6.38	< .001
Smoking (rp1)		0.46		0.21	6.94	
Living near a nuclear power plant (rp8)			0.78	0.61	a	
Exposure to chemicals from Industries (rp7)			0.67	0.45	8.43	< .001
Radioactive fallout from nuclear power plant (rp10)			0.60	0.36	8.33	< .001
Inter construct correlations†:						
EMF and X rays risks	1	0.08	0.22			
Lifestyle risks	0.28	1	0.03			
Chemical and nuclear risks	0.47	0.17	1			
Construct reliability	0.88	0.83	0.72			
Average variance extracted	57%	40%	47%			

c.r. = critical ratio (t-statistics); SMCs =Squared multiple correlations; a_Not estimated because of loading set to fixed value i.e. 1.0; †Values below the diagonal are correlation estimates among constructs and values above the diagonal are squared inter-construct correlations.

Inter construct covariance was 0.09 between ‘EMF risks’ and ‘lifestyle risks’ as well as between ‘EMF risks’ and ‘chemical and nuclear risks’ and 0.21 between ‘lifestyle risks’ and ‘chemical and nuclear risks’. The construct reliability for each construct was calculated and was found to be ≥.72 (Table 4.34). In addition, the average variance extracted (AVE) for each construct was calculated and is presented in Table 4.34. This showed that the highest AVE (57%) was for 'EMF risks' construct and the lowest AVE (40%) was for 'lifestyle risks' construct.

A summary of goodness of fit statistics for the hypothesised measurement (CFA) model of perception of health risk is presented in Table 4.35. The results showed support for the hypothesised model with χ^2 (32, N=323) = 68.57, p < .001 and goodness of fit indices observed were GFI, NFI, TLI, CFI and AGFI >.90, PNFI <.70, RMR <.05 and RMSEA <.06 (p = .195).

Table 4.35 Statistics of goodness of fit for measurement (CFA) model of perception of health risk

Goodness of Fit Statistics	*Hypothesised model*	*Post hoc model*
Chi-square (χ^2)		
Chi-square (χ^2)	68.569 (p=.000)	48.286 (p=.019)
Degrees of freedom (df)	32	30
Absolute Fit Measures		
Goodness of Fit Index (GFI)	.961	.972
Root mean square error of approximation (RMSEA)	.060	.044
90 % confidence interval for RMSEA (Low; high)	.040; .079 (p =.195)	.018; .065 (p=.660)
Root mean square residual (RMR)	.034	.031
Normed Chi-square (=χ^2/df)	2.143	1.610
Incremental Fit Indices		
Normed fit index (NFI)	.921	.945
Tucker-Lewis coefficient (TLI) *	.938	.967
Comparative fit index (CFI)	.956	.978
Relative fit index (RFI)	.889	.917
Parsimony fit Indices		
Adjusted goodness of fit index (AGFI)	.934	.949
Parsimony normed fit index (PNFI)	.655	.630

*Also known as the Bentler-Bonett non-normed fit index (NNFI) (Hair et al., 2010)

In order to develop a better fitting and parsimonious model, post hoc modifications were performed by applying the Lagrange multiplier test as suggested by modification indices obtained for the hypothesised model. Consequently, paths indicating co-variance between error terms of four measured variables i.e. between rp15 (EMFs in home I) and rp16 (EMFs in home II) and between rp3 (alcohol consumption up to legal limit) and rp4 (alcohol consumption above the legal limit) were added to create a post hoc model, which is shown in Figure 4.16. Statistics of goodness of fit for post hoc model are presented in Table 4.35, which suggest that the model was improved by addition of extra paths as described above. Overall, the goodness of fit indices revealed that the post-hoc model was better compared to the hypothesised model. However, the hypothesised model was retained because of a lack of theoretical support for addition of extra paths linking error terms of four indicator variables mentioned above.

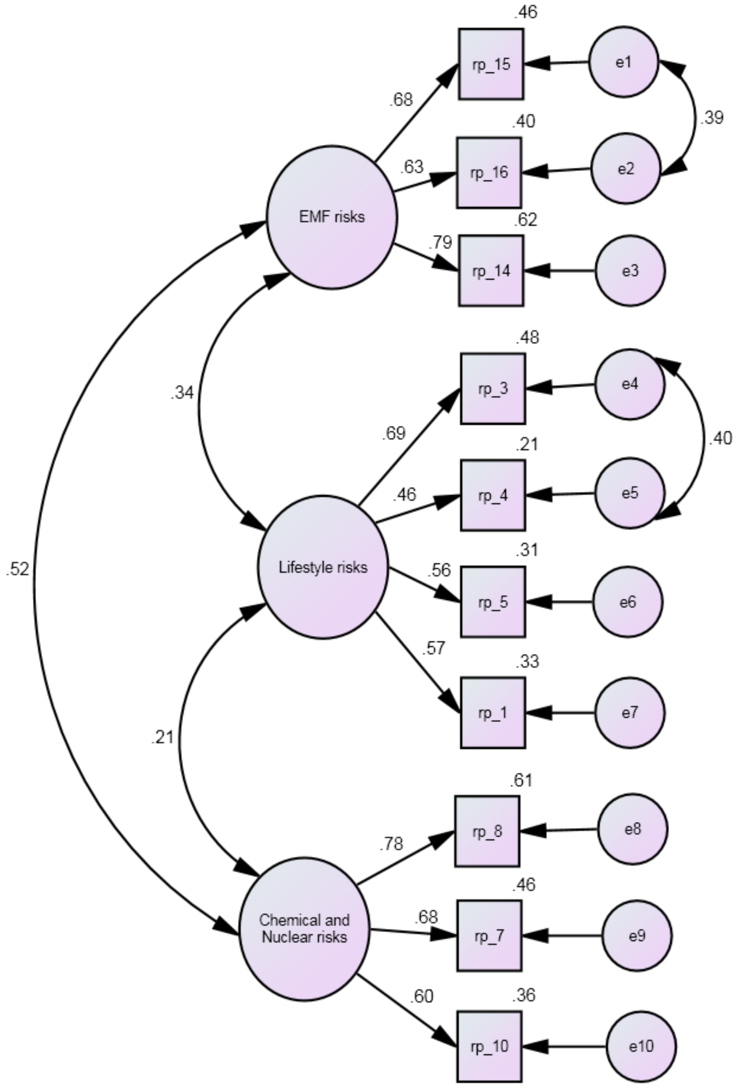


Figure 4.16 Post hoc measurement (CFA) model of perception of health risk

[rp15 = EMFs in home I (e.g. hair dryers and hi fi systems), rp16 =EMFs in home II (e.g. microwave), rp14 = EMFs in Physiotherapy department, rp3 = Alcohol consumption up to the legal limit, rp4 =Alcohol consumption over the legal limit, rp5 =Obesity, rp1= Tobacco Smoking, rp8 =Nuclear power plant, rp7= Industrial chemicals, rp10 =Radioactive fallout from nuclear power plant]

4.6.5 Latent constructs of perception of health risk

4.6.5.1 Creation of latent constructs

Three latent constructs were created one for each factor 1, 2 and 3 on the basis of results of EFA and CFA. All measured variables, henceforth called items, loaded on each latent factor were summated to create a latent construct as follows. A construct for EMF risks (factor 1) was created by addition of scores of rp14, rp15 and rp16 items. In this construct, mean values of items ranged between 1.83 and 2.43 and the grand mean for the construct was 2.16. A construct of lifestyle risks (factor 2) was created by adding together the scores of rp3, rp4, rp5 and rp1 items. For lifestyle risks construct, mean values of the items ranged from 3.01 to 4.67 and the grand mean was 3.99. Similarly, a construct of 'chemical and nuclear risks' (factor 3) was developed by adding up scores of rp8, rp7 and rp10 items. Grand mean of items of this construct was 3.98 and mean values of each item were between 3.55 and 4.34.

4.6.5.2 Reliability of latent constructs of perception of health risk

Reliability of the latent constructs was determined by Cronbach's alpha (α) coefficient using the Scale reliability analysis option provided in SPSS. Consequently, Cronbach's α coefficient observed was of .783 (standardised α =.792) for EMF risks construct, .686 (standardised α =.693) for lifestyle risks construct and .723 (standardised α =.726) for chemical and nuclear risks construct. Thus, results showed that EMF, lifestyle and chemical and nuclear risks scales had good reliabilities i.e. the reliability coefficient that determines internal consistency of the scale (Hair et al., 2009, p.125). Identification of three underlying dimensions (factors or constructs) confirmed the uni-dimensionality, an aspect of construct validity, (Brace et al., 2009, p.374) of the constructs and the questionnaire as a whole.

4.6.5.3 Outliers

For each of the latent construct, univariate and multivariate outliers were identified and subsequently deleted. Univariate outliers were identified by box plots and z-scores > ±2.5 value. Multivariate outliers were identified by calculating Mahalanobis distance (D^2) for three summated constructs (df =3) of perception of health risk scale. Any case with a D^2 value greater than the critical value of chi square (χ^2) = 16.277 at p = .001 for df = 3 was considered a multivariate outlier.

For univariate outliers, Z scores were calculated for all the three latent constructs to identify scores > ±2.5 score and thereafter box plots were run simultaneously for all the three latent constructs. This process was repeated until no outlier was found. Z scores and box plots revealed 15 univariate outliers (Table 4.36), which were deleted and the procedure was repeated but no z score > ±2.5 score was found. This showed that there were no more univariate outliers.

In addition, a box plot was run that also confirmed the absence of univariate outliers (Figure 4.17). This was achieved in two iterations. For identification of multivariate outliers, D^2 was determined. In the first step, D^2 was between .091 and 13.96, which was less than the cut off value for df=3, as mentioned earlier. In the second step i.e. after deletion of univariate outliers found in the first step, the maximum D^2 was found to be 11.35, which was again lower than cut off value of χ^2 =16.267 for df=3. This confirmed absence of multivariate outliers.

Table 4.36 Univariate and multivariate outliers on latent constructs for perception of health risk

EMF risks		*Lifestyle risks*		*Chemical and nuclear risks*	
Case ID	*Std* z score*	*Case ID*	*Std* z score*	*Case ID*	*Std* z score*
287	3.10	172	-2.9	218	-3.24
315	3.10				
58	2.54				
130	2.54				
153	2.54				
188	2.54				
223	2.54				
268	2.54				
280	2.54				
333	2.54				
337	2.54				
341	2.54				
371	2.54				

*Std = Standardised

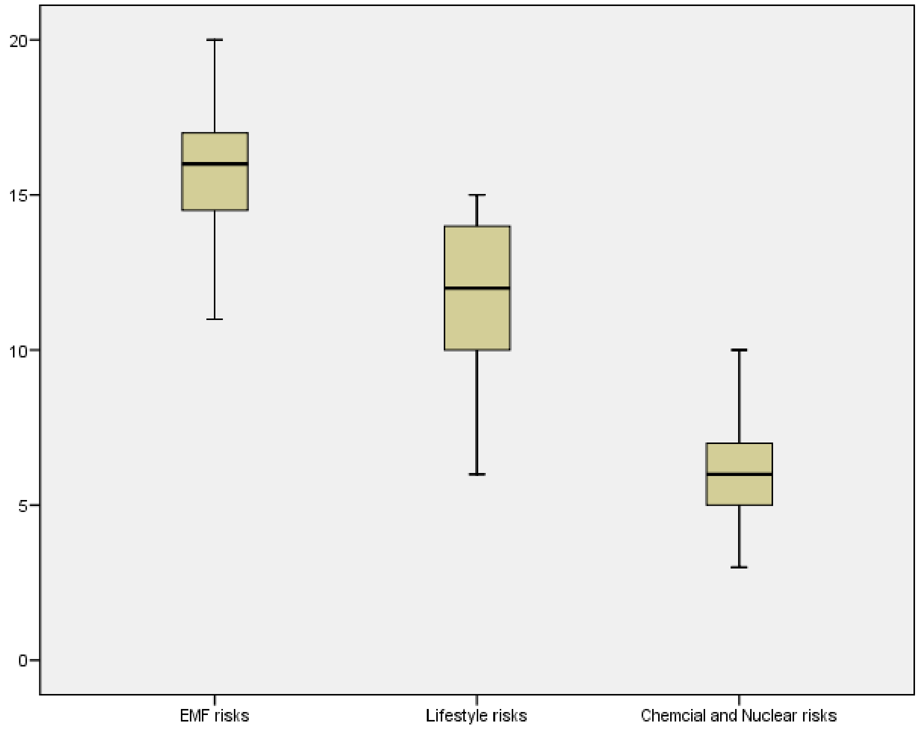


Figure 4.17 Boxplot for latent constructs of 'perception of health risk'

4.6.5.4 Normality

The normality of latent scales was determined by the Kolmogorov-Smirnov test and the Shapiro-Wilk test. Both tests were significant for all three constructs when run as a single sample (group) (Table 4.37a). However, when the constructs were split into two groups by gender, the results revealed that both tests were significant for both male and female participants on all the three scales (Table 4.37b). This suggested a lack of data normality. However, the K-S Test and S-W Test are well known to be sensitive to the sample size; therefore, they tend to become significant when the sample size is big (though no limit has been suggested) despite the data being slightly deviated from normally; hence other methods such as P-P plots and Q-Q plots (Figure 4.18a-f) were used to check the data normality (Field, 2009, p. 144). Therefore, results showing significant K-S test and S-W test in this study with a sample size of 390 do not suggest major deviation from normality.

Table 4.37a.Tests of normality of latent constructs of 'perception of health risk'

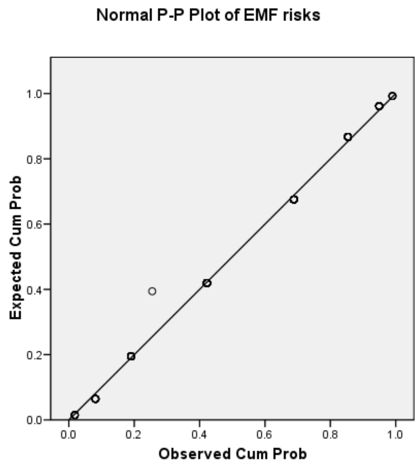
	Kolmogorov-Smirnov[(a)]Test			*Shapiro-Wilk Test*		
	Statistic	*Df*	*Sig.*	*Statistic*	*df*	*Sig.*
EMF risks	.168	308	.000	.953	308	.000
Lifestyle risks	.124	308	.000	.970	308	.000
Chemical and nuclear risks	.145	308	.000	.930	308	.000

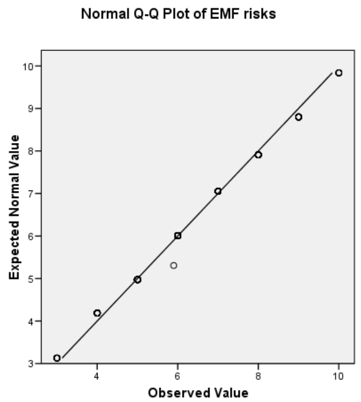
a Lilliefors Significance Correction

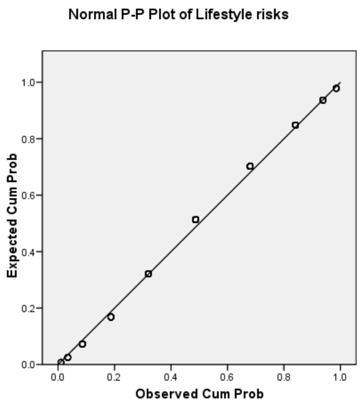
Table 4.37b.Tests of normality of latent constructs of 'perception of health risk' (by gender)

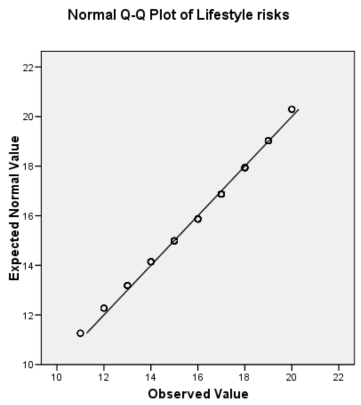
		Kolmogorov-Smirnov[(a)] Test			*Shapiro-Wilk Test*		
	Gender	*Statistic*	*df*	*Sig.*	*Statistic*	*Df*	*Sig.*
EMF risks	Male	.207	63	.000	.934	63	.002
	Female	.178	245	.000	.953	245	.000
Lifestyle risks	Male	.153	63	.001	.959	63	.035
	Female	.132	245	.000	.969	245	.000
Chemical and nuclear risks	Male	.188	63	.000	.929	63	.001
	Female	.161	245	.000	.924	245	.000

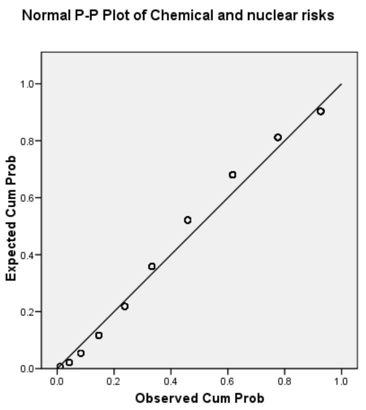
a Lilliefors Significance Correction











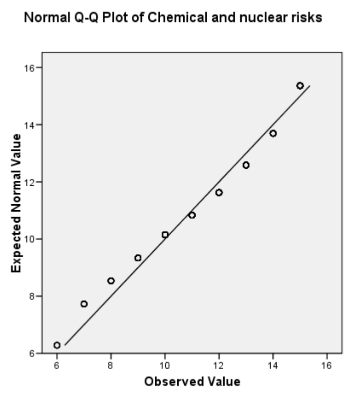


Figure 4.18a-f P-P and Q-Q plots of latent constructs of perception of health risk

4.6.5.5 Homogeneity of variance (homoscedasticity)

Homogeneity of variance between the latent constructs was determined by the Levene's test. All statistics for the Levene's test were not significant (Table 4.38), which confirmed homogeneity of variance between the constructs.

Table 4.38 Test of homogeneity of variance in latent constructs of 'perception of health risk'

		Levene Statistic	*df1*	*df2*	*Sig.*
EMF risks	Based on Mean	.311	1	306	.578
	Based on Median	.086	1	306	.770
	Based on Median and with adjusted df	.086	1	305.672	.770
	Based on trimmed mean	.400	1	306	.528
Lifestyle risks	Based on Mean	.204	1	306	.652
	Based on Median	.169	1	306	.681
	Based on Median and with adjusted df	.169	1	296.492	.681
	Based on trimmed mean	.194	1	306	.660
Chemical and nuclear risks	Based on Mean	.002	1	306	.965
	Based on Median	.265	1	306	.607
	Based on Median and with adjusted df	.265	1	285.107	.607
	Based on trimmed mean	.002	1	306	.963

4.6.5.6 Pearson correlations

Results of Pearson correlations (bivariate) between latent constructs, demographics and summated variables of 'perception of health consequences' and 'perception of protection against risk' are presented in Table 4.39. Results revealed that all the latent constructs were positively and significantly correlated with each other and with the 'perception of health consequences'. Moreover, 'EMF risks' construct and 'lifestyle risks' construct were significantly and positively correlated with gender, awareness and knowledge of EHI. In addition, the 'lifestyle risks' construct was significantly and positively correlated with alcohol consumption (Yes/No), quantity and frequency of alcohol consumption. There were no statistically significant correlations between 'chemical and nuclear risks' construct and demographic variables.

Table 4.39 Pearson correlations (Bivariate) between latent scales of perception of health risks demographics and summated variable of perception of health consequences and perception of protection against risk

	EMF risks	*Lifestyle risks*	*Chemical and nuclear risks*
EMF risks	1		
Lifestyle risks	.213(**)	1	
Chemical and nuclear risks	.366(**)	0.099	1
Perception of health consequences	.544(**)	.306(**)	.455(**)
Perception of protection against risk	-0.04	0.073	0.018
Gender	.207(**)	.157(**)	0.098
Alcohol consumption	0.066	.236(**)	0.091
Units of alcohol consumed / week	0.061	.134(*)	0.099
Alcohol consumption days / week	0.068	.199(**)	0.093
Awareness of environmental and health issues	.139(*)	.122(*)	0.094
Knowledge of environmental and health issues	.148(*)	.124(*)	0.096

** Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

4.6.5.7 Multiple regression of latent constructs of perception of health risks

4.6.5.7.1 Perception of EMF risks (RP Factor 1)

For determining predictors of perception of health risk from 'EMFs', first, all socio-demographic variables and summated variables of perception of health consequences and perception of protection against risk were simultaneously entered as IVs in the model applying stepwise method in multiple linear regression. The model retained only two IVs i.e. 'awareness and knowledge of

EHI' and 'perception of health consequences'. Thereafter, multiple linear regression applying the 'Enter method' was run with EMF risks as a dependent variable and gender, awareness and knowledge of EHI and perception of health consequences as IVs. All IVs were entered in the model in different steps i.e. first gender, then awareness and knowledge of EHI followed by perception of health consequences.

Using sequential / hierarchical multiple linear regression with enter method, a significant model of perception of EMF risks emerged: F (3,304) = 47.070, p <.000. The final model explained 31% of the variance (Adjusted R^2 = .309, R^2 = .310), which included 25.5% explained by 'perception of health consequences'. Gender accounted for the next highest variance (3.9%) in the outcome variable. Results of sequential multiple liner regression for perception of 'EMF risks' with its explanatory variables are presented in Table 4.40.

Table 4.40 Results of sequential multiple linear regression for perception of health risk from EMF risks

Variable	*B*	*SEB*	*Β*	*Sig.*	R^2	ΔR^2
Step 1					.039	.039
(Constant)	4.97	0.39		.000		
Gender	0.75	0.21	.20	.000		
Step 2					.062	.023
(Constant)	3.69	0.61		.000		
Gender	0.75	0.21	.20	.000		
Awareness and Knowledge of EHI	0.15	0.05	.15	.007		
Step 3					.310	.255
(Constant)	-0.15	0.63		.813		
Gender	0.54	0.18	.14	.003		
Awareness and Knowledge of EHI	0.06	0.05	.07	.171		
Perception of health consequence	0.08	0.01	.52	.000		

a Dependent Variable: Perception of health risk from EMF risks

The results reveal that for a change of 1 SD in the ‘perception of health consequences’ (while controlling for the other predictors), perception of ‘EMF risk’ increased by .52 SD. In the final step, ‘awareness and knowledge of EHI’ was not a significant predictor; however, all other variables were significant predictors of the outcome variable. Gender was a significant predictor of perception of health risk from EMFs in all models.

The histogram and P-P plot of residuals (Figure 4.19) of multiple regression of perception of health risk from EMFs variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.20) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

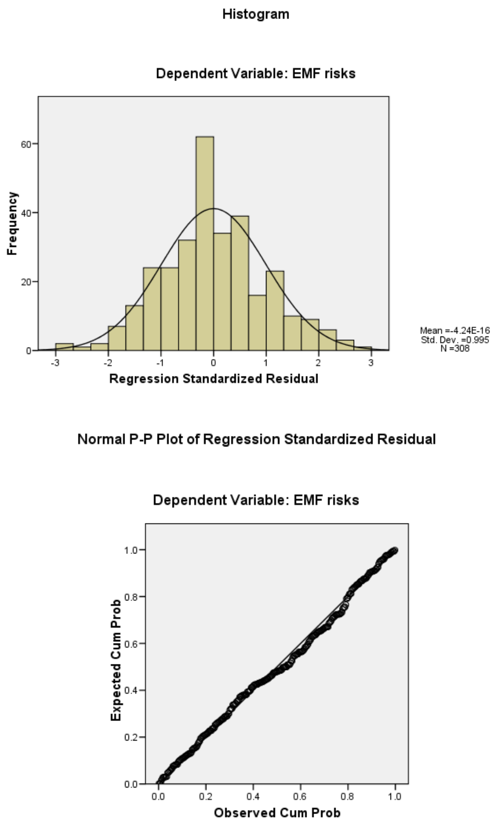


Figure 4.19 Histogram and normal P-P plot of normally distributed residuals of perception of health risk from EMFs

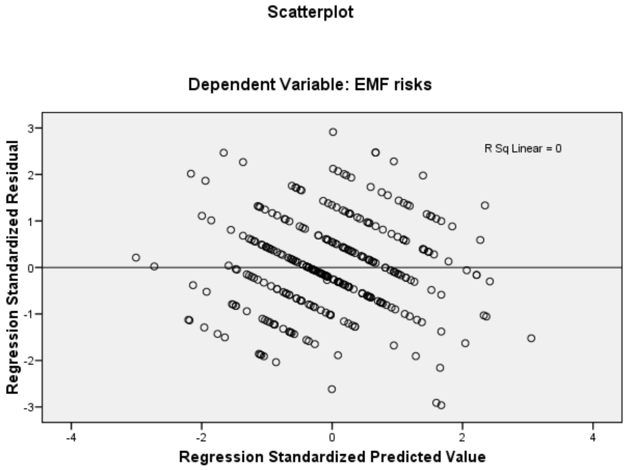


Figure 4.20 Scatterplot of ZRESID against ZPRED of multiple regression of perception of health risk from EMFs

4.6.5.7.2 Perception of lifestyle risks

For identifying predictors of perception of health risk from 'lifestyle risks', first, all socio-demographic variables and summated variables of 'perception of health consequences' and 'perception of protection against risk' were simultaneously entered in multiple linear regression using the 'Stepwise method'. Six IVs i.e. gender, 'awareness and knowledge of EHI', 'alcohol consumption' (Yes/No), 'quantity of alcohol consumed per week', 'perception of protection against risk' and 'perception of health consequences' were retained in the model. Thereafter, multiple linear regression applying the 'Enter method' was run with perception of health risk from 'lifestyle risks' as a dependent variable and gender, 'awareness and knowledge of EHI', 'alcohol consumption' (Yes/No), 'quantity of alcohol consumed per week', 'perception of protection against risk' and 'perception of health consequences' as IVs. All IVs were entered in the model in separate steps i.e. first gender, then awareness and knowledge of EHI followed by alcohol consumption, then quantity of alcohol consumed per week, followed by protection against risk and finally the perception of health consequences. Results however showed multicollinearity between alcohol consumption (Yes/No) and 'quantity of alcohol consumed per week', which was indicated by higher collinearity statistics especially by the VIF (variance inflation factor), which was indicated by higher collinearity statistics particularly the VIF, which was about 13 compared to its maximum acceptable value of 10. Therefore, alcohol consumption (Yes/No) variable was dropped from the regression equation and remaining five IVs were entered in the regression to find out significant predictors of the 'lifestyle risks'. Hence, one of these variables i.e. alcohol consumption (Yes/No) was dropped from the regression equation. Finally, five IVs were entered in the regression to find out significant predictors of the 'perception of lifestyle risks'.

Finally, using sequential / hierarchical regression with enter method, a significant model of perception of lifestyle health risks emerged with $F(5, 3276) = 14.681$, $p <.000$. The final model explained 19.6% of the variance (Adjusted $R^2 =.196$, $R^2 = .210$), which included 6.6% of the variance accounted for by 'perception of health consequences'. The 'quantity of alcohol consumed per week' explained the next highest variance (7.5%) in the outcome variable.

Table 4.41 gives information for each of the explanatory variables and reveals that for a change of 1 SD in the perception of health consequences variable (while controlling for the other predictors), perception of lifestyle health risk increased by.26 SD. However, 1 SD increase in the 'quantity of alcohol consumed per week' decreased perception of lifestyle health risk by .297 SD. In the last model, gender and awareness and knowledge of EHI were not significant predictors of the outcome variable i.e. perception of lifestyle health risk.

Table 4.41 Results of sequential multiple linear regression for perception of health risk from lifestyle risks

Variable	*B*	*SEB*	*Β*	*Sig.*	R^2	ΔR^2
Step 1					.024	.024
(Constant)	14.46	0.52		.000		
Gender	0.77	0.29	.16	.009		
Step 2					.043	.019
(Constant)	12.95	0.83		.000		
Gender	0.75	0.28	.15	.009		
Awareness and knowledge of EHI	0.18	0.08	.14	.02		
Step 3					.118	.075
(Constant)	14.77	0.88		.000		
Gender	0.33	0.29	.07	.254		
Awareness and knowledge of EHI	0.16	0.72	.13	.024		
Quantity of alcohol consumed (units /week)	-.52	0.11	-.29	.000		
Step 4					.144	.026
(Constant)	13.13	1.04		.000		
Gender	0.32	0.28	.07	.26		
Awareness and knowledge of EHI	0.16	0.07	.13	.023		
Quantity of alcohol consumed (units /week)	-.54	0.11	-.29	.000		
Protection against risk	0.04	0.01	.16	.004		
Step 5					.210	.066
(Constant)	10.79	1.11		.000		
Gender	0.22	0.27	.05	.423		
Awareness and knowledge of EHI	0.11	0.07	.08	.126		
Quantity of alcohol consumed (units /week)	-.52	0.10	-.28	.000		
Protection against risk	0.03	0.01	.14	.010		
Health consequences	0.05	0.01	.26	.000		

a Dependent Variable: perception of health risk from lifestyle risks

The histogram and P-P plot of residuals (Figure 4.21) of multiple regression of ‘perception of lifestyle risks’ variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.22) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

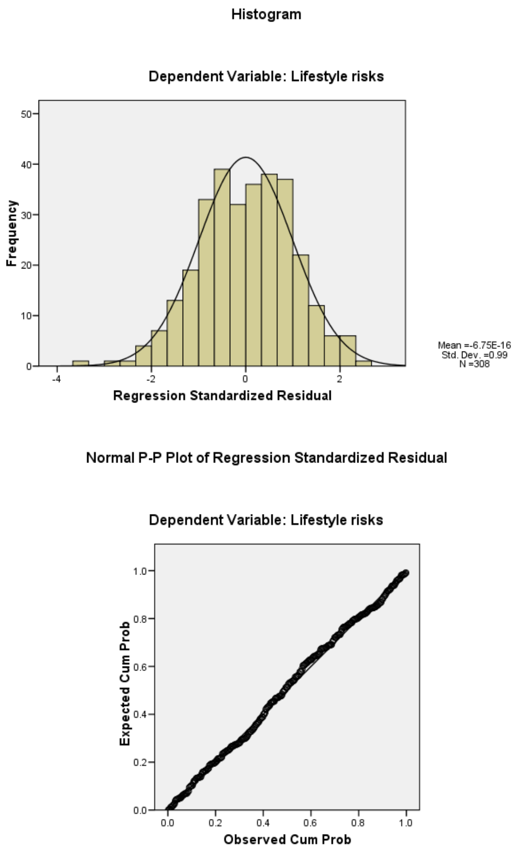


Figure 4.21 Histogram and normal P-P plot of normally distributed residuals of perception of health risk from lifestyle

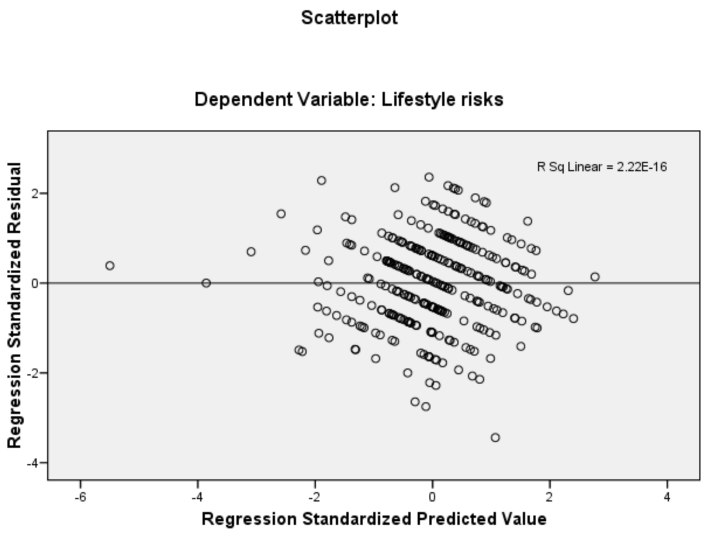


Figure 4.22 Scatterplot of ZRESID against ZPRED of multiple regression of perception of health risk from lifestyle

4.6.5.7.3 Perception of chemical and nuclear risks (RP Factor 3)

For determining predictors of perception of health risk from ‘chemical and nuclear risks’, first, all socio-demographic variables and summated variables of ‘perception of health consequences’ and ‘perception of protection against risk’ were simultaneously entered in multiple linear regression applying the ‘stepwise method’. Four IVs i.e. ‘perception of health consequences’, ‘frequency of undertaking vigorous exercise’, ‘balanced diet’ and ‘value placed on good health’ were retained in the model. Thereafter, a multiple linear regression applying the ‘enter method’ was run with ‘chemical and nuclear risks’ as a dependent variable and ‘perception of health consequences’, ‘frequency of undertaking vigorous exercise’, ‘balanced diet’ and ‘value placed on good health’ as IVs. All IVs were entered in the model in separate steps i.e. first ‘perception of health consequences’, then ‘frequency of undertaking vigorous exercise’ followed by ‘balanced diet’ and finally ‘value placed on good health’.

Using sequential / hierarchical regression with the ‘enter method’, a significant model of perception of health risk from chemical and nuclear risks emerged with $F (4,307) = 24.577$, $p <.000$. The final model explained 23.5% of the variance (Adjusted $R^2 = .235$, $R^2 = .245$). Overall, perception of health consequences explained the highest variance i.e. 21% in the dependent variable. Table 4.42 gives information for each of the explanatory variables, which reveals that for a change of 1 SD in the ‘perception of health consequences variable’ (while controlling for the other predictors), perception of ‘chemical and nuclear risks’ increased by .47 SD. In the last model, all predicting variables were significant.

Table 4.42 Results of sequential multiple linear regression for perception of health risk from chemical and nuclear risks

Variable	*B*	*SEB*	*β*	*Sig.*	R^2	ΔR^2
Step 1					.210	.210
(Constant)	4.94	0.78		.000		
Perception of health consequences	0.11	0.01	.46	.000		
Step 2					.220	.010
(Constant)	5.62	0.85		.000		
Perception of health consequences	0.11	0.01	.46	.000		
Frequency of undertaking vigorous exercise	-0.24	0.12	-.10	.046		
Step 3					.231	.011
(Constant)	4.81	0.92		.000		
Perception of health consequences	0.11	0.01	.47	.000		
Frequency of undertaking vigorous exercise	-0.29	0.12	-.12	.020		
Balanced diet	0.48	0.23	.11	.036		
Step4					.245	.014
(Constant)	1.40	1.71		.415		
Perception of health consequences	0.12	0.01	.47	.000		
Frequency of undertaking vigorous exercise	-0.26	0.12	-.11	.032		
Balanced diet	0.62	0.23	.14	.009		
Value placed on good health	0.54	0.23	.12	.019		

a Dependent Variable: perception of health risk from chemical and nuclear risks

The histogram and P-P plot of residuals (Figure 4.23) of multiple regression of ‘perception of health risk from chemicals and nuclear radiations’ variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.24) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

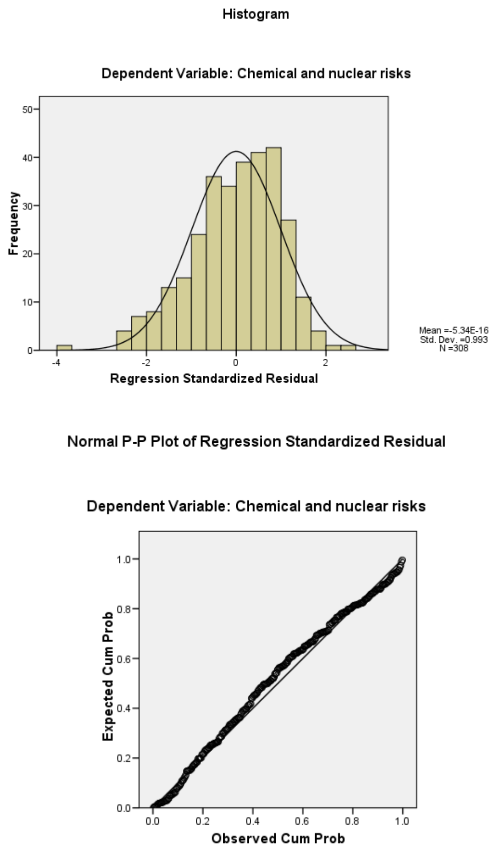


Figure 4.23 Histogram and normal P-P plot of normally distributed residuals of perception of health risk from chemicals and nuclear radiations

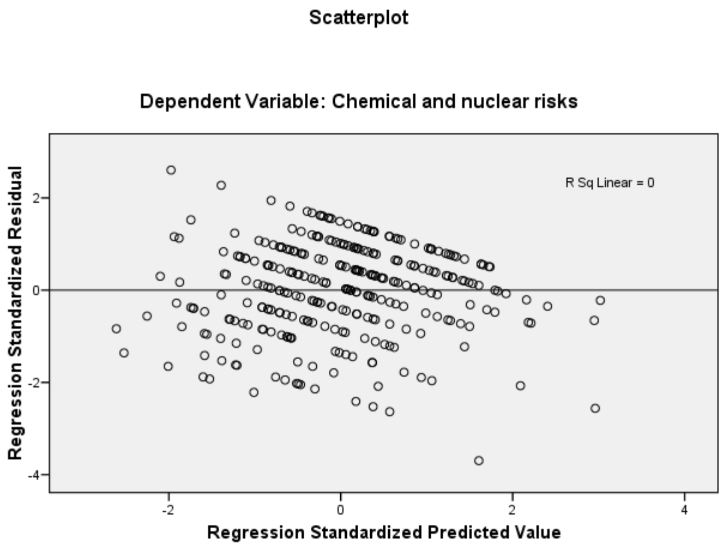


Figure 4.24 Scatterplot of ZRESID against ZPRED of multiple regression of perception of health risk from chemicals and nuclear radiation

4.7 Perception of Health Consequences

In this section, first results of multiple regression and structural equation of summated variable of perception of health consequences are presented and then results of exploratory factor analysis, confirmatory factor analysis and multiple regression of latent constructs of perception of health consequences are presented.

4.7.1 Multiple regression summated perception of health consequences variable

Assumptions for multiple regression were met before running the sequential multiple linear regression for summated perception of health consequences variable. Running sequential multiple regression using the 'enter method', a significant model of 'perception of health consequences' emerged with $F (3, 357) = 193.158$, $p <.000$. The final model explained 61.6 % of the variance in the dependent variable (Adjusted $R^2 = .616$, $R^2 = .619$), which included 59% of the variance accounted for by 'perception of health risk' variable. Gender and knowledge of EHI explained 1.5% and 1.4%, respectively, of the variance in the outcome variable. Table 4.43 gives information for each of the explanatory variables that significantly predicted the 'perception of health risk'.

The last (3rd) step showed that the 'perception of health risk' was the most important and only significant predictor (while controlling for the other predictors) of the 'perception of health consequences' and a change of 1 SD in the former variable increased the variance by .79 SD in the outcome variable. Gender and knowledge of EHI were not significant predictors in the last step; however, they were significant predictors for the dependent variable in the earlier steps (Table 4.43).

Table 4.43 Results of multiple regression with predictors of perception of health consequences

Variable	*B*	*SEB*	*β*	*Sig.*	R^2	ΔR^2
Step 1					.015	.015
(Constant)	57.38	2.42		.000		
Gender	3.10	1.31	.12	.019		
Step 2					.029	.014
(Constant)	52.90	3.11		.000		
Gender	3.01	1.31	.12	.022		
Knowledge of EHI	1.98	0.87	.12	.024		
Step 3					.619	.590
(Constant)	5.59	2.81		.047		
Gender	-0.92	0.84	-.04	.273		
Knowledge of EHI	0.66	0.55	.04	.234		
Perception of health risk (summated)	0.80	0.03	.79	.000		

a Dependent Variable: perception of health consequences (summated)

The histogram and P-P plot of residuals (Figure 4.25) of multiple regression of 'perception of health consequences' summated variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.26) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

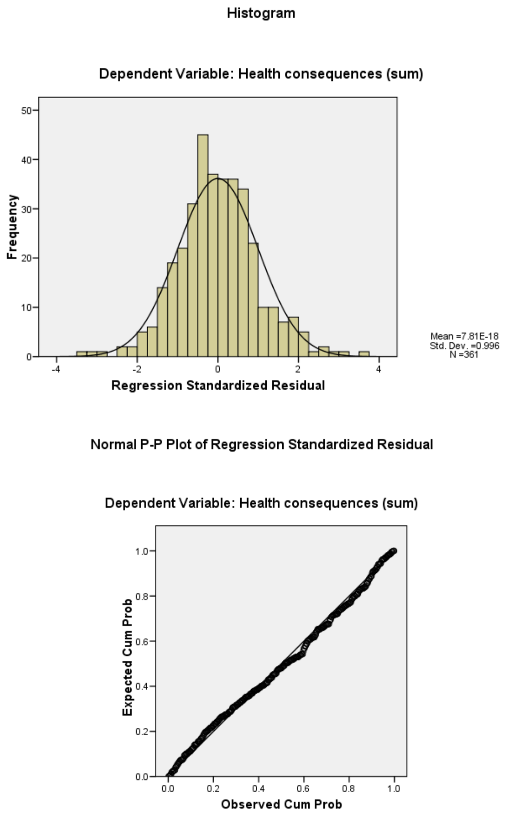


Figure 4.25 Histogram and normal P-P plot of normally distributed residuals of perception of health consequences

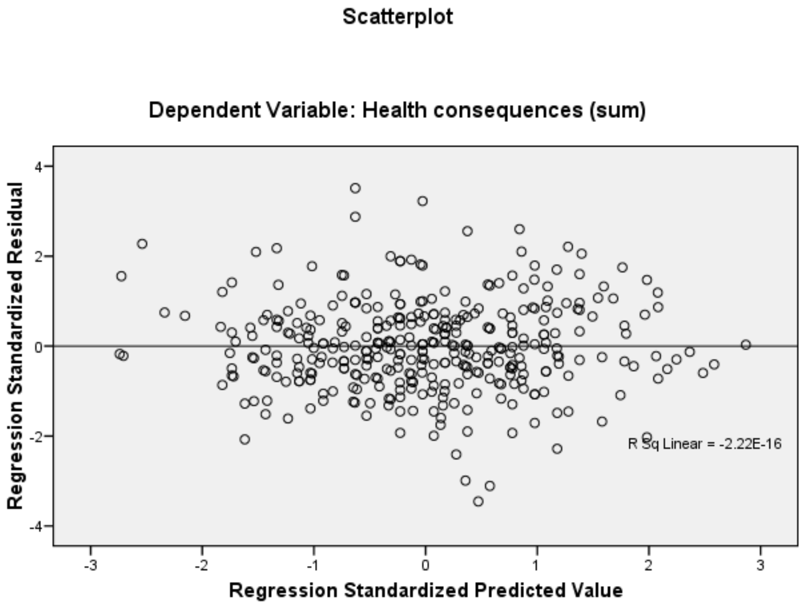


Figure 4.26 Scatterplot of ZRESID against ZPRED of multiple regression of perception of health consequences

4.7.2 Structural equation model summated perception of health consequences variable

A hypothesised model of perception of health consequences was run on SEM. Assumptions of SEM such as multivariate normality and linearity were met before running the model. Figure 4.27 represents the model showing the DV and IVs.

For the outcome variable i.e. 'perception of health consequences', standardised regression of the predictor variables observed were .784 for 'perception of health risk', -.037 for 'gender' and .053 for 'knowledge of EHI'. The only significant regression was between the 'perception of health risk' and the 'perception of health consequences' and the remaining regressions were not significant.

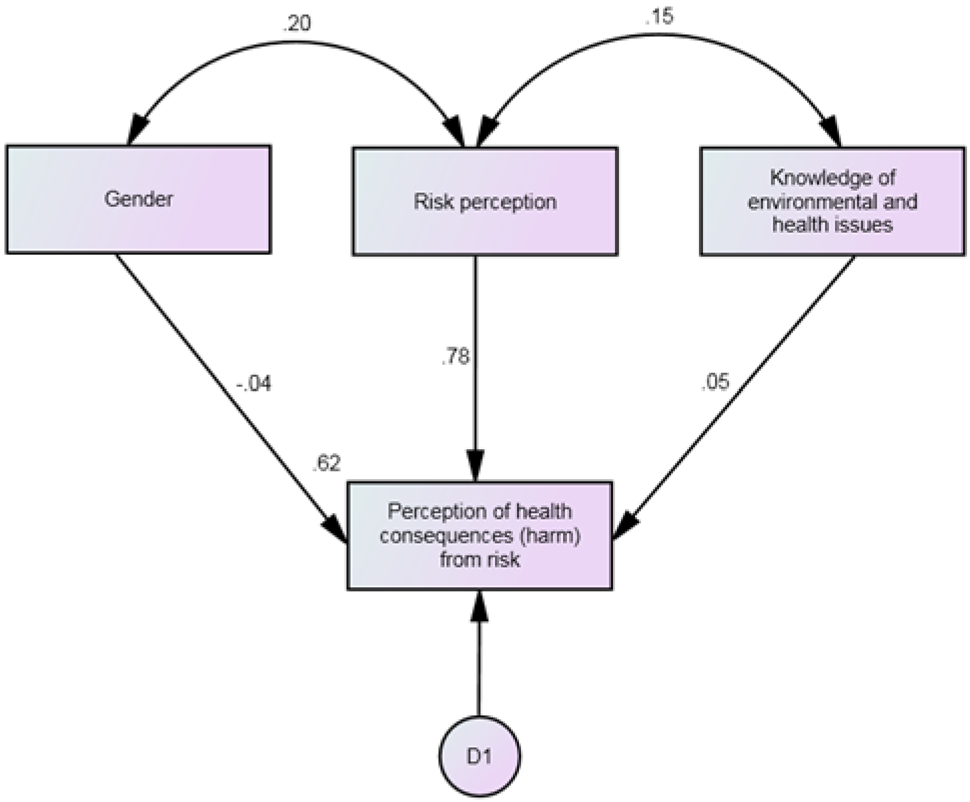


Figure 4.27 Hypothesised structural model of perception of health consequences

Summary of goodness of fit statistics for the structural model of 'perception of health risk' is given in Table 4.44 that show support for the model with χ^2 (1, N =361) = .519, p > .05 and fit indices such as the GFI, NFI, TLI, CFI, RFI and AGFI were > .90, PNFI < .40, and the RMSEA = .000 (p = .638).

Table 4.44 Goodness of fit statistics for structural model of perception of health consequences

Goodness of Fit Statistics	*Hypothesised model*
Chi-square (χ^2)	
Chi-square (χ^2)	.519 (p=.471)
Degrees of freedom (df)	1
Absolute Fit Measures	
Goodness of Fit Index (GFI)	.999
Root mean square error of approximation (RMSEA)	.000
90 % confidence interval for RMSEA (Low; high)	.000; .124 (p=.638)
Root mean square residual (RMR)	.110
Normed Chi-square (=χ^2/df)	.519
Incremental Fit Indices	
Normed fit index (NFI)	.999
Tucker-Lewis coefficient (TLI) *	1.008
Comparative fit index (CFI)	1.000
Relative fit index (RFI)	.992
Parsimony fit Indices	
Adjusted goodness of fit index (AGFI)	.993
Parsimony normed fit index (PNFI)	.166

*Also known as the Bentler-Bonett non-normed fit index (NNFI) (Hair et al., 2009)

4.7.3 Exploratory factor analysis perception of health consequences items

Exploratory factor analysis was carried out to reduce the dimensions and find out latent factors (constructs) for perception of health consequences from exposure to 21 different risk factors. Multiple criteria for extraction of latent factors were applied as follows:

a) Communalities greater than 0.30

b) Loadings greater than 0.40 on each factor

c) Measures of sampling adequacy (MSA) greater than 0.50

d) Kaiser latent root criterion of Eigen values greater than 1

e) Scree plot

f) Minimum variance extracted = 40%

It is reiterated that before finding out latent factors of perception of health consequences scale, one item i.e. exposure to radon gas (hc17) was excluded because 39.2 % (n=153) participants answered ‘do not know’ in ranking perception of health consequences for this item. Therefore it was deleted and for other items (n=21), the ‘do not know’ answer was treated as a missing value in all analyses but the score was not replaced by imputation because it was a valid answer provided by the respondents. Therefore the ‘exclude cases listwise’ option was used for handling ‘do not know’ as missing values while running exploratory factor analysis in SPSS. The process of factor extraction is described below.

A principal axis factor analysis of perception of health consequences was conducted on 21 variables applying the Oblique rotation (Oblimin) method. Prior to factor extraction, both univariate and multivariate outliers were identified and deleted as described earlier. The correlation matrix of items loaded in final factor solution showed that all items were positively and significantly correlated with each other ($p<.01$) except item hc10 (radioactive fallout from a nuclear power plant), which that was not statistically significantly correlated with hc3 (alcohol consumption up to the legal limit) and hc4 (alcohol consumption over the legal limit and item hc22 (chest X-ray) was not statistically significantly correlated with hc3, hc5 (obesity), and hc10.

Highest significant correlation i.e. r = .73 was observed between hc15 (EMFs in home I e.g. hair dryers and hi fi systems) and hc16 (EMFs in home II e.g. home microwave) variables. Other statistically significant correlations were between hc 14 and hc15 (r = .65) and between hc 14 and hc16 variables (r =.60). Another higher correlation i.e. r =.60 was observed between hc3 and hc4 variables. There were however no very high correlations (i.e. $r \geq .9$) between loaded variables that might have caused multicollinearity problems (Field, 2009, p.660).

In addition, the determinant of the correlation matrix was 0.023, which was greater than the requisite value of 0.0001, thus, it was confirmed the there was no multicollinearity problem between loaded variables.

Table 4.45 provides extracted latent factors, Eigen values and the variance as well the loadings, communalities and measures of sampling adequacy (MSA) for all measured variables that were loaded on the extracted latent factors. Anti-mage matrices showed observed MSA minimum as 0.682 and maximum as 0.892 (Table 4.45). All MSA were greater than the required standards (0.50), thus confirming that the sample was adequate to run factor analyses. KMO statistic observed was 0.794 that confirmed sampling adequacy for the analysis (Table 4.45). Bartlett's test of Sphericity = χ^2 (55) = 1217.5 ($p < .001$) showed that correlations between variables were significantly large for factor analysis (Table 4.44). Communalities extracted for each measured variable were between 0.27 and 0.75 (Table 4.45). Eigen values for each factor in the data were run and three factors were observed on the basis of Kaiser's Eigen values greater than 1 criterion (Table 4.45). Another criterion of extracting the number of factors, the

Scree plot (Figure 4.28) showed inflexion that also justified retention of three factor solution for perception of health consequences.

Total variance extracted by three factors solution was 52.4% (Table 4.45), which reveals that factor 1 explained 29.4 % of the variance and the other two factors accounted for the remaining variance (23%). Thus, the three factors solution was accepted.

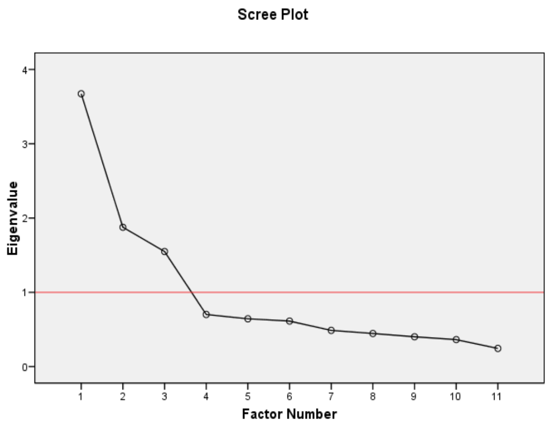


Figure 4.28 Scree plot of extraction of latent factors for perception of health consequences

In the final solution, 11 variables were retained and the pattern matrix showed extraction of three factors in 15 iterations. Factor 1 comprised four items: hc15, hc16, hc14 and hc22. Factor 2 also included four items i.e. hc3, hc4, hc5 and hc2. Factor 3 consisted of three items i.e. hc10, hc7 and hc8 (Table 4.45).

Table.4.45 Exploratory factor analysis of perception of health consequences

Dimension/Factor (and measured variables)	*Factor loading*	*Eigen value*	*Variance explained (%)*	*Communality extracted (h2)*	*Measures of Sampling Adequacy*	*Reliability (α)*
Factor 1=EMF and X-rays risks		3.67	29.34			.84
EMFs in home I (e.g. hair dryers and hi fi systems) (hc15)	.88			.76	.87	
EMFs in home II (e.g. microwave) (hc16)	.82			.69	.77	
EMFs in Physiotherapy department (hc14)	.70			.55	.80	
Chest X ray (hc22)	.59			.33	.89	
Factor 2=Lifestyle risks		1.88	13.03			.73
Alcohol consumption up to legal limit (hc3)	.90			.75	.68	
Alcohol consumption over the legal limit (hc4)	.69			.47	.74	
Obesity (hc5)	.53			.37	.81	
Passive smoking (hc2)	.45			.27	.87	
Factor3= Chemical and nuclear risks		1.10	9.96			.74
Radioactive fallout from nuclear power plant (hc10)	.73			.49	.73	
Exposure to chemicals from Industries (hc7)	.68			.54	.81	
Living near to a nuclear power plant (hc8)	.64			.54	.82	
Total			52.42			

Kaiser-Meyer-Olkin Measure of Sampling Adequacy .79	
Bartlett's Test of Sphericity:	
Approx. Chi-Square	1217.540
Degrees of freedom (df)	55
Significance (p value)	.000
Extraction method	Principal axis factoring
Rotation method	Oblimin with Kaiser normalisation
Factor loadings	>.30

The nature of variables loaded on the same factor suggested that factor 1 represented EMF and X-rays risks, factor 2 represented lifestyle risks and factor 3 represented chemical and nuclear risks. The highest and lowest loadings were .882 and .589 by hc15 and hc22 respectively on factor 1. On factor 2, hc3 and hc2 were loaded highest and lowest with .904 and .452 loadings respectively. The maximum and minimum item loadings on factor 3 were .731 and .638 by hc10 and hc8 respectively. Factor correlation matrix revealed that all factors extracted in the EFA were correlated with each other. A correlation of .281 was observed between EMF and X-rays risks (factor 1) and lifestyle risks (factor 2), .264 between EMF and X-rays risks (factor 1) and chemical and nuclear risks (factor 3), and .301 between lifestyle risks (factor 2) and chemical and nuclear risks (factor 3). Finally, the reliability of each factor was determined by calculating the Cronbach's alpha coefficient, which was found greater than the minimum required level of .70 for all the factors (Table 4.45).

4.7.4 Confirmatory factor analysis perception of health consequences items

A CFA was conducted through AMOS on three latent factors, as identified in EFA, presented in a hypothesised model, which is shown in Figure 4.29 where circles represent latent variables (also known as factors, constructs or unobserved variables) and rectangles represent measured variables (also called as indicators, observed or manifest variables). Double headed arrows represent covariance between two variables while single headed arrows show unidirectional hypothesised direct relationship between two variables. In the latter case, arrow points to the dependent variable while the variable on the other end is an independent variable. No direct effect between measured variables was hypothesised. Four measured variables i.e. EMFs in home I e.g. hair dryers and hi fi systems (hc15), EMFs in home II e.g. home microwave (hc16), EMFs in Physiotherapy department (hc14) and chest X ray (hc22) served as indicators of the first latent factor, which represented EMF and X-rays risks. The second latent factor represented lifestyle risks that was indicated by four measured variables i.e. alcohol consumption up to legal limit (hc3) and over the legal limit (hc4), obesity (hc5) and passive smoking (hc1). The third latent factor was chemical and nuclear risks, which was represented by three measured variables i.e. radioactive fallout from nuclear power plant (hc10), industrial chemicals (hc7) and living near to a nuclear power plant (hc8).

The assumption of multivariate normality and linearity were evaluated through SPSS. In addition, all cases with ‘do not know’ score for any of 11 variables included in the model were deleted and a separate file was saved to run structural equation modelling using AMOS software because AMOS do not run in the presence of missing values, in this case ‘do not know’ score. As such there were no missing values. Maximum Likelihood Estimation method was employed for estimating hypothesised measurement (CFA) model of perception of health consequences as a result of exposure to risk factors. All the three latent factors along with their respective indicator variables were retained in the hypothesised model. Results of the significant regression estimates along with average variance and correlation between the latent variables and their indicators applied in the measurement model are presented in Table 4.46. Henceforth latent factors will be referred as latent construct or scale according to the terminology used in the SEM. As found in the EFA, CFA results of the hypothesised measurement model show that all the three constructs were correlated with each other (Table 4.46).

Table 4.46 Standardised regression estimates, average variance extracted and construct reliabilities and inter construct correlations in measurement (CFA) model of perception of health consequences

	EMF and X-rays risks	*Lifestyle risks*	*Chemical and nuclear risks*			
Measured variables / indicators	*Standardised regression estimates*			*c.r.*	*Sig (p)*	*SMCs*
EMFs in home I (e.g. hair dryers and hi fi systems) (hc15)	0.87			a_		0.76
EMFs in home II (e.g. microwave) (hc16)	0.84			16.99	< .001	0.70
EMFs in Physiotherapy department (hc14)	0.74			14.90	< .001	0.55
Chest X ray (hc22)	0.56			10.34	< .001	0.31
Alcohol consumption up to legal limit (hc3)		0.81		a_		0.66
Alcohol consumption over the legal limit (hc4)		0.70		10.94	< .001	0.49
Obesity (hc5)		0.58		9.05	< .001	0.34
Passive smoking (hc1)		0.51		7.55	< .001	0.26
Radioactive fallout from nuclear power plant (hc10)			0.62	a_		0.39
Exposure to chemicals from Industries (hc7)			0.71	9.14	< .001	0.51
Living near to a nuclear power plant (hc8)			0.77	8.51	< .001	0.59
Inter construct correlations†:						
EMF and X rays risks	*1*	0.08	0.15			
Lifestyle risks	0.29	1	0.12			
Chemical and nuclear risks	0.39	0.34	*1*			
Construct reliability	0.80	0.79	0.75			
Average variance extracted (AVE)	58%	44%	49%			

c.r. = critical ratio (t-statistics); SMCs =Squared multiple correlations; a Not estimated because of loading set to fixed value i.e. 1.0; †Values below the diagonal are correlation estimates among constructs and values above the diagonal are squared inter-construct correlations.

Inter construct covariance was 0.11 between EMF and X-rays risks and lifestyle risks, 0.15 between EMF and X-rays risks and chemical and nuclear risks and 0.13 between Lifestyle risks and chemical and nuclear risks. Construct reliability of each construct was calculated, which was found to be ≥.75 (Table 4.46). In addition, AVE for each construct was calculated and is presented in Table 4.46, which shows that the highest AVE was for EMF and X-rays construct and the lowest AVE was for lifestyle risks construct.

A summary of goodness of fit indices for the hypothesised measurement model (CFA) of perception of health consequences is presented in Table 4.47, showing support for the hypothesised model with χ^2 (41, N=328) = 96.89, p < .001, and indices of GFI, NFI, TLI, CFI, and AGFI were >.90, PNFI < .70, RMR <.05 and RMSEA <.07.

Table 4.47 Statistics of goodness of fit for measurement (CFA) model of perception of health consequences

Goodness of Fit Statistics	*Hypothesised model*	*Post hoc model*
Chi-square (χ^2)		
Chi-square (χ^2)	96.895 (p=.000)	78.293 (p=.000)
Degrees of freedom (df)	41	39
Absolute Fit Measures		
Goodness of Fit Index (GFI)	.949	.958
Root mean square error of approximation (RMSEA)	.065	.056
90 % confidence interval for RMSEA (Low; high)	.048; .081 (p =.072)	.037; .073, (p=.287)
Root mean square residual (RMR)	.047	.042
Normed Chi-square (=χ^2/df)	2.363	2.008
Incremental Fit Indices		
Normed fit index (NFI)	.922	.937
Tucker-Lewis coefficient (TLI) *	.936	.953
Comparative fit index (CFI)	.953	.967
Relative fit index (RFI)	.895	.911
Parsimony fit Indices		
Adjusted goodness of fit index (AGFI)	.917	.929
Parsimony normed fit index (PNFI)	.687	.664

*Also known as the Bentler-Bonett non-normed fit index (NNFI) (Hair et al., 2010)

In order to develop a better fitting and parsimonious model, post hoc modifications were performed in the model by applying the Lagrange multiplier test as suggested by modification indices obtained for the hypothesised model.

Consequently, paths indicating co-variance between error terms of four measured variables i.e. between hc15 (EMFs in home I) and hc16 (EMFs in home II) and between hc3 (alcohol consumption up to legal limit) and hc4 (alcohol consumption above the legal limit) were added to create a post hoc model, which is shown in Figure 4.30. Statistics of goodness of fit for the post hoc model are presented in Table 4.47, which suggest that the model was improved by addition of extra paths as described above. Overall, the statistics of goodness of fit indices reveal that the post-hoc model was better compared to the hypothesised model. However, the hypothesised model was retained because there was no theoretical support to suggest addition of paths linking error terms of four indicator variables mentioned above.

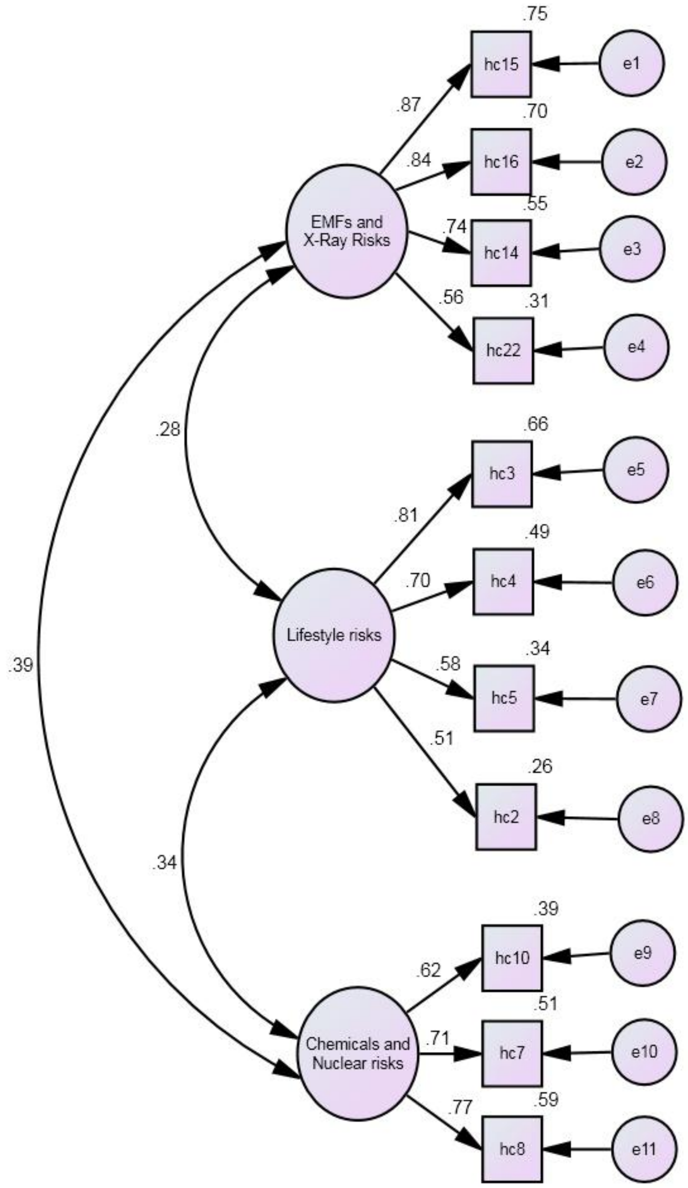


Figure 4.29 Hypothesised measurement (CFA) model of perception of health consequences

[hc=EMFs in home I (e.g. hair dryers and hi fi systems), hc16=EMFs in home II (e.g. microwave), hc14=EMFs in Physiotherapy department, hc22= Chest X ray (hc22), hc3= Alcohol consumption up to legal limit, hc4= Alcohol consumption over the legal limit, hc5=Obesity, hc1=Passive smoking, hc10=Radioactive fallout from nuclear power plant, hc7=Exposure to chemicals from Industries, hc8=Living near to a nuclear power plant]

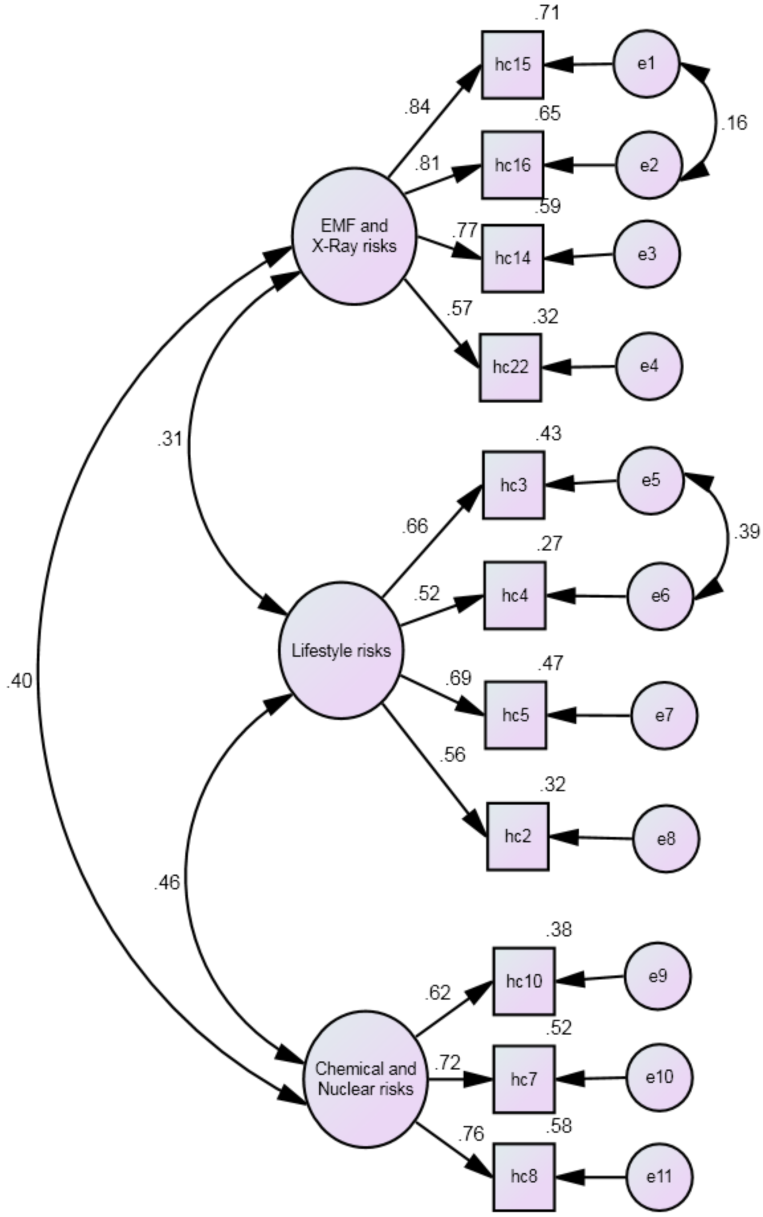


Figure 4.30 Post hoc measurement (CFA) model of perception of health consequences

[hc=EMFs in home I (e.g. hair dryers and hi fi systems), hc16=EMFs in home II (e.g. home microwave), hc14=EMFs in Physiotherapy department, hc22= Chest X ray (hc22), hc3= Alcohol consumption up to legal limit, hc4= Alcohol consumption over the legal limit, hc5=Obesity, hc1=Passive smoking, hc10=Radioactive fallout from nuclear power plant, hc7=Exposure to chemicals from Industries, hc8=Living near to a nuclear power plant]

4.7.5 Latent constructs of perception of health consequences

4.7.5.1 Creation of latent constructs

Three latent constructs were created one each for factor 1, 2 and 3 on the basis of results of EFA and CFA. All variables loaded on each latent factor were summated to create a latent construct as follows. A construct for EMF and X-rays risks was created by addition of the rating scores for hc14, hc15, hc16 and hc22 variables. Variables' means for this construct ranged between 1.77 and 2.21 and the grand mean of the construct was 2.04. A construct of lifestyle risks was created by adding together the rating scores of hc2, hc3, hc4 and hc5 variables. Variables' means for this construct ranged from 2.97 to 3.95 and the grand mean of the construct was 3.61. Similarly, a construct of chemical and nuclear risks was developed by adding up scores of hc7, hc8 and hc10 variables. Grand mean of this construct was 3.81 and mean scores of variables comprising this construct were between 3.30 and 4.32.

4.7.5.2 Reliability

Reliability of the latent constructs was determined by Cronbach's α coefficient, which was .835 (standardised α =.836) for EMF and X-rays risks construct, .732 (standardised α =.736) for lifestyle risks construct and .741 (standardised α =.747) for chemical and nuclear risks construct.

4.7.5.3 Outliers

For each of the latent construct, univariate and multivariate outliers were identified and subsequently deleted. Univariate outliers were identified by box plots and z-scores > ±2.5 value. Multivariate outliers were identified by calculating D^2 for three summated variables (df =3) as a critical value of chi square (χ^2) ≥ 16.277, p = .001. For univariate outliers, first Z scores were calculated for all the three latent constructs to identify scores > ±2.5 score and thereafter box plots were run simultaneously for all the three latent scale. This process was repeated until no outlier was found (Figure 4.31). Final results of both univariate (n=19) and multivariate outlier (n=1) cases are presented in Table 4.48, which shows that case number 54 was a univariate as well as a multivariate outlier. Thus, in total 19 outliers were deleted, this was achieved in three iterations.

Table 4.48 Univariate and multivariate outliers on latent constructs for perception of health consequences

Univariate outliers						*Multivariate outliers*		
EMF and X-rays risks		*Lifestyle risks*		*Chemical and nuclear risks*		*All three latent scales (df=3)*		
Case ID	*Std* z score*	*Case ID*	*Std* z score*	*Case ID*	*Std* z score*	*Case ID*	*Mahalanobis distance (D2)*	*D2/df*
54	4.92	216	-2.57	191	-2.65	54	25.162	8.39
234	3.68			247	-2.65			
315	3.68			364	-2.65			
111	3.26			218	-3.06			
341	3.26			384	-3.06			
360	3.26							
333	2.84							
371	2.84							
337	3.0							
66	2.5							
71	2.5							
153	2.5							
207	2.5							

*Std = Standardised

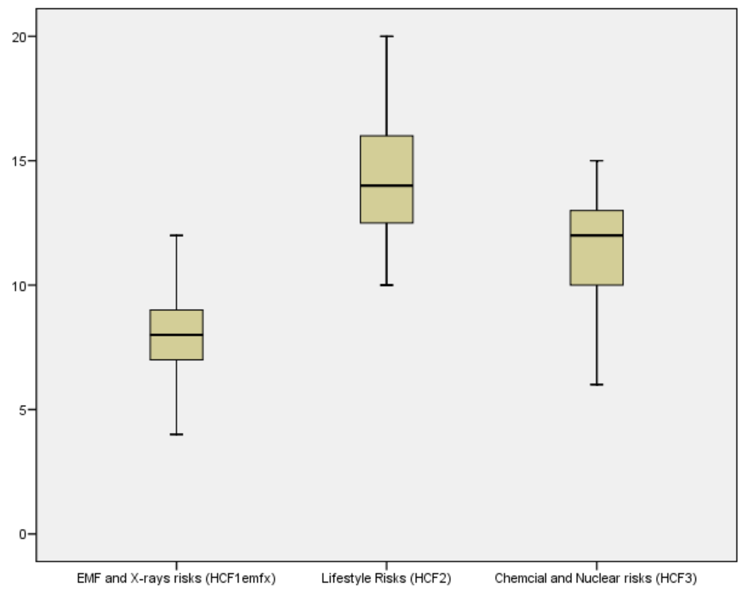


Figure 4.31 Boxplot for extraction of latent factors in exploratory factor analysis of perception of health consequences

4.7.5.4 Normality

Normality of latent constructs of perception of health consequences was determined by the Kolmogorov-Smirnov test and the Shapiro-Wilk test for normality. Both tests were significant for all three constructs when run as a single sample (group) (Table 4.49a). However, when scales were split into two groups by gender, the results revealed that both tests were significant for both male and female participants on all the three constructs except a not significant K-S test for male on chemical and nuclear risk construct (Table 4.49b), which confirmed normality only for this sub-set of the chemical and nuclear risks construct. This suggested a lack of data normality for the remaining data. It is however imperative to reiterate that the K-S Test and S-W Test are recognised to be sensitive to the sample size and they tend to become significant when the sample size is big (though no limit has been suggested) despite the data being slightly deviated from normally (Field, 2009, p. 144). Therefore, results showing significant K-S test and S-W test in this study with a sample size of 390 do not might suggest major deviation from normality. Nevertheless, other methods of determining data normality such as the P-P plots and Q-Q plots (Figure 4.32a-f) were used to check the normality of the latent constructs of perception of health consequences scale.

Table 4.49a.Tests of normality of latent constructs of perception of health consequences

	Kolmogorov-Smirnov[(a)] Test			*Shapiro-Wilk Test*		
	Statistic	*Df*	*Sig.*	*Statistic*	*Df*	*Sig.*
EMF and X-rays risks (hcF1emfx)	.159	307	.000	.954	307	.000
Lifestyle Risks (HCF2)	.110	307	.000	.968	307	.000
Chemical and Nuclear risks (HCF3)	.100	307	.000	.955	307	.000

a Lilliefors Significance Correction

Table 4.49b.Tests of normality of latent constructs of perception of health consequences (by gender)

	Gender	*Kolmogorov-Smirnov[(a)] Test*			*Shapiro-Wilk Test*		
		Statistic	*df*	*Sig.*	*Statistic*	*df*	*Sig.*
EMF and X-rays risk (hcF1emfx)	Male	.159	58	.001	.944	58	.009
	Female	.159	249	.000	.953	249	.000
Lifestyle risks (HCF2)	Male	.173	58	.000	.894	58	.000
	Female	.104	249	.000	.974	249	.000
Chemical and nuclear risks (HCF3)	Male	.104	58	.181	.950	58	.018
	Female	.113	249	.000	.954	249	.000

a Lilliefors Significance Correction

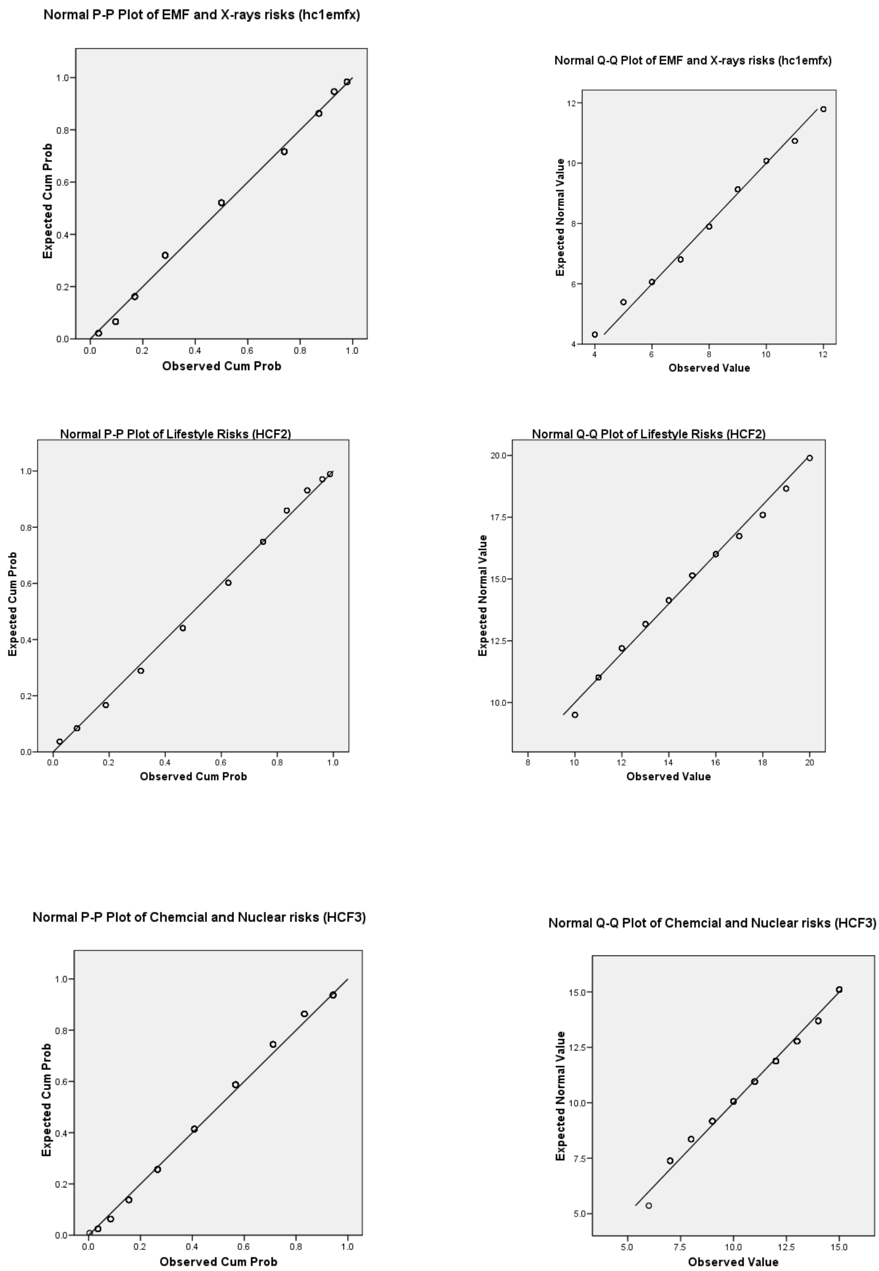


Figure 4.32a-f P-P and Q-Q plots of latent constructs of perception of health risk

4.7.5.5 Homogeneity of variance (homoscedasticity)

Homogeneity of variance between the latent constructs was determined by Levene's test. Results are presented in Table 4.50. Results revealed that all test statistics except the mean and the trimmed mean for lifestyle risk construct were not significant, which confirmed homogeneity of variance between the constructs.

Table 4.50 Test of homogeneity of variance in latent constructs of perception of health consequences

		Levene Statistic	*df1*	*Df2*	*Sig.*
EMF and X-ray risks (hcF1emfx)	Based on Mean	2.942	1	305	.087
	Based on Median	2.300	1	305	.130
	Based on Median and with adjusted df	2.300	1	304.725	.130
	Based on trimmed mean	3.064	1	305	.081
Lifestyle Risks (HCF2)	Based on Mean	4.720	1	305	.031
	Based on Median	2.564	1	305	.110
	Based on Median and with adjusted df	2.564	1	287.756	.110
	Based on trimmed mean	4.273	1	305	.040
Chemical and nuclear risks (HCF3)	Based on Mean	.010	1	305	.921
	Based on Median	.009	1	305	.926
	Based on Median and with adjusted df	.009	1	304.994	.926
	Based on trimmed mean	.004	1	305	.952

4.7.5.6 Pearson correlations

Results of Pearson correlations (bivariate) between latent constructs, demographics and summated variable of perception of risk (RP) and perception of protection against risk (PAR) are presented in Table 4.51. All three latent constructs were statistically significantly and positively correlated with each other. In addition, EMF and X-rays risks construct was significantly and positively correlated only with RP but significantly and negatively correlated with summated PAR. Lifestyle risk construct was statistically significantly and positively correlated with summated RP variable, gender, alcohol consumption (Yes/No), quantity and frequency of alcohol consumption, awareness of EHI, knowledge of EHI and summated variable of awareness and knowledge of EHI. Chemical and nuclear risk construct was statistically significantly and positively correlated with summated RP variable, awareness of EHI, knowledge of EHI, and summated variable of awareness and knowledge of EHI but statistically significantly and negatively correlated with smoking (Yes/No).

Table 4.51 Significant Pearson correlations (bivariate) between latent constructs of perception of health consequences and socio-demographic variables

	EMF and X-rays risks (hcF1emfx)	*Lifestyle Risks (HCF2)*	*Chemical and nuclear risks (HCF3)*
EMF and X-rays risks (hcF1emfx)	1		
Lifestyle risks (HCF2)	.187(**)	1	
Chemical and nuclear risks (HCF3)	.245(**)	.245(**)	1
Perception of risk (RP)	.483(**)	.512(**)	.499(**)
Perception of protection against risk (PAR)	-.122(*)	0.06	-0.05
Gender	0.03	.130(*)	0.07
Smoking (Yes/No)	-0.09	0.07	-.113(*)
Alcohol consumption (Yes/No)	0.02	.223(**)	0.07
Quantity of alcohol consumed (Units/week)	0.03	.145(*)	0.09
Frequency of alcohol consumption (days/week)	0.03	.198(**)	0.08
Awareness of environmental and health issues	0.09	.135(*)	.160(**)
General knowledge of environment and health issues	0.06	.182(**)	.178(**)
Awareness and knowledge of environment and health issues (combined)	0.08	.169(**)	.181(**)

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

4.7.5.7 **Multiple regression** of **latent constructs of perception of health consequences**

4.7.5.7.1 Perception of health consequences from EMF and X rays risks

In order to determine significant predictors of perception of health consequences from EMF and X rays risks, first all socio-demographic variables and summated variables of ‘perception of health risk’ and ‘perception of protection against risk’ were simultaneously entered in the model applying stepwise method in multiple linear regression, which retained smoking (Yes/No), number of cigarettes smoked per day and summated variables of ‘perception of health risks’ and ‘perception of protection against risk’ in the model.

Thereafter, sequential multiple linear regression applying the ‘Enter method’ was run with perception of health consequences from EMF and X-rays risks as a dependent variable and the perception of health risk, perception of protection against risk, smoking (Yes/No), and number of cigarettes smoked per day as IVs. It is pertinent to mention that the first two variables were statistically significantly correlated with the dependent variable while last two variables were not significantly correlated with the outcome variable but they were retained in the model during the stepwise method. All independent variables were entered in the model in separate steps as follows. First ‘perception of health risk’ then ‘perception of protection against risk’ followed by smoking (Yes/No) and finally number of cigarettes smoked per day were entered in the model.

Results revealed a significant model with F (4,302) = 27.423, p <.000. The final model explained 25.7 % of the variance (Adjusted R^2 = .257, R^2 = .266), which included 22.2% accounted for by ‘perception of health risk’, 1.2% by ‘perception of protection against risk’, 1.7% by the cigarette smoking and 1.5% variance was explained by the ‘number of cigarettes smoked per day’.

Results of sequential multiple linear regression for perception of health consequences from EMF and X-rays risks with its explanatory variables are presented in Table 4.52.

Table 4.52 Results of sequential multiple linear regression for perception of health consequences from EMF and X-rays risks

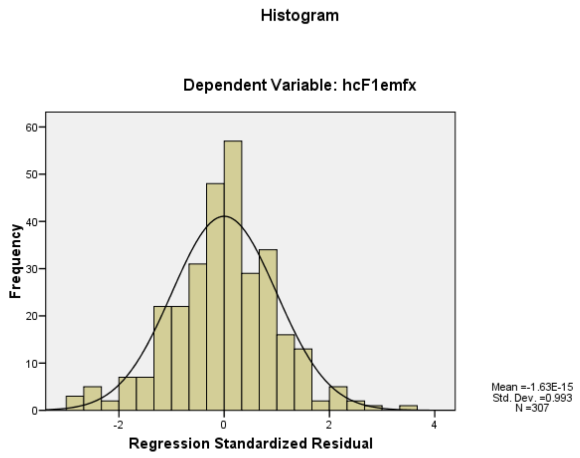
Variable	*B*	*SEB*	*Β*	*Sig.*	R^2	ΔR^2
Step 1					.222	.222
(Constant)	1.07	0.74		.147		
Perception of health risk (summated)	0.10	0.10	.47	.000		
Step 2					.235	.012
(Constant)	2.30	0.92		.013		
Perception of health risk	0.10	0.10	.47	.000		
Perception of protection against risk (summated)	-0.36	0.16	-.11	.027		
Step 3					.252	.017
(Constant)	4.90	1.34		.000		
Perception of health risk (summated)	0.10	0.10	.48	.000		
Perception of protection against risk (summated)	-0.36	0.16	-.11	.027		
Smoking	-1.42	0.54	-.13	.009		
Step 4						
(Constant)	6.90	1.56		.000	.266	.015
Perception of health risk (summated)	0.10	0.01	.49	.000		
Perception of protection against risk (summated)	-0.34	0.16	-.11	.033		
Smoking	-4.20	1.25	-.39	.001		
Number of cigarettes smoked daily	0.03	0.01	.28	.014		

a Dependent Variable: Perception of health consequences from EMF and X-rays risks (HCF1)

The results (Table 4.52) show that for a change of 1 SD in the 'perception of health risk' (while controlling for the other predictors), perception of health consequences from EMF and X-rays risk increases by .49 SD. However, 1 SD increase each in the 'perception of protection against risk' and smoking decreased perception of health consequences from EMF and X rays risks by .11 SD and .39 SD respectively. Increase in smoking here means non-smokers, which means non-smoking decreases while smoking increases perception of health consequences from EMF and X-rays risks. In addition, negative correlations between protection against health risk and perception of health consequences from EMF and X-rays risks means when perception of protection is higher than perception of health consequences from EMF and X-rays risks becomes lower. Conversely, increase in the number of cigarettes smoked per day by 1 SD increases the perception of health consequences from EMF and X-rays risks by .28 SD. This finding suggests that when the number of cigarettes smoked per day increases perception of health consequences from EMF and X-rays risks decreases. In other words, this might be explained as heavy smokers perceive less health consequences from EMF and X-rays risk.

In the last step model, all independent variables were significant predictors of the dependent variable i.e. perception of health consequences from EMF and X-rays chest risks.

In addition, histogram and P-P plot of residuals (Figure 4.33) of multiple regression of ‘perception of health consequences from EMF and X-rays risks’ variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.34) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.



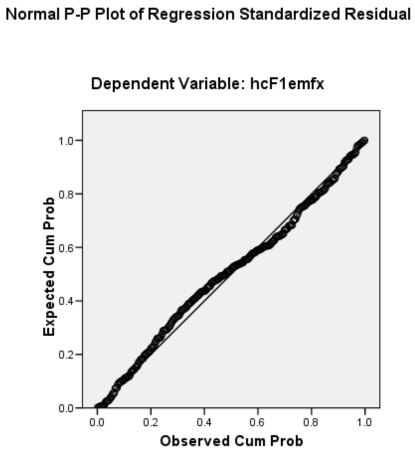


Figure 4.33 Histogram and normal P-P plot of normally distributed residuals of perception of health consequences from EMFs and X-rays risks

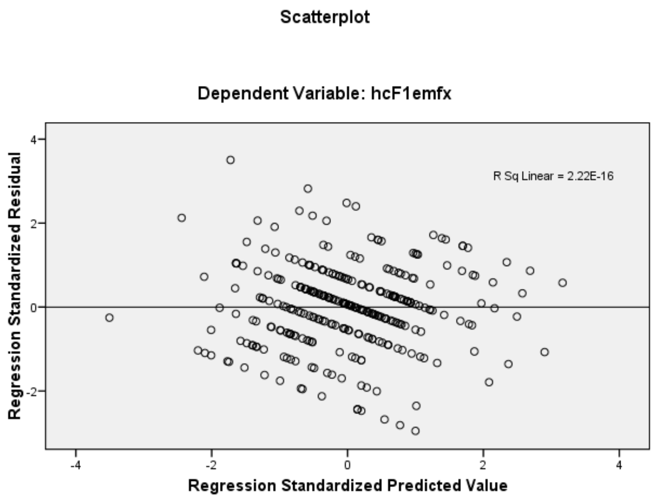


Figure 4.34 Scatterplot of ZRESID against ZPRED of multiple regression of perception of health consequences from EMF and X-rays risks

4.7.5.7.2 Perception of health consequences from lifestyle risks

To determine significant predictors of perception of health consequences from lifestyle risks, first ‘stepwise method’ was used and all demographics variables and summated variables of ‘perception of health risk’ and ‘perception of protection against risk’ were simultaneously entered in the model applying multiple linear regression. The model retained ‘perception of health risks’, alcohol consumption (Yes/No), quantity of alcohol consumed per week’ and ‘knowledge of EHI’ as significant predictors of the dependent variable. Thereafter, sequential multiple linear regression applying the ‘Enter method’ was run with perception of health consequences from lifestyle risks as a dependent variable and the summated variable of ‘perception of health risk’, summated variable of ‘perception of protection against risk’, alcohol consumption (Yes/No), quantity of alcohol consumed per week’ and ‘knowledge of EHI’ were entered as IVs, which were entered in different steps in the regression model. Results however showed multicollinearity between ‘alcohol consumption’ (Yes/No) and the ‘quantity of alcohol consumed per week’ (units/week), which was indicated by higher collinearity statistics particularly the VIF, which was about 14 compared to its maximum acceptable value of 10. Therefore, alcohol consumption (Yes/No) variable was dropped from the regression equation and the remaining five IVs were entered in the regression to find out significant predictors of ‘perception of health consequences from lifestyle risks’.

Results of sequential multiple linear regression with the ‘Enter method’ revealed a significant model with $F (5, 273) = 23.261$, $p <.000$. The final model explained 28.6% of the variance (Adjusted $R^2 = .286$, $R^2 = .299$), which included 17% of the variance explained by the ‘perception of health risk’ in the dependent variable i.e.

perception of health consequences from lifestyle risks. Protection against risk explained 3.9% the variance in the outcome variable. The 'quantity of alcohol consumed in a typical week' explained 5.4% of the variance in the dependent variable.

Table 4.53 gives information for each of the explanatory variables in five steps (models). In the final model (Step 5), all the explanatory variables, except gender and 'general knowledge of environmental and health issues' were significant predictors of perception of health consequences from lifestyle risks.

The last, 5th, step showed that for a change of 1 SD in the 'perception of health risk' (while controlling for the other predictors), variance in the perception of health consequences from lifestyle risk increased by .43 SD. 1 SD increase in the quantity of alcohol consumed per week decreased variance in the dependent variable by .17 SD. This means when quantity of alcohol consumed per week increases then perception of health consequences from lifestyle risks decreases. This finding suggests that people who consume more quantity of alcohol have less perception of health consequences from lifestyle risks and vice versa. Increase in perception of protection against risk by 1 SD increased perception of health consequences from lifestyle risks by .17 SD. This finding suggests that people who have higher perception of protection against risk from lifestyle risks perceive more health consequences from lifestyle risks.

The histogram and P-P plot of residuals (Figure 4.35) of multiple regression of 'perception of health consequences from lifestyle risks' variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.36) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

Table 4.53 Result of sequential multiple linear regression of perception of health consequences from lifestyle risks

Variable	*B*	*SEB*	*Β*	*Sig.*	R^2	ΔR^2
Step 1					.014	.014
(Constant)	12.92	0.67		.000		
Gender	0.72	0.36	.12	.048		
Step 2					.053	.039
(Constant)	9.45	0.99		.000		
Gender	0.68	0.36	.11	.058		
Perception of protection against risk (summated)	0.06	0.02	.20	.001		
Step 3					.108	.054
(Constant)	11.89	1.021		.000		
Gender	0.29	0.36	.05	.422		
Perception of protection against risk (summated)	0.06	0.02	.22	.000		
Quantity of alcohol consumed (units/ week)	-0.56	0.14	-.24	.000		
Step 4					.129	.022
(Constant)	10.10	1.22		.000		
Gender	0.29	0.36	.05	.414		
Perception of protection against risk (summated)	0.06	0.02	.21	.000		
Quantity of alcohol consumed (units/ week)	-0.53	.14	-.23	.000		
Knowledge of EHI	0.43	.17	.15	.010		
Step 5					.299	.170
(Constant)	4.35	1.31		.001		
Gender	-0.13	0.32	-.02	.700		
Perception of protection against risk (summated)	0.05	0.02	.17	.001		
Quantity of alcohol consumed (units/ week)	-0.52	.12	-.23	.000		
Knowledge of EHI	0.21	0.15	.07	.175		
Perception of health risk (summated)	0.11	.01	.43	.000		

a Dependent Variable: Perception of health consequences from Lifestyle Risks (HCF2)

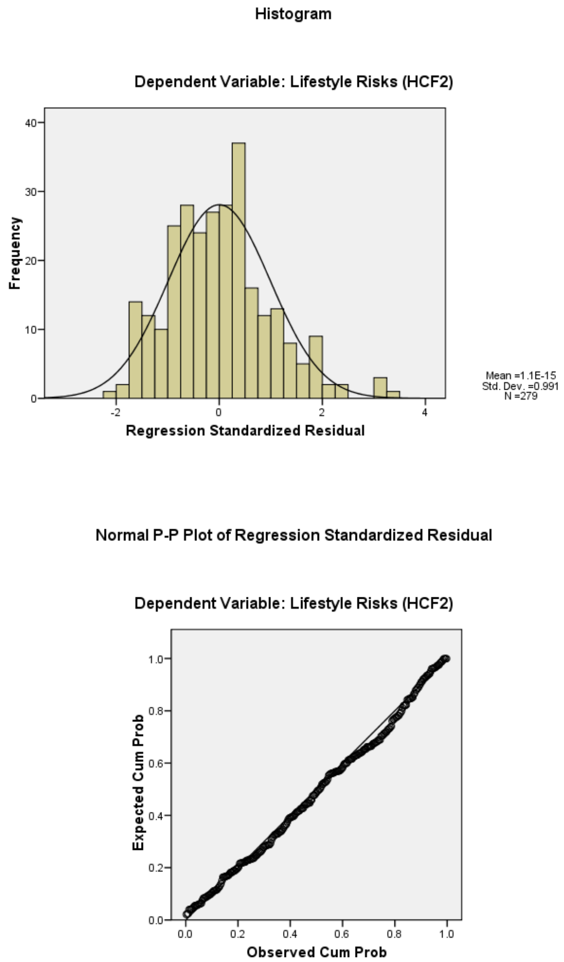


Figure 4.35 Histogram and normal P-P plot of normally distributed residuals of perception of health consequences from lifestyle risks

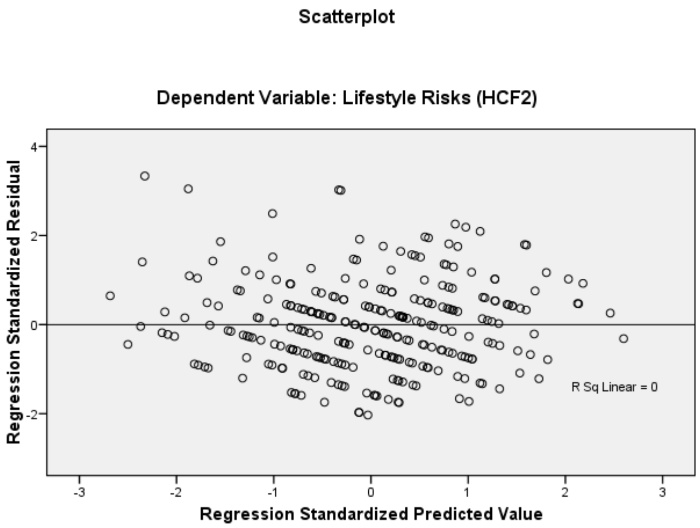


Figure 4.36 Scatterplot of ZRESID against ZPRED of multiple regression of perception of health consequences from lifestyle risk

4.7.5.7.3 Perception of health consequences from chemical and nuclear risks

To determine significant predictors of perception of health consequences from chemical and nuclear risks applying multiple linear regression, first ‘stepwise method’ was used with all demographic variables and summated variables of ‘perception of health risk’ and ‘perception of protection against risk’ were simultaneously entered in the model. The model retained ‘perception of health risks’, cigarette smoking (Yes/No) and ‘number of cigarettes smoked per day’ as significant predictors of the dependent variable. Thereafter, sequential multiple linear regression applying the ‘Enter method’ was run with the ‘perception of health consequences from chemical and nuclear risks’ as a dependent variable and the summated variable of ‘perception of health risk’, cigarette smoking and ‘number of cigarettes smoked per day’ were IVs that were entered in different steps in the regression model.

Running sequential multiple regression using the Enter method, a significant model of perception of health consequences from chemical and nuclear risks emerged with $F (3, 303) = 35.403$, $p <.000$. The final model explained 25.2 % of the variance (Adjusted $R^2 = .252$, $R^2 = .260$), which included 22.4% of the variance in the dependent variable explained by the ‘perception of health risk’. Cigarette smoking (Yes/No) explained 2.5% of the variance and the ‘knowledge of EHI’ accounted for 1% in the variance in the model.

Table 4.54 gives information for each of the explanatory variables, which significantly predicted perception of health consequences from chemical and nuclear risks. The last (3rd) model showed that for a change of 1 SD in the ‘perception of health risk’ (while controlling for the other predictors) the ‘perception of health consequences from chemical and nuclear risks’ increased by

.47 SD. Increase by 1 SD in cigarette smoking (Yes/ No) (increase here means being a non-smoker) reduced perception of health consequences from chemical and nuclear risks by .16 SD. Increase in the 'knowledge of EHI' by 1 SD increased perception of health consequences from chemical and nuclear risks by .16 SD. In the final model (Step 3), all the explanatory variables were significant predictors of perception of health consequences from chemical and nuclear risks'.

Table 4.54 Result of sequential multiple linear regression of perception of health consequences from chemical and nuclear risks

Variable	*B*	*SEB*	*B*	*Sig.*	R^2	ΔR^2
Step 1					.224	.224
(Constant)	3.34	0.88		.000		
Perception of health risk (summated)	0.12	0.01	.47	.000		
Step 2					.249	.025
(Constant)	7.11	1.46		.000		
Perception of health risk (summated)	0.12	0.01	.49	.000		
Smoking (Yes/No)	-2.05	0.64	-.16	.002		
Step 3					.260	.010
(Constant)	6.28	1.51		.000		
Perception of health risk (summated)	0.12	0.01	.47	.000		
Smoking (Yes/No)	-2.09	0.64	-.16	.001		
Knowledge of EHI	0.294	0.14	.10	.043		

a Dependent variable: perception of health consequences from chemical and nuclear risks (HCF3)

The histogram and P-P plot of residuals (Figure 4.37) of multiple regression of 'perception of health consequences from lifestyle risks' variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.38) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

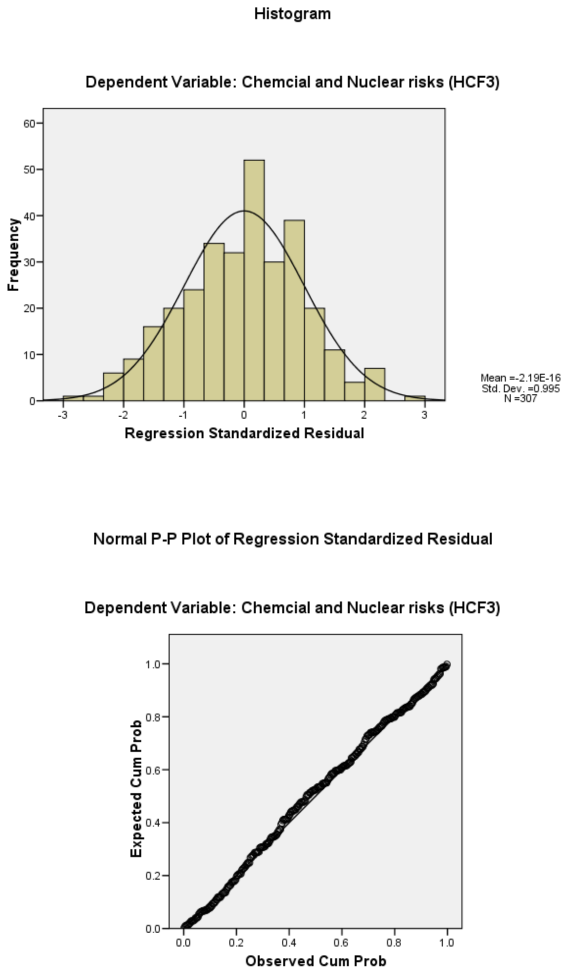


Figure 4.37 Histogram and normal P-P plot of normally distributed residuals of perception of health consequences from chemical and nuclear risks

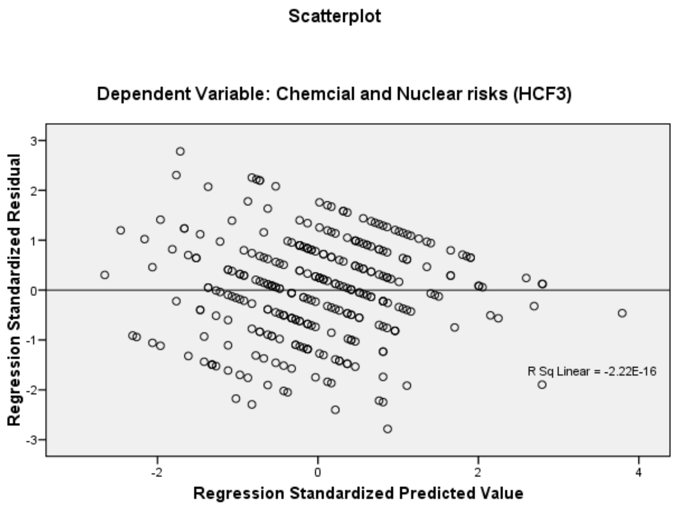


Figure 4.38 Scatterplot of ZRESID against ZPRED of multiple regression of perception of health consequences from chemical and nuclear risk

4.8 Perception of Protection against Health Risk

In this section, results of multiple regression and structural equation of summated variable of perception of protection against health risk are presented and then results of exploratory factor analysis, confirmatory factor analysis and multiple regression of latent constructs of perception of protection against health risk are reported.

4.8.1 Multiple regression of summated perception of protection against health risk variable

Running sequential multiple regression using the 'Enter method', a significant model of protection against risk emerged with F (4, 356) = 5.559, p <.000. The final model explained 4.8 % of the variance in the dependent variable (Adjusted R^2 = .048, R^2 = .059), which included 1.8% of the variance accounted for by the 'highest education level'. 'Perception of health risk' explained 1.7% of the variance in the criterion variable. Gender and the 'value placed on good health' each predicted 1.2% of the variance in the outcome variable.

Table 4.55 gives information for each of the explanatory variables, which significantly predicted protection against risk. All predictor variables were significant in the last (4th) step, which showed that the most important and significant predictor of the 'perception of protection against risk' was the 'perception of health risk', which for a change of 1 SD, while controlling for the other predictors, increased the variance in the outcome variable by .16 SD. Increase of 1 SD in the 'highest education level' and gender reduced the explanation of the variance in the dependent variable by .15 and .12 SD, respectively. Here, increase in gender here means female who perceive lower perception of protection against health risk while decrease in gender here means male who perceive higher perception of protection from health risk. Similarly, people with higher education level perceive lower perception of protection against health risk and vice versa. In addition, the ‘value placed on good health’ increased the variance by .11 SD for the ‘perception of protection against risk’. This finding might suggest that people who put a high value on their good health have higher perception of protecting themselves from risks and vice versa.

Table 4.55 Result of sequential multiple linear regression of perception of protection against health risk

Variable	*B*	*SEB*	*β*	*Sig.*	R^2	ΔR^2
Step 1					.018	.018
(Constant)	49.52	1.35		.000		
Education highest level achieved	-1.31	0.52	-.13	.011		
Step 2					.034	.017
(Constant)	41.90	3.34		.000		
Education (highest level achieved)	-1.29	0.51	-.13	.012		
Perception of health risk (summated)	0.11	0.04	.13	.013		
Step 3					.047	.012
(Constant)	45.02	3.63		.000		
Education highest level achieved	-1.43	0.51	-.14	.006		
Perception of health risk (summated)	0.12	0.04	.15	.004		
Gender	-2.29	1.07	-.11	.033		
Step 4					.059	.012
(Constant)	36.38	5.42		.000		
Education (highest level achieved)	-1.48	0.51	-.15	.004		
Perception of health risk (summated)	0.13	0.04	.16	.003		
Gender	-2.47	1.07	-.12	.021		
Value placed on personal good health	1.57	0.73	.11	.033		

a Dependent Variable: Perception of protection against health risk (summated)

The histogram and P-P plot of residuals (Figure 4.39) of multiple regression of ‘perception of protection against risk’ (summated) variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.40) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

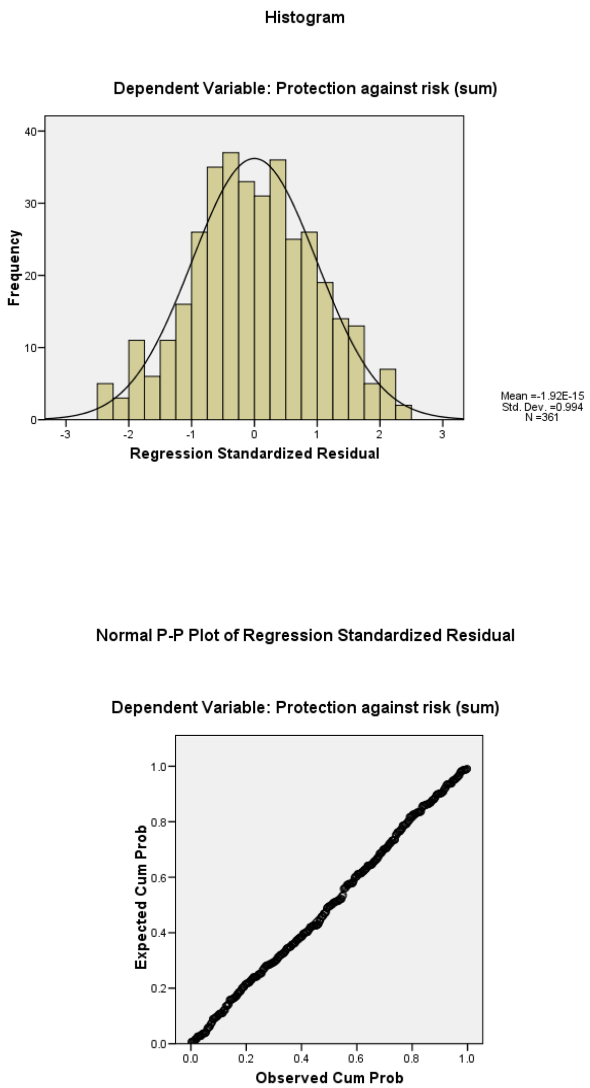


Figure 4.39 Histogram and normal P-P plot of normally distributed residuals of perception of protection against health risk

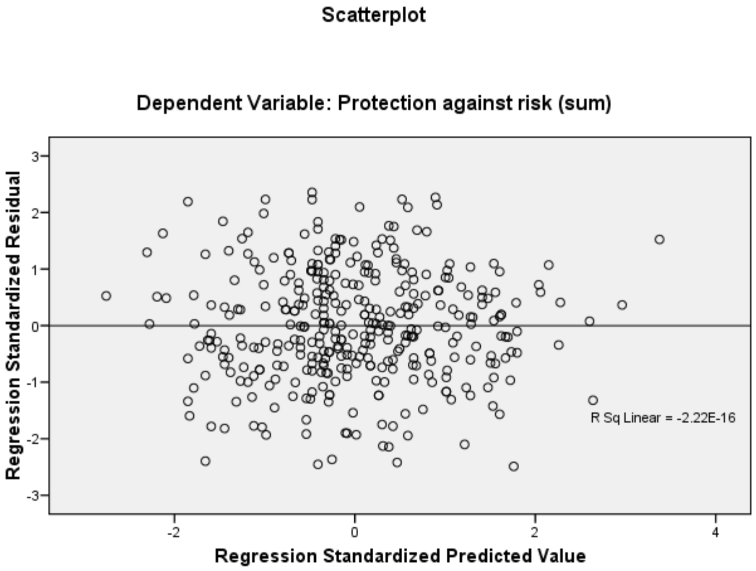


Figure 4. 40 Scatterplot of ZRESID against ZPRED of multiple regression of perception of protection against health risk

4.8.2 Structural model of summated perception of protection against health risk variable

A hypothesised model of the ‘perception of protection against risk’ was run with structural equation modelling using the Maximum Likelihood method. Assumptions of SEM such as multivariate normality and linearity were met before running the model. Figure 4.41 represents the model showing the dependent and independent variables.

For the dependent variable i.e. ‘perception of protection against risk’, standardised regression weights of the predictor variables observed were .156 for perception of health risk, -.123 for gender, -.149 for highest education level and .110 for knowledge of EHI. All regression weights were significant ($p <.05$).

The SEM model revealed that about 6% of the variance in the perception of protection against health risk was explained by the four predictor variables entered in the model. Thus, SEM results confirmed explanation of about 5.9% of the variance in the dependent variable indicated by R^2 = .059 obtained in the multiple linear regression model.

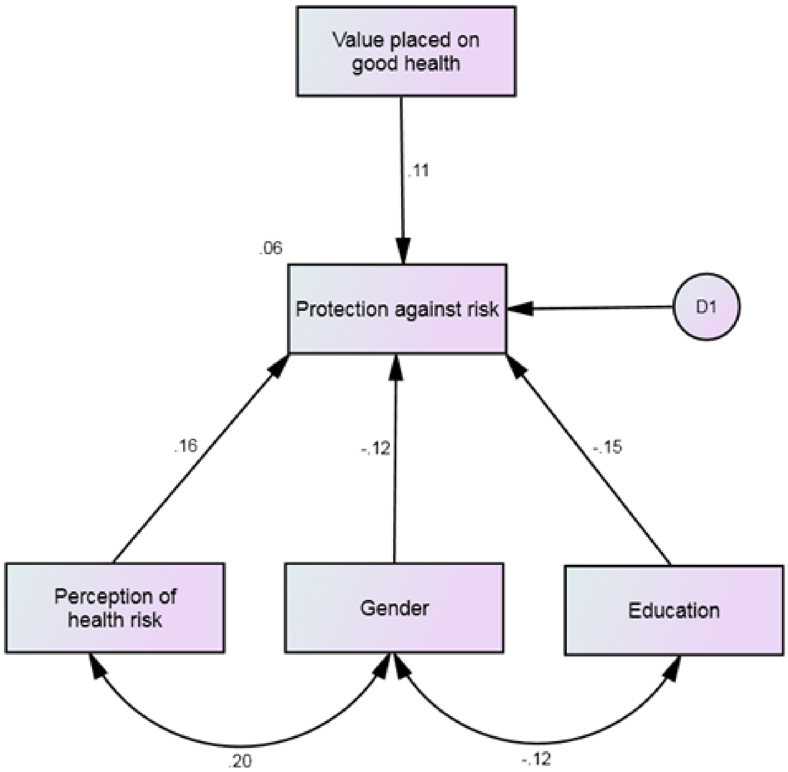


Figure 4.41 Hypothesised structural model of perception of protection against risk

Summary of goodness of fit statistics for the hypothesised structural model of 'perception of protection against risk' (Table 4.56) shows support for the model fit to the given data with χ^2 (4, N =361) = 3.093, p > .05 and model fit indices of GFI, NFI, TLI, CFI and AGFI were > .90, PNFI was .40, and RMSEA was .000 (p > .05).

Table 4.56 Goodness of fit statistics for structural model of 'perception of protection against health risk'

Goodness of Fit Statistics	*Hypothesised model*
Chi-square (χ^2)	
Chi-square (χ^2)	3.093 (p=.542)
Degrees of freedom (df)	4
Absolute Fit Measures	
Goodness of Fit Index (GFI)	.997
Root mean square error of approximation (RMSEA)	.000
90 % confidence interval for RMSEA (Low; high)	.000; .171 (p=.841)
Root mean square residual (RMR)	.079
Normed Chi-square (=χ^2/df)	.773
Incremental Fit Indices	
Normed fit index (NFI)	.932
Tucker-Lewis coefficient (TLI) *	1.064
Comparative fit index (CFI)	1.000
Relative fit index (RFI)	.832
Parsimony fit Indices	
Adjusted goodness of fit index (AGFI)	.987
Parsimony normed fit index (PNFI)	.400

*Also known as the Bentler-Bonett non-normed fit index (NNFI) (Hair et al., 009)

4.8.3 Exploratory factor analysis of perception of protection against health risk items

EFA was carried out to reduce the dimensions and find out latent factors for perception of protection against health risk.

4.8.3.1 Procedure

Multiple criteria for extraction of latent factors were applied as follows:

a) Communalities greater than 0.30

b) Loadings greater than 0.30 on each factor

c) Measures of sampling adequacy (MSA) greater than 0.50

d) Kaiser latent root criterion of Eigen values greater than 1

e) Scree plot

f) Minimum variance extracted = 40%

Before finding out latent factors of perception of protection against health risk, one variable i.e. exposure to radon gas (par11) was excluded because 44.4% (n=173) of participants answered ‘do not know’ while ranking their perception of protection against risk for this variable. For the remaining 14 items, the ‘do not know’ answer was treated as a missing value in all inferential analyses; however, the score was not replaced by imputation because it was a valid answer provided by the respondents. Therefore, while running EFA in SPSS, the option of ‘exclude cases listwise’ was used for handling ‘do not know’ answers, which were treated as missing values. The process of factor extraction is described below. Excluding ‘exposure to radon gas’ (par11) variable, all other items (n=14) in the ‘perception of protection against risk’ were entered in the data reduction analysis option available in SPSS for running an EFA. Consequently, there were 318 valid cases that were analysed in the EFA.

4.8.3.2 Results of exploratory factor analysis

A principal axis factor analysis of perception of protection against risk was conducted on 14 variables with the Oblique rotation using Oblimin with Kaisar normalisation method. Prior to factor extraction, both univariate and multivariate outliers were identified and deleted as described earlier. Correlation matrix of items loaded in the final factor solution showed that they were positively and significantly correlated with each other ($p<.01$) except item hc4 (alcohol consumption over the legal limit) that was not correlated with item par9 (EMFs in home I e.g. hair dryers and hi fi systems) and item par10 (EMFs in home II e.g. home microwave) variables. The highest significant correlation (r =.87) was found between par 9 and par10 items. In addition, two other items i.e. par6 and par7 were significantly highly correlated (r= .79) with each other and with item par4 with r=.72 and r=.68, respectively. The determinant of the correlation matrix was 0.028, which was greater than the required value of 0.0001; thus, it confirmed the absence of multicollinearity between the loaded items in the final EFA solution.

Table 4.57 provides extracted latent factors, Eigen values and the variance as well the loadings, communalities and measures of sampling adequacy (MSA) for all measured variables that were loaded on the extracted latent factors. Anti-image matrices showed observed MSA minimum as 0.613 and maximum as 0.912 (Table 4.57). All MSA were greater than the required standard (0.50), which confirmed that the sample was adequate to run factor analysis. KMO statistic observed was 0.708, which confirmed sampling adequacy for the analysis (Table 4.57). Bartlett's test of Sphericity with χ^2 (15) = 1127.2 ($p < .001$) showed that correlations between variables were statistically significant and large enough for factor analysis (Table 4.57). Communalities extracted for each measured variable were between 0.63 and 0.90 and are presented in Table 4.57. Communalities extracted were greater than .50 that was higher than the minimum cut off value of .30 required for the sample size of this study.

Eigen values for each factor in the data were run and two factors were observed on the basis of Kaiser's Eigen values greater than 1 criterion (Table 4.57). Another criterion of extracting the number of factors, the Scree plot (Figure 4.42) showed inflexion that also justified retention of two factor solution for perception of protection against risk. Total variance extracted by two factors solution was 71.2% (Table 4.57). Factor 1 explained 43.6% of the variance and factor 2 accounted for the remaining variance (27.6%). Thus, the two factors solution was accepted.

Table 4.57 Results of exploratory factor analysis of perception of protection against health risk items

Latent factor (construct) and loaded items	*Factor loading*	*Eigen value*	*Variance explained (%)*	*Communality extracted (h^2)*	*Measures of Sampling Adequacy*	*Reliability Cronbach's α*
Factor 1=Outdoor EMFs		2.87	43.57			.89
Mobile phone transmitter (par6)	.91			.82	.71	
Overhead power line (par7)	.85			.76	.75	
Electricity sub-station (par4)	.80			.63	.91	
Factor 2= Indoor EMFs		1.89	27.59			.84
EMFs in home I (e.g. hair dryers and hi fi systems) (par9)	.96			.90	.61	
EMFs in home II (e.g. microwave) (par10)	.93			.83	.62	
EMFs in Physiotherapy department (par8)	.54			.33	.81	
Total			71.15			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy .71						
Bartlett's Test of Sphericity:						
Approx. Chi-Square	1127.202					
Df	15					
Sig.	.000					
Extraction method	Principal axis factoring					
Rotation method	Oblimin with Kaiser normalisation					
Factor loading (minimum)	.30					

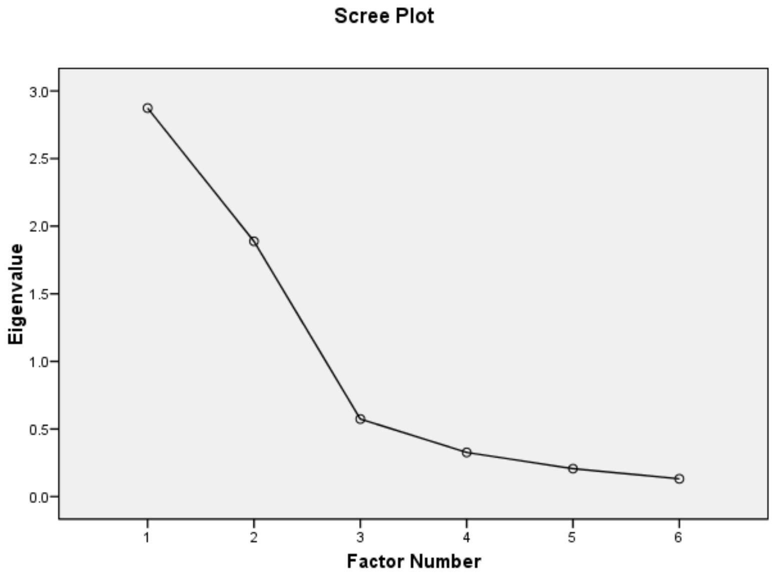


Figure 4.42 Screeplot of extraction of latent factors in exploratory factor analysis of perception of protection against health risk

In the final solution, six variables were retained and the pattern matrix revealed extraction of two factors, which was achieved in 5 iterations. Extracted factors along with loaded variables and their loadings on respective factors are shown in Table 4.57.

Factor 1 comprised three items par6, par7 and par4. Factor 2 included three items i.e. par9, par10 and par8. On Factor 1, the highest and lowest loadings were .906 for par 6 and .802 for par 4 respectively. On factor 2, maximum item loading was .961 for par9 and minimum item loading was .544 for par8. The variables that clustered on the same factors suggested that factor 1 represented outdoor EMF risks while the variables loaded on factor 2 suggested that it represented indoor EMF risks.

Factor correlation matrix revealed that two factors extracted in EFA were correlated (r=.238) with each other. Residuals were computed between observed and reproduced correlations and the reproduced correlation showed no non-redundant residuals with absolute values greater than 0.05. Factor score covariance matrix revealed good covariance (0.685) between the two extracted factors. Finally, the reliability of each factor was determined by calculating the Cronbach's alpha, which was found greater than .80 for both latent factors (Table 4.57).

4.8.4 Confirmatory factor analysis perception of protection against health risk items

A CFA was conducted through AMOS on two latent factors, as identified in EFA. Two latent factors along with their loaded items were presented in a hypothesised CFA model (Figure 4.43) where circles represent latent variables (also known factors, constructs or unobserved variables) and rectangles represent measured variables (also called indicators, observed or manifest variables). Double-headed arrows represent covariance between two variables while single-headed arrows show unidirectional hypothesised direct relationship between two variables. In the latter case, arrows point to the dependent variable while the variable on the other end is an independent variable. No direct effect between measured variables was hypothesised.

In the CFA, first, a structural path was built on the basis of loadings between the measured variables and the latent factors identified in the EFA. Variance of error for all the measured variables was not correlated whereas the variance between the two latent factors was not-fixed. The latent factors were assumed to be related with each other as such relationship between the two was made by putting a double-headed arrow between them. Before running CFA, all variables with any missing values such as 'do not know', which were marked as missing but were not replaced, were identified and then all observations (cases) with 'do not know' score were deleted and a new file was saved. This was undertaken because there is no facility of 'exclude cases listwise' in the AMOS. As such, there were no missing values. Thereafter, all multivariate outliers (n=2) were identified and deleted. In addition, the assumption of multivariate normality and linearity were evaluated through SPSS.

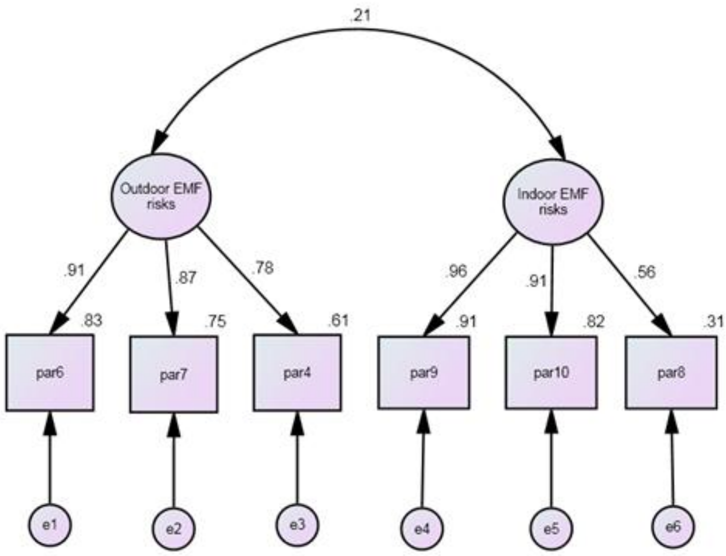


Figure 4.43 Hypothesised measurement (CFA) model of perception of protection against risk

[par6 = mobile phone transmitter, par 7 = overhead power line, par 4 = electricity sub-station, par 9 = EMFs in home I (e.g. hair dryers and hi fi systems), par 10 = EMFs in home II (e.g. home microwave), par 8 = EMFs in Physiotherapy department]

The Maximum Likelihood Estimation (MLE) method was employed for estimating hypothesised measurement (CFA) model of the perception of protection against health risk. Both latent factors along with their respective indicator variables were retained in the hypothesised CFA model (Figure 4.43).

Results of the CFA model of perception of protection against risk showing significant regression estimates along with average variance extracted and correlation between the latent variables and their indicators are presented in Table 4.58. Henceforth, the latent factors will be referred to as the latent constructs according to the terminology used in the SEM.

Table 4.58 Standardised regression estimates, average variance extracted and construct reliabilities and inter construct correlations of measurement (CFA) model of perception of protection against health risk

	Standardised regression estimates		*t-statistics*	*Sig (p)*	*SMCs*
Measured variables / indicators	*Outdoor EMF risks*	*Indoor EMF risks*			
Mobile phone transmitter (par6)	0.91		a_		0.83
Overhead power line (par7)	0.87		18.85	< .001	0.75
Electricity sub-station (par4)	0.78		16.95	< .001	0.61
EMFs in home I (e.g. hair dryers and hi fi systems) (par9)		0.96	a_		0.91
EMFs in home II (e.g. microwave) (par10)		0.91	18.93	< .001	0.82
EMFs in Physiotherapy department (par8)		0.65	10.78	< .001	0.32
Inter construct correlations †:					
Outdoor EMF risks	1	0.04			
Indoor EMF risks	0.207	1			
Construct reliability	0.86	0.85			
Average variance extracted (AVE)	.73 (73%)	.68 (68%)			

c.r. = critical ratio (t-statistics); SMCs =Squared multiple correlations; a_Not estimated because of loading set to fixed value i.e. 1.0; †Values below the diagonal are correlation estimates among constructs and values above the diagonal are squared inter-construct correlations.

CFA results for the hypothesised measurement model show that both constructs (i.e. outdoor EMFs and indoor EMFs) of perception of protection against risk were correlated with each other (Table 4.58). Inter construct covariance between the constructs was 0.23. The construct reliability was calculated for each construct, which was .86 and .85 for the ‘outdoor EMFs’ and ‘indoor EMFs’, respectively (Table 4.58). In addition, the AVE for each construct was calculated and is presented in Table 4.58 that shows that the highest AVE was 73%, which was for outdoor EMF risks construct.

A summary of goodness of fit statistics for the hypothesised measurement model (CFA) of perception of protection against risk is presented in Table 4.59. Results show support for the hypothesised model with χ^2 (8, N=318) = 17.24, $p < .05$, fit indices of GFI, NFI, TLI, CFI, and AGFI were >.90, PNFI was < .70, RMR was =.057 and RMSEA was < .07 (Table 4.59).

Table 4.59 Goodness of fit statistics for measurement (CFA) model of perception of protection against health risk

Goodness of Fit Statistics	*Hypothesised model*	*Post hoc model*
Chi-square (χ^2)		
Chi-square (χ^2)	17.24 (p=.028)	11.657 (p=.112)
Degrees of freedom (df)	8	7
Absolute Fit Measures		
Goodness of Fit Index (GFI)	.982	.988
Root mean square error of approximation (RMSEA)	.060	.046
90 % confidence interval for RMSEA (Low; high)	.019; .100 (p =.288)	.000; .091, (p=.501)
Root mean square residual (RMR)	.057	.040
Normed Chi-square (=χ^2/df)	2.155	1.665
Incremental Fit Indices		
Normed fit index (NFI)	.985	.990
Tucker-Lewis coefficient (TLI) *	.985	.991
Comparative fit index (CFI)	.992	.996
Relative fit index (RFI)	.872	.978
Parsimony fit Indices		
Adjusted goodness of fit index (AGFI)	.954	.964
Parsimony normed fit index (PNFI)	.525	.462

*Also known as the Bentler-Bonett non-normed fit index (NNFI) (Hair et al., 2010)

In order to develop a better fitting and parsimonious model, post hoc model modifications were performed by applying the Lagrange multiplier test as suggested by modification indices obtained for the hypothesised model.

Consequently, paths indicating co-variance between error terms of two measured variables i.e. between par9 (EMFs in home I) and par10 (EMFs in home II) were added to create a post hoc model (Figure 4.44). Goodness of fit statistics for the post hoc model is presented in Table 4.59 that suggests that the model was improved by addition of extra paths as described above. Overall, the statistics the goodness of fit indices reveal that the post-hoc model was better compared to the hypothesised model. However, the hypothesised model was retained because there was no theoretical support to suggest addition of paths linking error terms of four indicator variables mentioned above.

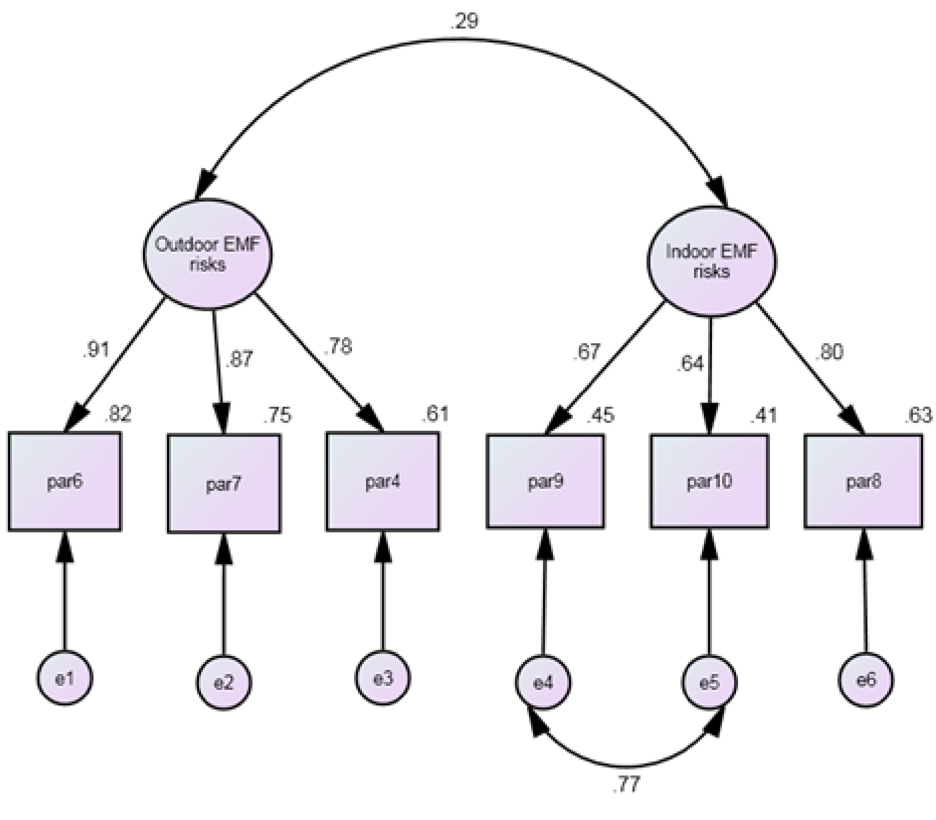


Figure 4.44 Post hoc measurement (CFA) model of perception of protection against risk [par6 = mobile phone transmitter, par 7 = overhead power line, par 4 = electricity sub-station, par 9 = EMFs in home I (e.g. hair dryers and hi fi systems), par 10 = EMFs in home II (e.g. home microwave), par 8 = EMFs in Physiotherapy department]

4.8.5 Latent constructs of perception of protection against health risk items

4.8.5.1 Creation of latent constructs

Two latent constructs were created one for each factor 1 and 2 on the basis of results of EFA and CFA. All variables loaded on each latent factor were summated to create a latent construct as follows. A construct for outdoor EMF risks was created by addition of scores for par4, par6 and par7 measured variables. For the outdoor EMFs construct, the summary of item statistics showed the items' mean were between 3.11 and 3.58 and the grand mean was 3.3. Similarly, a construct of indoor EMF risks was developed by adding up scores of par8, par9 and Par10 measured variables. The summary of item statistics for the indoor EMFs construct showed the items' mean ranged from 3.23 to 3.59 and the grand mean was 3.4.

4.8.5.2 Reliability of latent constructs

The reliability of latent constructs of the perception of protection against health risk' was determined by Cronbach's alpha (α) coefficient, which was .888 (standardised α =.888) for the outdoor EMF risks construct and .844 (standardised α =.840) for the indoor EMF risks construct. Cronbach's α coefficient ≥.84 confirmed that the two latent constructs had higher good internal reliability and consistency. In addition, identification of the two underlying dimensions confirmed the uni-dimensionality, an aspect of construct validity, of the two latent constructs of the 'perception of protection against health risk'.

4.8.5.3 Outliers

For each of the latent construct, univariate and multivariate outliers were determined as follows. Univariate outliers were identified by box plots and z-scores > ±2.5 value. Multivariate outliers were identified by calculating D^2 for two summated variables (df =2) as a critical value of chi square (χ^2) ≥ 13.82, p = .001. For both constructs, Z scores ranged between -2.49 and 1.66, which were less than the cut off value of ±2.5 and the boxplots showed no outliers (Figure 4.45). The maximum D^2 observed was 9.45 that was less than the cut off critical value of χ^2 at df=2. As such, no univariate and multivariate outliers were found for both latent constructs of perception of protection against health risk.

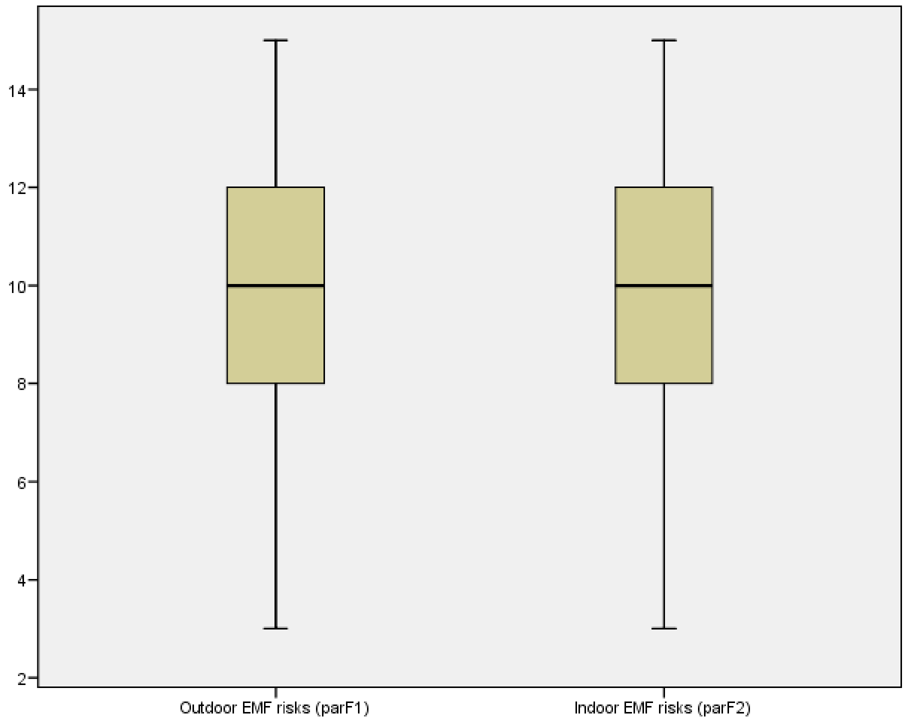


Figure 4.45 Boxplot for latent constructs of 'perception of protection against risk'

4.8.5.4 Normality

Normality of latent constructs of 'perception of protection against risk' was determined by the K-S test and the S-W test. Both tests were significant for both latent constructs when the tests were run on the data as a single sample (group) (Table 4.60a). The data were split by gender into two groups and both tests of normality were run. The results revealed that both the tests were significant for both male and female participants for both constructs (Table 4.60b), which suggested data deviated from normality. However, due to large sample size, K-S test and S-W test tend to become significant despite data being nearly normally distributed. Therefore, results showing significant K-S test and S-W test in this study with a sample size of 390 do not suggest major deviation from normality. However, other methods of determining data normality such as the P-P plots and Q-Q plots (Figure 4.46a-d) were used to check the normality of the latent constructs of perception of protection against health risks scale.

Table 4.60a Test of normality of latent constructs of perception of protection against health risk

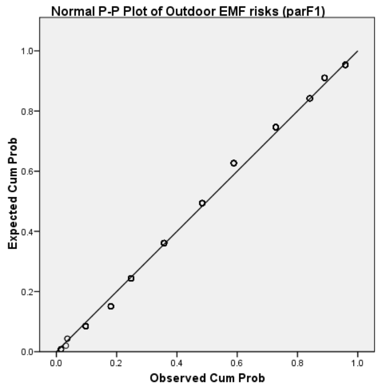
	Kolmogorov-Smirnov[(a)] Test			*Shapiro-Wilk Test*		
	Statistic	*Df*	*Sig.*	*Statistic*	*df*	*Sig.*
Outdoor EMF risks (parF10	.109	318	.000	.962	318	.000
Indoor EMF risks (parF2)	.135	318	.000	.960	318	.000

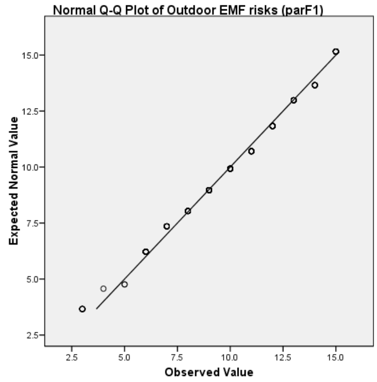
a Lilliefors Significance Correction

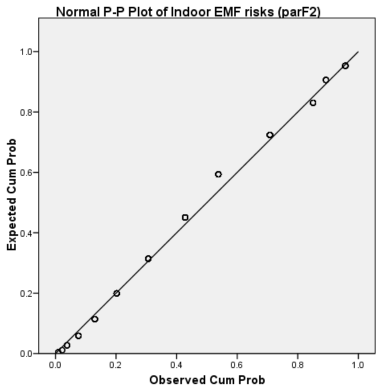
Table 4.60b Tests of normality of latent constructs of perception of protection against health risk (by gender)

	Gender	*Kolmogorov-Smirnov[(a)] Test*			*Shapiro-Wilk Test*		
		Statistic	*Df*	*Sig.*	*Statistic*	*df*	*Sig.*
Outdoor EMF risks (parF1)	Male	.137	62	.006	.936	62	.003
	Female	.105	256	.000	.963	256	.000
Indoor EMF risks (parF2)	Male	.183	62	.000	.950	62	.013
	Female	.124	256	.000	.959	256	.000

a Lilliefors Significance Correction







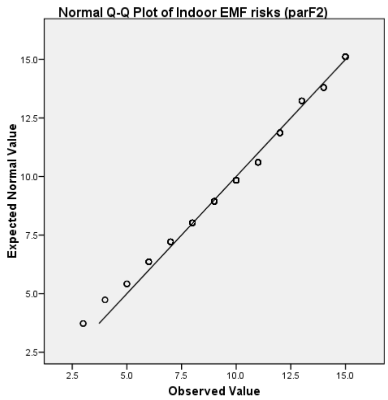


Figure 4.46a-d P-P and Q-Q plots of latent constructs of perception of protection against health risk

4.8.5.5 Homogeneity of variance (Homoscedasticity)

Homogeneity of variance between the latent scales was determined by Levens's test and results are presented in Table 4.61. All test statistics were not significant, which confirmed homogeneity of variance between the outdoor EMFs and indoor EMFs constructs of perception of protection against risk.

Table 4.61 Test of homogeneity of variance in latent constructs of perception of protection against health risk

		Levene Statistic	*df1*	*Df2*	*Sig.*
Outdoor EMF risks (parF1)	Based on Mean	1.771	1	316	.184
	Based on Median	1.457	1	316	.228
	Based on Median and with adjusted df	1.457	1	310.893	.228
	Based on trimmed mean	1.701	1	316	.193
Indoor EMF risks (parF2)	Based on Mean	2.728	1	316	.100
	Based on Median	2.634	1	316	.106
	Based on Median and with adjusted df	2.634	1	314.567	.106
	Based on trimmed mean	2.758	1	316	.098

4.8.5.6 Pearson correlations

Results of Pearson correlations (bivariate) between the two latent constructs of perception of protection against risk, demographics and summated variables of 'perception of health risk' and the 'perception of health consequences' were run on SPSS. Results of only significant correlations are shown in Table 4.62 that shows that both latent constructs i.e. outdoor EMF and indoor EMF risks were positively and significantly correlated with each other. In addition, outdoor EMF risk construct was significantly and negatively correlated with the frequency of vigorous exercise, age and awareness of EHI'. The outdoor EMF risks construct had highest correlation with age which was statistically significant and negative (r=.133, p<.05).

Table 4.62 Significant Pearson correlations (bivariate) between latent constructs of 'perception of protection against health risk' and socio-demographic variables

Variables	*Outdoor EMF risks (PARF1)*	*Indoor EMF risks (PARF2)*
Outdoor EMF risks (PARF1)	1	
Indoor EMF risks (PARF2)	.171(**)	1
Time since qualification	-.081	.124(*)
Frequency of undertaking vigorous exercise (> 30 minutes) (days/week)	-.123(*)	-.005
Age group	-.133(*)	.144(*)
Awareness of environmental and health issues	-.127(*)	.115(*)
Knowledge of environment and health issues	-0.059	.177(**)

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Bivariate correlations showed that the indoor EMF risk construct was statistically significant and positively correlated with the time since qualification, age, awareness of EHI and knowledge of EHI. The highest correlation (r=.177, p<.01) was between indoor EMF risks construct and knowledge of EHI.

4.8.5.7 Multiple regression of latent constructs of perception of protection against health risk

4.8.5.7.1 Multiple regression of perception of protection against health risk from outdoor EMFs

Assumptions required for multiple regression were met before running the multiple regression. Variables that were significantly correlated with outdoor EMF risks were entered one by one in the regression and results are presented as follows.

Using enter method for sequential multiple regression, a significant model of protection against outdoor EMF risks emerged with F (2,302) = 7.798, p <.000.

The final model explained 4% of the variance (Adjusted R^2 = .043, R^2 = .049). The highest educational level explained the most variance (3%) in the predicted variable. The age explained the remaining variance in the outcome variable.

Results of sequential multiple linear regression for outdoor EMF risk variable with its explanatory variables are given in Table 4.63 that presents information for each of the explanatory variables and their impact on the variance in the criterion variable. Results reveal that while controlling for the other predictors, a change of 1 SD in age and the highest educational level decreased perception of protection against outdoor EMF risks by .29 and .24 SD, respectively. All predictors were statistically significant during all steps in the model. Overall, age was the major predictor of perception of protection against outdoor EMF risks.

Table 4.63 Results of sequential multiple regression of perception of protection of health from outdoor EMF risks

Variable	*B*	*SEB*	*β*	*Sig.*	R^2	ΔR^2
Step 1					.018	.018
(Constant)	10.88	0.39		.000		
Age	-0.22	0.09	-.13	.021		
Step 2					.049	.032
(Constant)	13.89	1.03		.000		
Age	-.46	.12	-.29	.000		
Education highest level achieved	-.83	.26	-.24	.002		

a. Dependent Variable: Perception of protection of health from outdoor EMFs (parF1)

In addition, histogram and P-P plot of residuals (Figure 4.47) of multiple regression of ‘perception of protection against outdoor EMF risks’ variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.48) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

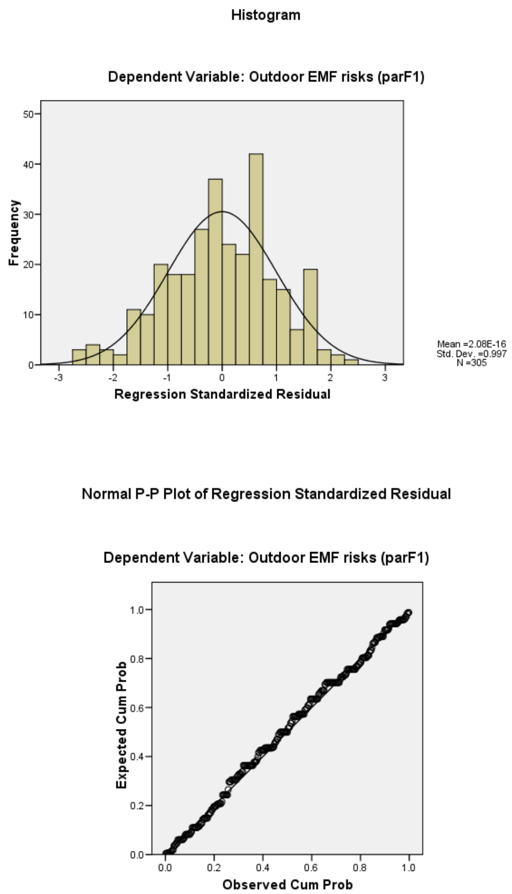


Figure 4.47 Histogram and normal P-P plot of normally distributed residuals of perception of protection against health risk from outdoor EMF risks

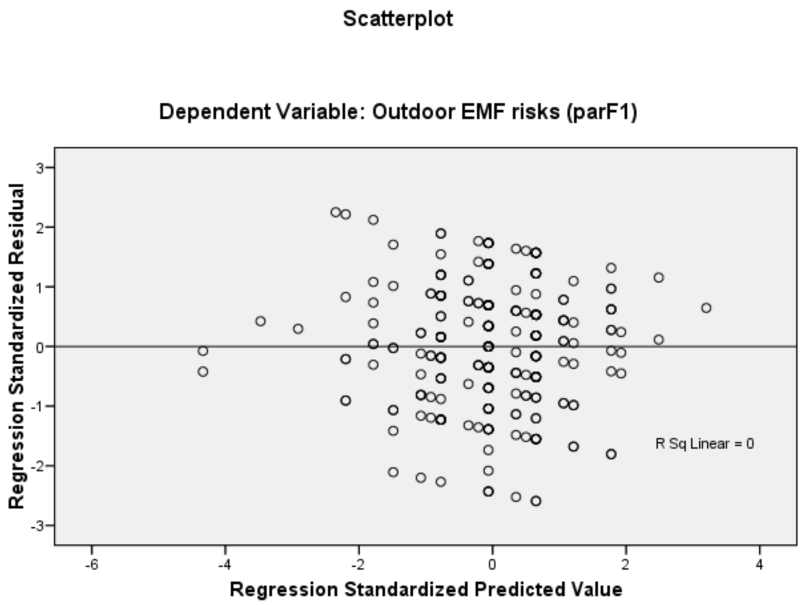


Figure 4.48 Scatterplot of ZRESID against ZPRED of multiple regression of perception of protection against health risk from outdoor EMF risks

4.8.5.7.2 Multiple regression perception of protection against risk from indoor EMFs

Running sequential multiple linear regression using the 'Enter method', a significant model of perception of protection against indoor EMF risks emerged with F (2,302) = 6.916, p =.001. The final model showed that age and knowledge of environmental and health issues explained about 4% of the variance (Adjusted R^2 = .036, R^2 =.037) in the dependent variable i.e. perception of protection against risk from indoor EMF risks. Knowledge of environmental and health issues explained the highest variance (2.3%) in the outcome variable.

Table 4.64 presents information for each of the explanatory variables, which reveals that age and knowledge of EHI were significant predictors of 'perception of protection of health from indoor EMF risks. Both predictors were statistically significant during all steps in the model. Results show that an increase of 1 SD in the 'knowledge of EHI', while controlling for the other predictor, increased perception of protection of health from indoor EMF risks by .16 SD. Increase in age by 1 SD increased perception of protection of health from indoor EMF risks by .11 SD. Overall, knowledge of EHI was the major predictor of perception of protection against indoor EMF risks.

Table 4.64 Results of sequential multiple linear regression of perception of protection of health risk from indoor EMF risks

Variable	*B*	*SEB*	*Β*	*Sig.*	R^2	ΔR^2
Step 1					0.017	0.017
(Constant)	9.49	.37		.000		
Age	.22	.09	.14	.012		
Step 2					0.037	0.023
(Constant)	7.47	.83		.000		
Age	.18	.09	.11	.047		
Knowledge of EHI	.52	.19	.16	.007		

a Dependent Variable: Perception of protection of health risk from indoor EMFs (parF2)

In addition, histogram and P-P plot of residuals (Figure 4.49) of multiple regression of ‘perception of protection from indoor EMF risks’ variable confirmed that the data met the assumption that errors were normally distributed and scatterplot of residuals (Figure 4.50) confirmed that residuals were relatively uncorrelated with the independent variables and the variance of the residuals was constant.

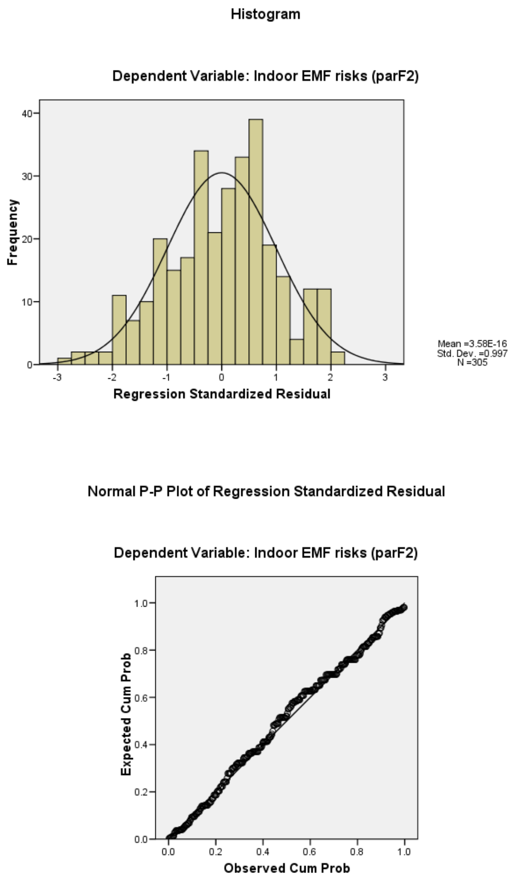


Figure 4.49 Histogram and normal P-P plot of normally distributed residuals of perception of protection against health risk from indoor EMF risks

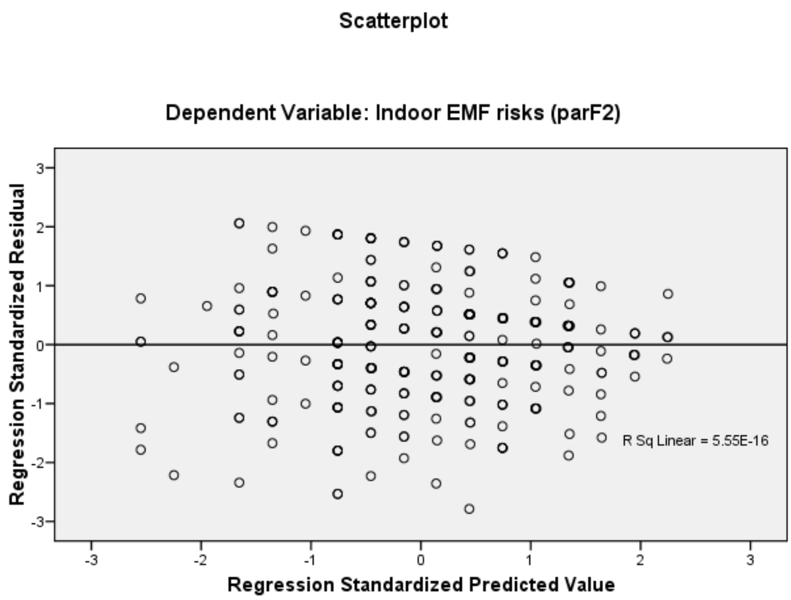


Figure 4.50 Scatterplot of ZRESID against ZPRED of multiple regression of perception of protection against health risk from indoor EMF risks

4.9 Summary

This chapter presented results of audit of electrotherapy equipment availability and use and practices and procedures in physiotherapy departments, observational visits to physiotherapy departments (n=46 including seven departments in the pilot study), and questionnaire survey of 390 physiotherapists' perception of health risk, perception of health consequences and perception of protection against risk from different known health hazards. The audit was conducted using an in-house developed practices and procedures questionnaire and the risk perception survey was conducted using an adapted health risk perception questionnaire.

The results revealed that the internal consistency and reliability of both questionnaires determined by Cronbach's α was found .798 and .884 for practices and procedures questionnaire and risk perception questionnaire respectively. > .70). The response rate in the audit and observational visits was 100% i.e. all departments that agreed to take part in this study completed the audit questionnaire and participated in observational study. The response rate in the risk perception questionnaire survey was 66.8% (390 out of 584 physiotherapists). The findings of the audit study were as follows.

Device related issues found were absolute non-availability and no use of MWD in all physiotherapy departments included in this study. Ultrasound was available in all departments while availability of other modalities was variable in the surveyed physiotherapy departments. Ultrasound and PSWD were commonly used modalities in these physiotherapy departments. CSWD, PSWD and laser were not used in some physiotherapy departments despite availability. In the majority of departments, electrotherapy equipment were maintained most commonly by an in house facility and the frequency of maintenance was mostly every 4-6 months.

User / operator related issues showed that physiotherapists were trained in the safe use of electrotherapy and the operator's distance during treatment with PSWD and CSWD was > 2m in from the equipment in the majority of departments. The majority of departments reported a number of contraindications for physiotherapists' safety such use of CSWD and PSWD by pregnant physiotherapists reported by 24% and 72%, respectively, of departments. The use of CSWD and PSWD was also contraindicated for physiotherapists wearing cardiac pacemakers by 24% and 64% of departments respectively.

The only on treatment related issue i.e. treatment time was variable according to the electrotherapy modality; however, in the majority of departments the average treatments time was most commonly >10 min for all electrotherapy modalities except ultrasound and laser.

Workplace related issues identified that in the majority of surveyed departments, average size of treatment cubicles used for electrotherapy was 2-4m^2 and large metallic objects such as radiators and filling cabinets were present in the treatment cubicles / rooms. Electrotherapy was given on treatment plinths containing metal and physiotherapists left the treatment cubicle/ room after setting and switching on PSWD or CSWD on the patient in most of the departments. In the majority (35%) of departments reported occurrence of electromagnetic interference caused by SWD (both CSWD and PSWD) with other equipment.

Department related issues discovered were as follows. The average number of physiotherapists per department was 13 (SD=6) and there were 10-20 physiotherapists in the majority (52%) of surveyed departments. The mean of total number of patients/week attending the department was 418 (SD=261) and the highest number of weekly patients / department was 600-1200 patients attending

22% of the surveyed departments. The highest percentage of total number of patients / week per department treated with electrotherapy was between 30% and 50% in about 15% of departments. In the majority (32.6%, n=15) of departments, electrotherapy was given to up to 10% of patients per week per department.

Observational visits to physiotherapy departments included in this study identified presence of large metallic objects such as filling cabinets and radiators in rooms often used for electrotherapy with PSWD and CSWD. Treatment plinths used for electrotherapy with PSWD and CSWD were not always wooden in the surveyed departments.

Results of physiotherapists' risk perception survey showed that risk ratings by male and female physiotherapists were different for a number of risk factors. The average ratings for perception of health risk and perception of health consequences from exposure to EMFs in physiotherapy departments were lower than other sources of EMFs except EMFs in home. Perception of protection against risk from exposure to EMFs in physiotherapy departments was higher than exposure to EMFs from other sources except EMFs in home. Multiple linear regression identified gender, perception of health consequences and perception of protection against risk as statistically significant predictors of perception of health risk. Statistically significant predictors of perception of health consequences were gender, knowledge of environmental and health issues and perception of health risk. For protection against health risk, statistically significant predictors were education highest level, gender, perception of health risk and value placed on good health.

Exploratory and confirmatory factor analyses / structural equation modelling revealed three latent dimensions each of perception of health risk and perception of health consequences and two latent dimensions of perception of protection against health risk from exposure to a number of risk factors included in this study. Three latent dimensions identified from 23 risk factors included in perception of health risk were EMF risks, lifestyle risks, and chemical and nuclear risks. Using sequential multiple linear regression, statistically significant predictors of latent dimensions of perception of health risk were identified as follows. Statistically significant predictors of health risk perception from EMF risks were gender and perception of health consequences. Statistically significant predictors of perception of health risk from lifestyle risks were perception of health consequences, perception of protection against risk and quantity of alcohol consumed per week. Statistically significant predictors of perception of health risk from chemical and nuclear risks were perception of health consequences, frequency of undertaking vigorous exercise, balanced diet and value placed on good health.

Three latent dimensions identified from 22 risk factors included in perception of health consequences were EMF and X-rays risks, lifestyle risks, and chemical and nuclear risks. Using sequential multiple linear regression, statistically significant predictors of latent dimensions of perception of health consequences were identified as follows. Statistically significant predictors of perception of health consequences from EMF and X-rays risks were perception of health risk, perception of protection against risk, smoking and number of cigarettes smoked daily. Statistically significant predictors of perception of health consequences from lifestyle risks were perception of health risk and quantity of alcohol consumed weekly. Statistically significant predictors of perception of health consequences from chemical and nuclear risks were perception of health risk, smoking and Knowledge of environment and health issues.

Two latent dimensions emerged from 15 risk factors included in perception of protection against risk were outdoor EMF risks and indoor EMF risks. Using sequential multiple linear regression, statistically significant predictors of latent dimensions of perception of protection against risk were identified as age and highest educational level achieved for outdoor EMF risks and age and knowledge of environmental and health issues for indoor EMF risks.

The next chapter presents discussion on the findings of this study.

5 DISCUSSION

In this chapter, findings of the study are discussed with reference to relevant literature published by other researchers. This chapter is divided in two sections. The first section provides discussion on the findings of physiotherapists' practices and procedures in the safe use of electrotherapy devices and observation of physical features in physiotherapy workplace. The second section presents a discussion of physiotherapists' risk perception.

5.1 Physiotherapists' Practices and Procedures and Workplace

From the discussion point of view, the findings of audit of physiotherapists' practices and procedures and observational visits to physiotherapy departments are combined in this section due to their close association with each other.

5.1.1 Reliability of practices and procedures questionnaire

The researcher developed and applied a practices and procedures questionnaire which showed the Cronbach's α reliability of 0.798 for all items (n=114) except all items (n =13) related to microwave diathermy, which was not available in any of the participating departments. The Cronbach's alpha option 'if item deleted' revealed that the Cronbach's α could be increased to .898 by deleting some of the items such as the 'number of patients visiting the physiotherapy department per week'. The researcher however did not delete the suggested items because the internal reliability obtained as Cronbach's α level was already higher than the minimum cut-off level of .70 suggested for establishing the internal consistency and scale reliability of any scale or a survey questionnaire (Bowling, 2005, p. 397; Brace et al., 2009, p. 368).

5.1.2 Response rate

For studying physiotherapists' practices and procedures in the use of electrotherapy, the recruitment rate was 80.7% i.e. 46 out of 57 physiotherapy departments. All those departments (n=46) that agreed to participate in this study took part in the audit of practices and procedures conducted using a questionnaire alongside observational visits to the departments. Thus, the response rate for the study of physiotherapists' practices and procedures was 100%. The response rate was higher than some previous studies involving physiotherapy departments such as 67.9% in a study by (Cromie et al., 2000) and 75% in the study by Shields et al. (2002b). The number of participating physiotherapy departments in the present study (n=46, which included 7 in pilot and 39 in the main study) was higher than 20 departments and clinics in the study by Martin et al. (1990a) and 41 departments in the study by Shields et al. (2002b).

5.1.3 Device issues

This study found that most commonly available and used electrotherapy devices were ultrasound, interferential and PSWD whereas MWD was not available in surveyed NHS physiotherapy departments and clinics. In 1994, Wilton (1994) had reported decline in the use of MWD. In 2001, Grant (2001) reported that use of MWD has almost disappeared. The finding of non-availability of MWD in the present study confirms that the use of MWD has ceased at least in the surveyed departments. These findings however may not be representative for all physiotherapy departments and clinics in the NHS across the country due to the regional nature of the present study. It might be possible that MWD is still available and used in physiotherapy departments in the NHS and private physiotherapy practices in other parts of the country. A full picture of MDW use and availability may be revealed through a future study involving physiotherapy departments in the NHS and private physiotherapy practices in the country. It can be noted that there are about 360 physiotherapy practices in the private sector (Private Healthcare UK, 2011) and there are about 4000 physiotherapists associated with private physiotherapy practices (Physio First, 2011).

The present study has shown that therapeutic ultrasound devices were available in all departments and it was the most commonly used form of electrotherapy. This corroborates findings of earlier studies (Pope et al., 1995; Kitchen and Partridge, 1996; Kitchen and Partridge, 1997; Robertson and Baker, 2001) as well as the most recent studies (Chipchase and Trinkle, 2003; Chipchase et al., 2009).

Results of the present study revealed that interferential devices were available in 96% and used in 80% of departments; however, an earlier study conducted in England by Pope et al. (1995) had reported availability of about 97% and use of this modality by 99% of departments. A study conducted in the Republic of Ireland by Cooney et al. (2000) reported 98% availability and 100% use of this modality in surveyed physiotherapy practices. This suggests that the availability and the use of interferential have decreased at the time the present study was conducted. Nevertheless, the present study has revealed that this modality is still used as one of the most commonly used electrotherapy modalities.

Findings of this study show that TENS was available in about 83% and used in 60% of departments, indicating that the use of this modality has decreased compared to its use (between 96% -100% departments that owned this equipment) reported in earlier studies (Pope et al., 1995; Robertson and Spurritt, 1998; Cooney et al., 2000).

Regarding shortwave diathermy, some earlier studies such as by Lindsay et al. (1990; Lindsay et al., 1995) and Cooney et al. (2000) only reported higher availability and did not report the exact number of PSWD and CSWD devices per department. In this study, the availability of PSWD was a maximum of 8 device per department and for CSWD devices there was a maximum of 3 devices per department, which is greater than the quantity of devices per department reported by others (Shields et al., 2001). The number of devices per department does not necessarily mean that the modality is good or bad. The availability of the device however might depend on different factors such as the clinical need and the nature of clinical practice (Cooney et al., 2000; Scudds et al., 2009). Therefore, the number of devices can vary in departments at regional, national and global levels.

A study conducted in the Republic of Ireland by Shields et al. (2001) reported that the use of PSWD and CSWD was equal. According to Grant (2001), the use of CSWD has almost stopped while PSWD is still used. In 2006, Al Mandeel and Watson (2006) reported the use of PSWD in the North England and reported that this modality was used for treating 8%-13% (mean 11%) of patients and about 76% of physiotherapists used this modality once a week or one a single occasion. The present study has revealed that the use of PSWD was higher (used in 69.6% of surveyed departments) than CSWD (used in 8.7% of surveyed departments) and PSWD was commonly used (reported as 1st to 5th choice on a 9 point Likert scale) while CSWD was less commonly used (reported as 5th to 7th choice on 9 point Likert scale). The difference in the use of PSWD and CSWD might be due to physiotherapists' preference for the use of non-thermal modalities (i.e. PSWD) over thermal modalities (i.e. CSWD) in the British NHS (Kitchen and Partridge, 1996). In addition, low use of CSWD might be due to safety issues (Larsen et al., 1991; Ouellet-Hellstrom and Stewart, 1993; Robertson and Spurritt, 1998; Lerman et al., 2001).

The availability and/or frequency of use of therapeutic laser have been reported in a number of earlier studies (Lindsay et al., 1990), (Baxter et al., 1991), (McMeeken and Stillman, 1993), (Kitchen, 1995), (Pope et al., 1995), (Kitchen and Partridge, 1996), (Kitchen and Partridge, 1997), (Robertson and Spurritt, 1998), (Partridge and Kitchen, 1999), (Cooney et al., 2000) and later studies (Chipchase et al., 2009),(Scudds et al., 2009) but only McMeeken and Stillman (1993) reported the number of laser devices available in each physiotherapy department/practice. McMeeken and Stillman (1993) maximum 3 laser devices in a department and the present study found maximum two devices per department, which suggests that the number of laser devices available in physiotherapy departments/ practices has declined by about 33% by the time the present study was conducted. In the present study, laser was available in 50% of departments surveyed, which is less than 92% availability of this modality reported by Pope et al. (Pope et al., 1995). However, the availability of this modality was higher in the present study compared to availability reported up to 40% by Kitchen (1995), 33% by Kitchen and Partridge (1996; 1997), 38% by Cooney et al. (Cooney et al., 2000) and 32% by Chipchase et al. (2009). The use of laser in the present study was 37% compared to 58% reported by Lindsay et al. (1990), 93% by Pope et al. (Pope et al., 1995), 32% by Kitchen and Partridge (1996; 1997), 59% by Cooney et al. (Cooney et al., 2000) and 8% by Chipchase et al. (2009). These findings suggest variations in the availability and use of laser that might be due to differences in the practice in physiotherapy departments/clinics due to differences in their geographical locations.

Moreover, in the present study, the use of laser was less than the use of ultrasound and PSWD and greater than the use of CSWD, which is in agreement with the findings of an earlier study conducted in England (Kitchen and Partridge, 1996).

The present study found non-use despite availability of electrotherapy devices and the non-use varied between departments and between modalities. In the present study, the order of non-use of modalities despite equipment availability was highest for H-wave (93.5%) followed by CSWD (89%), laser (52.2%), biofeedback (17.4%), TENS (17.4%), PSWD (15.2%) and interferential (4.3%). The present study revealed that H-wave, CSWD and laser were the three most non-used modalities despite device availability. The non-use despite availability equipment of electrotherapy modalities was reported in earlier studies. A study conducted in England by Pope et al. (1995) reported non-use despite availability for MWD (36%), CSWD (35%), laser (7%), biofeedback (6%), PSWD (3%), H-wave (3%) and TENS (1%) equipment. A study in the Republic of Ireland by Shields et al. (2001) reported non-use of CSWD (44%), PSWD (12%), laser (12%) and interferential (1%). These findings suggest that the non-use of electrotherapy equipment is increasing.

The researcher did not ask for the reasons of non-use of electrotherapy modalities; however, the findings of this study suggest that the non-use is determined not only by the availability of the equipment (Kitchen and Partridge, 1996; Kitchen and Partridge, 1997) but also by other issues. A number of factors that may contribute to the non-use have been reported (Table 5.1)

The present study revealed that devices of therapeutic ultrasound were available and used in all departments and it was the most commonly used mode of electrotherapy in the departments. This finding substantiates that Ultrasound is the most common type of electrotherapy reported in earlier studies (Pope et al., 1995; Kitchen and Partridge, 1996; Kitchen and Partridge, 1997; Robertson and Baker, 2001). Again, the researcher did not request the reasons why ultrasound was the most commonly used. A future study may be required to investigate these reasons and to ascertain the influence of safety, clinical effectiveness, ease of use and portability of the device on use of this modality.

Table 5.1 Reasons for non-use of electrotherapy modalities in physiotherapy

Reasons for non-use	*References*
Equipment non-availability	(Kitchen and Partridge, 1996; Kitchen and Partridge, 1997; Busse and Bhandari, 2004)
Safety concerns / fear of safety	(Paxton, 1980; Lindsay et al., 1990; Kitchen and Partridge, 1992; Robertson and Spurritt, 1998)
Lack of evidence for clinical effectiveness	(Robinson and Snyder-Mackler, 1988; Kitchen and Partridge, 1992; McMeeken and Stillman, 1993; Kitchen, 1995; Turner and Whitfield, 1997b; Robertson and Spurritt, 1998; Cooney et al., 2000; Shields et al., 2001; Laakso et al., 2002; Shields et al., 2002b; Scudds et al., 2009)
Physiotherapist's choice	(Pope et al., 1995) (Kitchen and Partridge, 1996)
Lack of knowledge / training and unfamiliarity	(Pope et al., 1995; Turner and Whitfield, 1997b; Turner et al., 1999; Cooney et al., 2000)
Lack of research and information	(Baxter et al., 1991; McMeeken and Stillman, 1993)
Nature of the clinical condition	(Kitchen and Partridge, 1996)
Supersession of modality	(Cooney et al., 2000)
Level of ease / difficulty in using	(Lindsay et al., 1990)
Area / nature of practice i.e. private vs. public, busy vs less busy	(Robinson and Snyder-Mackler, 1988; ter Haar et al., 1988)
Equipment cost	(Robinson and Snyder-Mackler, 1988; Pope et al., 1995; Cooney et al., 2000)

Regular maintenance and calibration of any medical device is essential from the safety and effectiveness perspectives. The present study found that electrotherapy devices were maintained and most commonly checked for electrical safety, usually every six months. This was carried out in house by medical engineering or the medical physics department in the hospital or by an external agency on a contract basis. This is in accordance with previous research (Docker et al., 1992, 1994; Robertson et al., 2001; Shields et al., 2001; Bazin, 2002) and the professional guidelines issued by the Chartered Society of Physiotherapy (CSP) in the UK (Docker et al., 1992, 1994; Baxter et al., 2006; Bazin et al., 2008) and elsewhere (Health Canada, 1983). Maintenance might mean different things such as testing of electrical safety, identification of faulty parts and undertaking the calibration tests. During visits of the physiotherapy departments, the researcher found notices of electrical safety checks with dates on various electrotherapy devices in most of the departments, which is in accordance with the CSP guidance on electrotherapy (Baxter et al., 2006; Bazin et al., 2008). However, despite periodic, usually six monthly and annually, maintenance of electrotherapy devices reported by the departments, the researcher found a faulty PSWD device in one of the departments. No written instructions about the device defect were displayed either on the device or in the treatment room with the faulty device. This might be however an isolated case. Because safe use of electrotherapy requires reporting of faulty electrotherapy devices is required as soon as the fault is discovered or suspected (Baxter et al., 2006; Bazin et al., 2008), tagging of faulty equipment is required to avoid any health and safety issues (Robertson et al., 2001; Chartered Society of Physiotherapy, 2005) and none use any device that has not been calibrated and checked for safety (Baxter et al., 2006; Bazin et al., 2008).

Safety issues related to electrotherapy devices are addressed under standard 18 of the Core Standards of Physiotherapy Practice in the UK (Chartered Society of Physiotherapy, 2005); however, no specific time framework is provided for calibration of the devices. A timetable for calibration of all electrotherapy devices should exist in physiotherapy departments but the researcher did not find a timetable in any department. There is therefore a need for a set timetable at the department level to undertake device calibration.

The finding of electromagnetic interference (EMI) caused by operating SWD devices with other electrotherapy equipment such as interferential devices and laser and other electrical equipment such as telephones and computers substantiates findings of earlier studies (Valtonen et al., 1975; Jones, 1976; Wilton, 1994; McAuley, 2000; Ruggera et al., 2003). The occurrence of EMI does not mean that high intensity EMF is present (McDowell and Lunt, 1991). However, it can be the source of a health risk (Grant, 2001) to patients, staff and visitors in physiotherapy departments who have implants, such as cardiac defibrillators or pacemakers, as well as electrical and electronic devices that may be in the close vicinity. It is therefore important to mitigate EMI within physiotherapy departments (Wilton, 1994). Mitigation of EMI is well recognised and it can be done by different means (Hanada et al., 2001; Hanada et al., 2002). For example, by using SWD devices at a minimum at 3 m (Baxter et al., 2006; Bazin et al., 2008) and preferably at 5 m from other equipment (Docker et al., 1992, 1994; Belanger, 2002), isolation of SWD devices (McDowell and Lunt, 1991), placing the SWD device at a separate location in the department building (Crevenna et al., 2003) and locating physiotherapy departments away from special care units, computer departments, workstations, offices and telephone exchanges (Wilton, 1994). Another way of avoiding EMI caused by SWD is by shielding of the treatment room usually with a ferromagnetic material (Dey et al., 1995; Hanada et al., 2002; Robinson et al., 2003; Aniolczyk et al., 2004). The researcher found only one department where SWD was used in a specially shielded room.

This suggests that use of ferromagnetic shielding is uncommon which might be due to financial and other reasons. A study of implications of establishing ferromagnetic shielded treatment rooms in NHS may be useful. which may be investigated in the future. Above all, the issue of EMI can be primarily addressed by developing EMI immune medical devices (Hanada et al., 2002). For safe use of an electrotherapy device, reading and understanding of the device manual prior to device usage has been recommended for physiotherapists (Baxter et al., 2006; Bazin et al., 2008). The present study found that user manuals for electrotherapy devices were available in the majority of departments; however, they were not available in some departments. Physiotherapy managers therefore should ensure availability of user manuals for all types of electrotherapy devices used in their departments for ready reference by the physiotherapists.

5.1.4 User / operator (physiotherapist) issues

In the present study, three issues related to electrotherapy device users i.e. physiotherapists, were studied, which included physiotherapists' training and distance from operating equipment as well as contraindications and precautions with respect to use of specific electrotherapy modalities. Physiotherapists are required to use only those electrotherapy devices for which they are properly trained (Chartered Society of Physiotherapy, 2002c) and in accordance with the suggested safety and clinical guidelines (Stuchly et al., 1982; Health Canada, 1983; NHMRC, 1986a, b; Delpizzo and Joyner, 1987; Martin et al., 1990a; Docker et al., 1992, 1994; Chartered Society of Physiotherapy, 1997d; Robertson et al., 2001; Grandolfo and Spinelli, 2002; Chartered Society of Physiotherapy, 2005; Baxter et al., 2006; Bazin et al., 2008). The present study found that physiotherapists in most of the surveyed departments were trained in the safe use of electrotherapy. There were however comments from some departments that there was a need for training and refresher courses on a regular basis, which is required to keep abreast of the latest knowledge and clinical evidence (Baxter et al., 2006; Bazin et al., 2008) as well as a requirement for physiotherapist's professional development (Chartered Society of Physiotherapy, 2003). The minimum period for physiotherapists' further training is unknown; however, Docker et al. (1992, 1994) have suggested refresher courses for physiotherapists every five years. There is therefore a need for guidelines for physiotherapists' further training by the physiotherapists' professional bodies as well as a set timetable at the departmental level.

Physiotherapists are required to reduce and avoid as much as possible their own exposure to EPAs from operating electrotherapy equipment (Low and Reed, 2000; Kitchen and Bazin, 2002). Therefore, a safe distance between the physiotherapist and the operating SWD device, cables and leads has been suggested at least 1 m (Stuchly et al., 1982; Health Canada, 1983; NHMRC, 1986a; Martin et al., 1990a; Docker et al., 1992, 1994; Chartered Society of Physiotherapy, 1997d; Robertson et al., 2001; Baxter et al., 2006; Bazin et al., 2008) or a greater distance (Shields et al., 2004b). In addition, it has been suggested that physiotherapists might leave the treatment cubicle after setting and switching on the SWD machine (Veit and Bernhardt, 1984; Baxter et al., 2006; Bazin et al., 2008). The present study has revealed that in 60% to 80% of departments physiotherapists remained at the recommended distances and in some departments, physiotherapists left the treatment cubicle after setting and switching on the SWD device, as suggested in the CSP guidelines on the clinical use of EPAs (Baxter et al., 2006; Bazin et al., 2008). In the latter situation, instructions were given to the patients to use the call bell provided in the event of any problem, as suggested (Robertson et al., 2001; Baxter et al., 2006; Bazin et al., 2008) and physiotherapists popped in to the treatment cubicle from time to time to check everything was alright. Physiotherapists therefore generally work in the far field of these devices (Martin et al., 1990a). However, the practice of the physiotherapist leaving the treatment cubicle may not be necessarily due to safety concerns.

Guidelines on contraindications and precautions for patients regarding the use of EPAs have been reported for a long time (Paterson, 1940; Delpizzo and Joyner, 1987; Docker et al., 1992, 1994; Robertson et al., 2001; Belanger, 2002; Shields et al., 2002a; Shields et al., 2004a). According to Scott (2002), contraindications and precautions for patients are applicable to physiotherapists. In addition, the Chartered Society of Physiotherapy issued guidance for the clinical use of EPAs (Baxter et al., 2006) provide detailed advice on safe use and precautions for physiotherapists using different EPAs (Bazin et al., 2008). The guidance included advice for physiotherapists' safety such as non-use of SWD and MWD by pregnant physiotherapists and staying at least 1 m from operating SWD and MWD, electrodes and leads as well as consultation with the professional health and safety guidance on safe practice in use of electrotherapy (Goats, 1990; Chartered Society of Physiotherapy, 1997d; Baxter et al., 2006; Al-Mandeel and Watson, 2008; Bazin et al., 2008). The present study revealed that female physiotherapists who were pregnant did not used PSWD and CSWD, which suggests either the compliance with health and safety guidelines (Docker et al., 1992, 1994; Chartered Society of Physiotherapy, 1997d; Baxter et al., 2006; Al-Mandeel and Watson, 2008; Bazin et al., 2008) or female physiotherapists' perception of health risks from SWD (Taskinen et al., 1990; Ouellet-Hellstrom and Stewart, 1993; Lerman et al., 2001).

5.1.5 Treatment issues

5.1.5.1 Treatment time

According to the ICNIRP Guidelines, the average time for calculating the level of occupational exposure to EMFs is 6 minutes (ICNIRP, 1998). Therefore, information on average treatment time was important for assess the time of physiotherapists' exposure to RF EMFs while using CSWD, PSWD and MWD. Average treatment time with MWD was not reported because this modality was not used in these departments as noted above. The average treatment time with CSWD and PSWD was reported 10 minutes per treatment session, which means that if the operator remained the entire period of the session then the six minutes time limit could be met. However, physiotherapists were not staying in the treatment cubicle /room during the entire period of electrotherapy with CSWD and PSWD, as mentioned above. In such situations, wearing personal dosimeters might be helpful in recording.

5.1.6 Occupational environmental / workplace issues

Observational visits to physiotherapists' occupational environment revealed that the cubicles used for electrotherapy were mostly 2 - 4 m^2 and were commonly separated from each other by curtains. The size of treatment cubicles in physiotherapy departments seems adequate to provide at least 1m distance from diathermy device to the physiotherapist operating the device. However, the curtain partitions in the treatment cubicle cannot shield stray EMFs from diathermy devices from passing to adjacent cubicles and corridors (Chartered Society of Physiotherapy, 1997d; Aniolczyk et al., 2004), which might result in unwanted

EMF exposure (Grant, 2001; Grandolfo and Spinelli, 2002). Such situation could be a source of health risk to physiotherapists, patients and other people in the close vicinity. Avoidance of exposure to stray EMFs would therefore require notices or a flashing light at appropriate places in the department indicating 'SWD was in operation' (NHMRC, 1986a, b).

Administration of electrotherapy with PSWD, CSWD is always recommended on a wooden plinth, couch or chair (Health Canada, 1983; NHMRC, 1986a, b; Docker et al., 1992, 1994; Chartered Society of Physiotherapy, 2001) and no large metallic objects should be present in the treatment room or cubicle (Robertson et al., 2001). The present study however found treatment couches containing metal were used for administering electrotherapy with PSWD and CSWD. There were also large metallic objects such as radiators and filling cabinets in the treatment cubicles used for SWD. The presence of objects with metallic components near operating diathermy devices can disturb/deflect EMF energy from the devices (Docker et al., 1992, 1994; Grandolfo and Spinelli, 2002; Hrnjak and Zivkoviae, 2002) and increase reflection of EMFs (Grant, 2001), which can be up to 100% in the case of MWD (McMeeken and Stillman, 2002) but this modality was not used in these departments. However, the presence of large metallic objects in the rooms used for CSWD and PSWD can be a source of a health hazard (Docker et al., 1992, 1994; Shields et al., 2003), and therefore should be avoided (Goats, 1990). Physiotherapy managers should therefore ensure that CSWD and PSWD are administered on wooden beds and that large metallic objects are removed from the treatment room or cubicle. If impossible, any metallic objects should be at least 3 m away from the operating diathermy equipment (Health Canada, 1983; Baxter et al., 2006; Bazin et al., 2008).

5.1.7 Departmental issues

The findings of statistically significant abut negative bivariate Pearson's correlation ($r = 0.4$; $P < 0.05$) between the total number of physiotherapist in the department and percentage of weekly patients per department treated with electrotherapy suggest that physiotherapists in departments with less number of physiotherapists use more electrotherapy in a week compared to physiotherapists in departments with large numbers of physiotherapists. This means that physiotherapists in smaller departments would be using electrotherapy devices repeatedly in a week and they might be exposed to EMF emissions from these devices. This finding may be important from the perspective of physiotherapists' occupational exposure to EMFs in the smaller departments.

It was found that a large number of patients per week visited departments for physiotherapy services, which might put pressure on physiotherapists, especially in smaller departments, to treat large numbers of patients per day. The researcher is not aware of the maximum number of patients per day that a physiotherapist can treat; however, if there is any professional limit of patients per day, the managers of physiotherapy departments must ensure compliance to that limit to protect physiotherapists' health and safety. If there are no such guidelines, then physiotherapists' professional bodies and the managers responsible for physiotherapists' health and safety should develop guidelines with regard to the maximum number of patients per day or per week attended by a physiotherapist.

The researcher's discussion with superintendent physiotherapists during visits to the surveyed departments revealed that audits were not a common practice. In addition to conducting audit of clinical performance in physiotherapy departments(Turner et al., 1999), there is a need for regular audits (Baxter et al., 2006; Bazin et al., 2008) for assessing physiotherapists' practices and procedures during electrotherapy, determining the use and non-use of available resources such as equipment and beds, assess and distribute physiotherapists' workload, identifying and resolving physiotherapists' health and safety issues. In addition, where a health and safety risk is identified then a formal risk assessment will be required (HMSO, 1974, 1992; Chartered Society of Physiotherapy, 1997c).

5.2 Physiotherapists' Risk Perception

Hospital workers might have high exposure but low perception and awareness of exposure to radiation at their workplace (Behrens and Brackbill, 1993). Physiotherapists are hospital workers and they may be exposed to more than the permissible limits of radiofrequency electromagnetic radiation from electrotherapy devices such as shortwave and microwave diathermy at their workplace (Tzima and Martin, 1994; Grandolfo and Spinelli, 2002; Shields et al., 2004b; Macca et al., 2008). Exposure to higher levels of stray radiofrequency electromagnetic radiation from diathermy devices can be a health risk to physiotherapists, patients, or other people near the devices (Benetazzo et al., 2003).

The present study investigated physiotherapists' perception of health risks from exposure to EMFs in physiotherapy departments and a number of other health risk factors. This section presents discussion of the validity and reliability of the risk perception questionnaire and findings of physiotherapists' perception of health risk, perception of health consequences and perception of protection from health risk with reference to a number of risk factors.

5.2.1 Response rate

The number of participant physiotherapists who participated in the risk perception part of the present study was 584 and those who returned completed surveys were

390, which is higher than the sample size (n =≤321) reported in previous studies conducted in England (Turner and Whitfield, 1997a; Turner and Whitfield, 1997b; Turner and Whitfield, 1999; Dickson et al., 2004), n = ≤258 in Australia (Turner, 2001, 2002) and n = 203 in the Republic of Ireland (Shields et al., 2005). In the present study the response rate was 66.8%, which was greater than in previous studies that involved physiotherapists (Turner and Whitfield, 1997a; Turner and Whitfield, 1997b; Turner and Whitfield, 1999); however, it was less than the response rate in a study on physiotherapists' risk perception conducted in the Republic of Ireland (Shields et al., 2005). The response rate of 66.8 % achieved in the present study is considered between a good and a very good response rate (Babbie, 1973), which was higher than average response rate of 60% reported in medical journals (Asch et al., 1997). Nevertheless, the response rate in this study might have been improved had the survey questionnaires been sent directly to the individual physiotherapists rather than through the department manager or superintendent physiotherapist.

5.2.2 Risk perception questionnaire

The risk perception questionnaire applied in this research was adapted from a previous study (Stollery et al., 1999; Shields et al., 2005), but they did not report the validity, internal consistency and reliability of the questionnaire. To ascertain the internal consistency and reliability of the survey questionnaire used in the present study, the researcher determined the Cronbach's α, which was observed as 0.884 for all items (n=82) included in the survey instrument. The alpha reliability was higher than the minimum cut-off level of .70 needed to establish the internal consistency of the questionnaire (Bowling, 2005, p. 397; Brace et al., 2009, p. 368). Thus, internal consistency of the applied version of the risk perception survey questionnaire with α = .884 can be declared as good (Field, 2009, p. 681). In this questionnaire there were three scales i.e. perception of health risk, perception of health consequences and perception of protection from risk; and their reliability was also determined by Cronbach's α and the findings are discussed in the relevant sections in this chapter.

5.2.3 Demographic characteristics

The gender of physiotherapists who participated in this survey indicates that 80.5% of them were female, which is similar to the overall gender composition of NHS employees reported elsewhere (Van Stolk et al., 2009). The age of the majority (82%) of physiotherapists in this study was between 21 and 40 years. This revealed that physiotherapists in the surveyed NHS physiotherapy departments were younger than the average age of NHS employees reported in a survey on health and well-being of NHS employees (Van Stolk et al., 2009).

5.2.4 Current health and lifestyle status

In the present study, the physiotherapists' current health status and lifestyle were determined through a number of variables, which included smoking, alcohol consumption, physical exercise, diet, BMI, current health status and value placed on health. The study of obesity, smoking, alcohol consumption, diet, and physical exercise is important because these factors are major health determinants (Wanless et al., 2007). Most of these variables were investigated in a study on health and well-being of NHS employees (Boorman, 2009a, b; Van Stolk et al., 2009). It will be therefore relevant to compare findings of the present study with the NHS employees' health and well-being study, known as the Boorman Report, issued in two phases i.e. an interim report (Boorman, 2009b) and the final report (Boorman, 2009a).

In the present study, physiotherapists' self-reported current health and lifestyle status revealed that the vast majority were non-smokers (96%), which is higher than the non-smokers (80%) reported in the NHS study (Boorman, 2009b). Those who smoked, reported a maximum of 20 cigarettes smoked per day, which is equivalent to that reported in the NHS employees study (Boorman, 2009b; Van Stolk et al., 2009).

The finding of alcohol consumption by 92% of physiotherapists in the present study is higher than the 85% of alcohol consumers reported in the NHS study (Van Stolk et al., 2009). Consumption of 5 units of alcohol / week was reported by 46% of physiotherapists in the present study, which is comparable to 45% of NHS employees who reported consumption of the same amount of alcohol (Boorman, 2009b; Van Stolk et al., 2009). However, in this study, 3% of physiotherapists consumed >21 units of alcohol / week which was lower than the 5% of NHS employees who consumed the same amount of alcohol (Boorman, 2009b; Van Stolk et al., 2009). These findings suggest that quantity of alcohol consumption by physiotherapists reported in the present study is not very different from NHS Employees (Boorman, 2009b; Van Stolk et al., 2009); however, the minor differences in overall percentage about alcohol consumption could be due to differences in sample sizes of the present study (N=390) and the studies involving a large body of NHS employees (Boorman, 2009b; Van Stolk et al., 2009).

The current health status reported by the 83% of physiotherapists was very good to excellent, which was higher than the general health status reported as very good (about 38%) in the health and well-being study of NHS employees (Boorman, 2009b; Van Stolk et al., 2009). In the present study, vigorous physical exercise (>

30 minutes / day) was undertaken on average 3 days / week while the mild exercise (<30 minutes / day) was undertaken on average for 2 days / week. The NHS employees study did not ask separately for information on vigorous and mild exercise, ascertaining only physical exercise in general. However, the overall pattern of frequency of physical exercise was similar in the two studies.

The NHS health and wellbeing study (Boorman, 2009a, b; Van Stolk et al., 2009) did not report on diet, BMI or obesity among NHS employees. The findings on these variables from the present study are therefore compared and discussed with reference to other related studies (NHS Information Centre, 2009). The present study found that 77% of physiotherapists reported that they usually ate the right amount of food and 70% usually had a balanced diet. This suggests that physiotherapists in the survey within NHS hospitals in England are conscious of their diet and health, which might be due to physiotherapists' recognition that obesity is a major public health issue in England (Martin, 2008) as well as their professional involvement in promoting physical activity and controlling the obesity (Chartered Society of Physiotherapy, 2002b).

Determination of the BMI is important because it is a measure of obesity (Zaninotto et al., 2006). Using height and weight data provided by the participants (there were no validity checks on height and weight), the researcher calculated participants' BMI by dividing the weight in kilograms (kg) by the squared height in meters (m) (Cismaru and Lavack, 2007). To categorise participants by the level of their BMI, the researcher used the WHO criteria for BMI classification under which BMI $\leq$ 18.49 is categorised as underweight, BMI between 18.5 and 24.9 is considered as normal weight, BMI between 25 and 29.9 is declared as overweight and a BMI $\geq$30 is regarded as obese (World Health Organisation, 2000). The present study revealed that the average BMI of the participating physiotherapists was 22.9 within the limits of a normal range of BMI (18.5-24.9), which is considered as healthy weight (World Health Organisation, 2000; Janssen and Mark, 2007; Liu et al., 2010). However, the BMI of 21.8% (n=85) of physiotherapists was ≥25, which included 18.5% (n=75) having a BMI of 25 to 29.9 indicating they were overweight (World Health Organisation, 2000; Janssen and Mark, 2007) and 3.3% (n=10) had a BMI ≥30 suggesting they were obese (World Health Organisation, 2000). Thus the total percentage of overweight including obese physiotherapists in this study was about 22%, which was lower than the percentage of overweight including obese sample of the general population (i.e. 65% of men and 56% of women, reported, for year 2007) in England (Cross-Government Obesity Unit, 2009; NHS Information Centre, 2009). However, if 21.8% physiotherapists with BMI ≥25 (showing overweight and obese) is considered representative of the total number of physiotherapists working in the whole NHS, which was 14,455 (The NHS Information Centre, 2006) at the time the present study was undertaken, then the total number of physiotherapists with BMI of ≥25 (overweight including obese) would be 3,151 (i.e. 2674 over weight and 477 obese). This may have serious implications for the physiotherapists themselves, their employer – the NHS, and the nation. The implications of obesity and overweight in the UK are enormous including the economic burden (National Audit Office, 2001; Wanless et al., 2007), which can include direct costs for treating obesity and overweight and indirect costs including costs of sickness absence and premature death (Department of Health, 2004; Wanless et al., 2007). Controlling obesity in NHS staff is already one of the Government's priorities (Wanless et al., 2007; Boorman, 2009b). It is therefore essential that physiotherapists control their BMI and this may need changes to their current lifestyle. Change in the lifestyle for controlling obesity and overweight may include a review and change in the diet, physical activity and other behavioural attitudes (Mulvihill and Quigley, 2003). In addition, prevalence of overweight and obesity in physiotherapists can be investigated by a study at the national level involving all physiotherapists working in the NHS. Study of obesity is important because it is a well-known health risk factor (James et al., 2001; Flint et al., 2010).

5.2.5 Perception of health risk

5.2.5.1 Reliability of perception of health risk scale

The perception of health risk scale comprised 23 known health risk factors, which can be categorised as environmental, lifestyle and radiation (both ionising and non-ionising) risks. The reliability and internal consistency of a scale can be confirmed by Cronbach's α that should be at least .70 (Bowling, 2005, p. 397; Brace et al., 2009, p. 368). The Cronbach's α for the perception of health risk scale was .880, which is considered good (Field, 2009, p. 681) and was higher than the minimum cut off value of .70; thus, the internal consistency and reliability of the scale were confirmed. Bivariate Pearson correlations revealed that perception of health risk was significantly and positively correlated with gender, alcohol consumption (Yes/No), 'awareness and knowledge of EHI' and negatively correlated with the height and weight. This finding was important because these variables could act as significant predictors of perception of health risk such as gender which is a recognised predictor of perception of health risks (Hampson et al., 2000; Siegrist et al., 2005; Lemyre et al., 2006; Ulla Diez and Perez-Fortis, 2009).

5.2.5.2 Rating of health risks

Studies on perception of health risk have investigated rating of risk to self (personal risk) and to others (general risk) (Kaellmen, 2000; Sjoberg, 2000c). The researcher investigated perception of health risk only to the respondents themselves, similar to that reported by others (Shields et al., 2005). The health risk rating for a large number of different health hazards, using different levels of the Likert scale, have been reported (Sjoberg, 2000c; Lee et al., 2005; Krewski et al., 2006, 2008; Lee et al., 2008a; Lee et al., 2008b; Krewski et al., 2009; Lee et al., 2009; Lee and Lemyre, 2009). An example is the study of 34 health hazards on a 7 point Likert scale by Sjoberg et al. (2000c). The present study investigated physiotherapists' rating of personal health risk from 23 risk factors on a 6 point Likert scale, which included 'do not know' as the sixth point. In the final analyses, all cases with 'do not know' score were excluded and ratings from point 1 to point 5 were included in the analyses. This means in this study effectively five point scale was used, which was the same scale that was reported by Shields et al. (2005) who also used an adapted version of the same questionnaire.

Overall, the mean ratings of perceived health risks by female physiotherapists were higher for all 23 risk items, compared to male physiotherapists. This confirms findings of previous studies reporting that women perceive higher risks compared to men (Cutter and Tiefenbacher, 1992; Greenberg and Schneider, 1995; Davidson and Freudenburg, 1996; Hampson et al., 2000; Sjoberg, 2000c; Wester-Herber and Warg, 2002; Siegrist et al., 2005; Lemyre et al., 2006; Chauvin et al., 2007).

Statistically significant differences in average rating of risk by male and female physiotherapists were determined by the t-test (Orton et al., 2001). T-test with the total sample of male (n=80) and female (n=310) participants (Appendix XII, section 8.12.1) revealed that the mean ratings of passive smoking (rp_2), alcohol consumption per week over 21 units for men and 14 units for women (rp_3), alcohol consumption per week up to 21 units for men and 14 units for women (rp_4), high fat diet (rp_5), living near a nuclear power plant (rp_8), living near an electricity sub-station (rp_9), living near a mobile phone transmitter (rp_11), using a mobile phone (rp_13), exposure to EMFs in physiotherapy departments (rp_14), EMFs from hair dryer and hi fi systems (rp_15), EMFs from home microwave oven (rp_16), exposure to noise (rp_18) and driving with twice the legal limit of alcohol (rp_20) by male and female physiotherapist were statistically and significantly ($p<0.05$) different. The mean ratings for all other items included in perception of health risk were different for male and female physiotherapists but they were not statistically significant, which corroborated the findings reported by others (Kaellmen, 2000).

To check the effect of unequal sample size of male (n=80, 20%) and female (n=310, 80%) physiotherapists in resulting differences in their mean ratings, t-tests were rerun using the equal number (which varied for each item due to no response and/or do not know score) of both male and female physiotherapists. The results of t-tests with equal number of male and female physiotherapists (Appendix XII, section 8.12.1) confirmed statistically significant differences in the mean ratings of male and female physiotherapists' perception of health risk from rp_2, rp_4, rp_8, rp_9, rp_11, rp_14, rp_16 and rp_18, as found with the full sample. However, the difference between the mean ratings of rp_15 (EMFs from hair dryer and hi fi systems) by male and female physiotherapists became statistically not significant in t-test with equal number of male and female physiotherapists.

It is important to point out that when full sample of participants (n=390 with male =80 and female =310) was used, then the difference between male and physiotherapists' mean ratings for rp_3 (alcohol consumption per week over 21 units for men and 14 units for women), rp_5 (high fat diet) and rp_20 (driving with twice the legal limit of alcohol) was statistically not significant. However, the mean ratings for these three items became statistically significant in T-tests with equal number of male and female physiotherapists. This finding suggests that unequal sample size of two groups of research participants can affect t-test results.

The order of ranking (from highest mean rank to lowest mean rank) of the mean rating of health risk from alcohol consumption per week over 21 units for men and 14 units for women, living near a nuclear power plant, alcohol consumption per week up to 21 units for men and 14 units for women, living near an electricity substation, exposure to EMFs in the physiotherapy department and exposure to radiation from a single chest X-ray showed that female physiotherapists ranked these risk higher compared to male physiotherapists. The order of ranking of the mean rating of perceived health risks for leading a sedentary lifestyle, exposure to poor air quality, exposure to radon gas, living near a mobile phone transmitter, air travel and train travel revealed that these risks were rated higher by male physiotherapists compared to female physiotherapists. The order of mean ratings of health risks for the remaining items was the same for male and female physiotherapists. These findings suggest that the average rating of perception of health risk differs by gender of the respondent as well as by the nature of the risk factor (Wester-Herber and Warg, 2002; Lemyre et al., 2006; Lee et al., 2008b;

Blettner et al., 2009; Jardine et al., 2009; Allman-Farinelli et al., 2010). The present study thus revealed some similarities and differences in rating of health risks from various hazards by male and female physiotherapists.

The female physiotherapists' statistically and significantly higher rating of health risk from EMFs in physiotherapy departments was probably influenced by the research studies that investigated use of shortwave and microwave diathermy and associated reproductive and pregnancy outcomes. For example, spontaneous abortion (Ouellet-Hellstrom and Stewart, 1993), congenital malformations (Larsen, 1991), low birth weight and altered gender ratio i.e. fewer male babies (Larsen et al., 1991; Lerman et al., 2001) born to female physiotherapists who were occupationally exposed to electrotherapeutic diathermy devices.

Results revealed that physiotherapists perceived the highest health risk from driving with an alcohol level that was double the legal limit, which is in agreement with findings of a similar study by Shields et al. (2005). A perception of the highest risk associated with driving with an alcohol level that was double the legal limit might be due to the fact that this is a significant health risk which can involve not only the person who is driving with a high blood alcohol level but also the passengers and others (Pedersen and McCarthy, 2008).

The present study showed that physiotherapists perceived the lowest health risk from EMF emissions from hair dryers and hi fi systems, which is in agreement with findings of a similar study by Shields et al. (2005). The second lowest rating of perceived health risk was found for home microwave ovens, which was lower rating to that reported by others (Shields et al., 2005). The present study found that perceived health risk from home microwave ovens was higher than for hair dryers and hi fi systems used in home. This reflects findings of previous studies, which reported that the strength of EMF emissions from microwave ovens were higher compared to hair dryers and hi fi systems (Preece et al., 1997). EMF emissions from use of these home electrical appliances were reported to be higher than the reference levels (Leitgeb et al., 2008a, b) but no association between childhood leukaemia and EMFs from these appliances has been established (Kaune et al., 2002). Nevertheless, exposure to EMFs from home appliances could not be ignored (Leitgeb et al., 2008b).

In the present study, risk from exposure to EMFs in the physiotherapy department was ranked as 17th out of 23 (from higher to low risk), which suggested that physiotherapists perceive low risk from EMFs in their workplace. However, 17th rank of EMFs in physiotherapy departments found in the present study was a higher rating than the 19th ranking for the same risk item reported by Shields et al. (2005). The difference in risk rating by respondents belonging to the same occupational speciality for the same potential health hazard in the two studies might be due to the differences in the respondents' risk perception due to differences in their geographical locations (Orton et al., 2001; Viklund, 2003; Krewski et al., 2006) and the culture (Slovic et al., 2004; Schoell, 2009). In addition, the rating of perceived health risk from EMFs in physiotherapy departments was lower than the risk rating for exposure to EMFs from overhead power lines, electricity substation, mobile phone and mobile phone transmitter (Shields et al., 2005). Perception of higher health risk from exposure to EMFs from living near to overhead power lines was reported in previous studies (Gregory and von Winterfeldt, 1996; Poortinga et al., 2008), which might be due to association of childhood leukaemia with close proximity with overhead power lines (Ahlbom et al., 2001; Draper et al., 2005).

Among seven items concerned with exposure to EMFs, the highest rating of perceived health risk was found for the mobile phone transmitter, which might be influenced by an increased public health concern regarding exposure to EMFs from mobile phone transmitters (Blettner et al., 2009). These have been reported as associated with the development of neuropsychiatric problems (Abdel-Rassoul et al., 2007), behavioural problems (Thomas et al., 2010), sleep disturbance, tiredness, headache, dizziness and loss of memory (Coggon, 2006; Hutter et al., 2006). A study commissioned by the NRPB (Mann et al., 2000) reported that the exposure to RF EMFs near mobile phone base stations does not exceed the safe limits (the researcher could not find the information about the closest distance from mobile phone mast at which the measurements were taken in the said study). However, exposure to RF EMFs from mobile phone masts cannot be ignored (Warburton, 2000). According to Shields et al. (2005), the rating of a higher risk from mobile phone transmitters compared to mobile phones, despite emissions of electric fields from mobile phone masts being less compared to mobile phones, might be due to the influence by the media (Shields et al., 2005; McKinlay, 2008) because the media is a recognised factor that contributes to health risk perception (Breakwell, 2000; World Health Organisation, 2006; Hackett, 2008).

5.2.5.3 Predictors of perception of health risk

Models of perception of health risk explaining up to 60% of variances have been reported (Sjoberg, 2000a). The present study revealed physiotherapists' perception of health risk model with 63% of the variance statistically and significantly explained by four predictors which included gender, awareness and knowledge of EHI, perception of protection against risk and perception of health consequences (Table 5.2). Gender was found to be a significant predictor through all steps of the perception of health risk model and it explained about 4% of the variance in the model. This finding is in agreement with other studies that reported that the gender is a significant predictor of health risk perception (Davidson and Freudenburg, 1996; Lemyre et al., 2006; John and Mark, 2007; Blettner et al., 2009). Another significant predictor of physiotherapists' perception of health risk was the 'awareness and knowledge of EHI'. Knowledge as a significant predictor of perception of health risk has already been reported (Hay et al., 2005; Vandermoere, 2008). However, 'awareness and knowledge of EHI' became a non-statistically significant predictor when the 'perception of health consequences' variable was entered into the regression model in the present study. This might be due to the effect of the perception of health consequences variable on the effect of 'awareness and knowledge of EHI' variable. In addition, it is worth mentioning that the 'awareness and knowledge of EHI' variable was created by summating the 'awareness of EHI and the 'knowledge of EHI' because these two variables were highly correlated (i.e. r = .76) and combining the two variables together resulted in explanation of more variance (3.4%) in the perception of health risk model.

The locus of control is an important predictor of perception of risk (Kaellmen, 2000), which could be the central government, regional government, local authorities and one's own self. In the present study, personal ability to protect from health risk was studied and the perception of protection against risk was found to be a statistically significant predictor of perception of health risk; explaining about 2% variation in the regression model.

In the present study, the major significant predictor of perception of health risk was the perception of health consequences, which explained about 54% variance in the model. This is because the risk is defined by the perception of possible consequences that might result from exposure to a risk factor (Ricci and Cirillo, 1985; Slimak and Dietz, 2006; Aven and Eidesen, 2007). Health consequences may be expressed as the harm and risk is the function of harm and probability, and safety increases when the harm decreases (Moller et al., 2006). This suggests that if perception of health consequences (operationalized as harm) is high then the perception of health risk will also be high and vice versa.

Overall, the aforementioned four predictors i.e. gender, awareness and knowledge of EHI, perception of protection against risk and perception of health consequences (Table 5.2), when entered together in the regression equation explained about 63% variance in the perception of health risk model, which is higher than reported earlier (Sjoberg, 2000a). This was confirmed in regression path analysis using structural equation modelling.

Goodness of fit statistics obtained in the SEM model for the 'perception of health risk' confirmed the good fit of the model to the data with Chi-square (χ^2) (4, N =361) = 5.01, p=.286, which was greater than p=.05, fit indices such as GFI, NFI, TLI, CFI, RFI and AGFI were > .90, PNFI was < .40 and RMSEA was = .026 (p=.660), which was less than the minimum required level of $\leq$.06 (p>.05) (Tabachnick and Fidell, 2007, p.716-17). The SEM model however revealed that gender, perception of protection against risk and perception of health consequences were significant predictors but the awareness and knowledge of EHI was not a significant predictor of 'perception of health risk'. This might be due to the influence of the perception of health consequence variable on the 'awareness and knowledge of EHI' variable; hence, there is a need for a further study in this regard.

5.2.5.4 Latent dimensions of perception of health risk

Exploratory and confirmatory factor analyses of perception of health risk from 22 risk factors identified three latent (unmeasured) dimensions, also known as factors or constructs (Field, 2009; Hair et al., 2010). Identification of three different latent dimensions (constructs) from 23 measured items for the perception of health risk confirmed presence of unidimensionality of items, which means that the measured items only load on one latent factor / dimension also known as an underlying construct) (Hair et al., 2010, p. 696). Thus, the presence of unidimensionality confirmed validity of constructs (latent dimensions) identified in the perception of health risk scale. Thereby, validity of constructs confirmed validity of perception of health risk scale because construct validity is a part of scale validity. (Brace et al., 2009, p. 374). In addition, average variance extracted for each latent construct was higher than the squared inter construct correlations that confirmed divergent validity of the constructs (Fornell and Larcker, 1981; Farrell, 2010; Hair et al., 2010). After identification in the EFA and confirmation in the CFA, the latent dimensions were named as ‘EMF risks’, ‘lifestyle risks’ and chemical and nuclear risks’ on the basis of loaded items (Field, 2009).

5.2.5.4.1 EMF risks

The ‘EMF risks’ construct consisted of three items i.e. EMFs from home microwave, EMFs from hair dryer and hi fi systems, and EMFs in physiotherapy department. Significant loading of these items only on this construct showed unidimensionality of the construct (Hair et al., 2010, p. 696). Results showed that Cronbach’s α of this construct was .783 that was higher than the minimum requirement of α level of .70 which confirmed the reliability and internal consistency of this construct (Bowling, 2005, p. 397; Brace et al., 2009, p. 368).

In addition, the construct validity of this construct was .88, which confirmed that the construct was valid (Hair et al., 2010).

Multiple linear regression revealed that gender, awareness and knowledge of EHI and perception of health consequences were significant predictors of perception of health risk from EMFs (Table 5.2). Gender was found as a significant predictor of perception of health risk from ‘EMFs risks’ during all steps of the model, which confirms similar findings reported about gender in risk perception studies by others (Davidson and Freudenburg, 1996; Gustafsod, 1998; Breakwell, 2000; Lemyre et al., 2006; Blettner et al., 2009).

Another significant predictor of physiotherapists’ perception of health risk from EMFs was the ‘awareness and knowledge of EHI’, which is a recognised predictor of perception of health risk (Hay et al., 2005; Vandermoere, 2008). However, it became not significant when the ‘perception of health consequences’ variable was entered in the regression model. The perception of health consequences was the major predictor for perception of health risk from EMFs, which is in agreement with previous studies (Ricci and Cirillo, 1985; Moller et al., 2006; Slimak and Dietz, 2006; Aven and Eidesen, 2007).

The present study revealed that the perception of health consequences contributed about 82% in the total variance in the model of ‘perception of health risk from EMFs’. Explanation of this level of variance in health risk perception by perception of health consequences (operationalized as a harm in this study) is probably because the risk is a function of harm and probability (Moller et al., 2006). In the model of ‘health risk perception from EMF risks’, there were three significant predictors i.e. gender, awareness and knowledge of EHI and perception of health consequences, which explained only 31% of the variance and 69% of the variance remained unexplained in the model. Explanation of less variance in risk perception models, such as in the above mentioned model, is not unexpected because study of health risk perception can result in extraction of very low (up to 5%) variance (Sjoberg, 2000c); however, extraction of more variance in the risk perception models is possible with addition of more significant predictors (Sjoberg, 2000a). There is therefore a need for further research to identify other significant predictors of perception of health risk from EMFs.

5.2.5.4.2 Lifestyle risks

The 'lifestyle risks' construct consisted of four items, which included alcohol consumption up to the legal limit, alcohol consumption over the legal limit, smoking (Yes/No) and obesity. The unidimensionality of the construct was confirmed by significant loading of all items only on this construct (Hair et al., 2010, p. 696). For this construct, the Cronbach's α was .69, which was a little less than the minimum Cronbach's α level of .70 required to confirm the reliability and internal consistency of a construct (Bowling, 2005, p. 397; Brace et al., 2009, p. 368). The Cronbach's α was less probably due to the low level of loadings i.e. .45 and .46 for obesity and smoking variables, respectively, on this construct. However, the construct validity of this construct was .83, which was good and confirmed that the construct was valid (Hair et al., 2010).

Results of sequential multiple linear regression revealed a significant model for perception of health risk from lifestyle factors, which was achieved in five steps and explained about 19.6% variance in the model. The percentage of explained variance in this model is less than 60% variance achieved in previous studies on risk perception (Sjoberg, 2000a) as well as up to 63% variance extracted for the 'health risk perception' scale in the present study. However, extraction of less variance in risk perception studies is not unexpected because it depends on the dimensions of risk perception such as egalitarian, individualistic, hierarchical and fatalistic which comprise cultural theory approach to risk perception, which explain very little variances (up to 5%) in the risk perception (Sjoberg, 2000c). Compared to cultural theory approach, the psychometric approach to risk perception tend to explain more variance (up to 20%) in the risk perception due to perception of risk on the basis of a risk factor's general properties (Sjoberg, 1996). Significant predictors of perception of health risk from lifestyle risks are shown in Table 5.2. The main predictor of perception of health risk from lifestyle risks was the perception of health consequences, which is probably because the perception of health consequences is seen as an outcome usually in the shape of harm in the health risk perception (Moller et al., 2006); hence it might determine the perception of health risk (Ricci and Cirillo, 1985; Moller et al., 2006; Slimak and Dietz, 2006; Aven and Eidesen, 2007). Another predictor of perception of health risk from lifestyle risks was gender, which is a well-known predictor of perception of health risk (Flynn et al., 1994; Davidson and Freudenburg, 1996; Hampson et al., 2000; Lemyre et al., 2006; Jardine et al., 2009; Krewski et al., 2009).

In the model of perception of health risk from lifestyle risks, gender was significant predictor up to step two of the model; however, it became insignificant at step three when the 'quantity of alcohol consumption' variable was entered into the model as well as in all subsequent steps of the regression model. Awareness and knowledge of EHI was found to be a significant predictor of perception of health risk from lifestyle factors, as reported by others (Hay et al., 2005; Vandermoere, 2008); however, this variable became not significant at the last (fifth) step when the perception of health consequences variable was entered in the regression model of perception of health risk from lifestyle risks. Perception of protection against risk was also a statistically significant predictor of perception of health risk from lifestyle risks. It was however interesting to find that the quantity of alcohol consumed was negatively associated with perception of health risk from lifestyle factors, which suggested that when the quantity of alcohol consumed increases then the perception of health risk from lifestyle risks decreases.

Table 5.2 Predictors of perception of health risk, perception of health consequences and perception of protection against health risk

	Dependent variable										
	Perception of health risk				*Perception of health consequences*				*Perception of protection against health risk*		
Predictor (independent) variable	**Mixed risks / hazards*	*EMF risks*	*Lifestyle risks*	*Chemical & Nuclear risks*	*†Mixed risks / hazards*	*EMF & X-rays risks*	*Lifestyle risks*	*Chemical & Nuclear risks*	*‡Mixed risks / hazards*	*Outdoor EMF risks*	*Indoor EMF risks*
Gender	Yes	Yes	No	-	No	-	No	-	Yes	-	-
Age	-	-	-	-	-	-	-	-	-	Yes	Yes
Education (highest level achieved)	-	-	-	-	-	-	-	-	Yes	Yes	-
Smoking	-	-	-	-	-	Yes	-	Yes	-	-	-
Number of cigarettes smoked daily	-	-	-	-	-	Yes	-	-	-	-	-
Quantity of alcohol consumed (units/week)	-	-	Yes	-	-	-	Yes	-	-	-	-
Frequency of undertaking vigorous exercise	-	-	-	Yes	-	-	-	-	-	-	-
Balanced diet	-	-	-	Yes	-	-	-	-	-	-	-
Value placed on good health	-	-	-	Yes	-	-	-	-	Yes	-	-
Awareness and knowledge of EHI	No	No	No	-	-	-	-	-	-	-	-
Knowledge of EHI	-	-	-	-	No	-	No	Yes	-	-	Yes
†Perception of health consequences (summated)	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
‡Perception of protection against risk (summated)	Yes	-	Yes	-	-	Yes	Yes	-	-	-	-
*Perception of health risk (summated)	-	-	-	-	Yes	Yes	Yes	Yes	Yes	-	-

Yes = significant in the last step of regression, No = not significant in the last step of regression, - = not correlated / not entered in the regression

5.2.5.4.3 Chemical and nuclear risks

The construct of perception of health risk from chemical and nuclear risks comprised three items i.e. living near to a nuclear power plant, exposure to industrial chemicals and radioactive fallout from a nuclear power plant. The significant loading of these three items only on this construct confirmed the unidimensionality of the construct (Hair et al., 2010, p. 696). The Cronbach's α of this construct was .72 which was higher than the minimum Cronbach's α level of .70; hence, the reliability and internal consistency of this construct were confirmed (Bowling, 2005, p. 397; Brace et al., 2009, p. 368). The construct validity of this construct was .72, which was less than the other constructs of perception of health risk identified in the present study; however, it was higher than the minimum required level of .70; thus, it confirmed that the construct was valid (Bowling, 2005, p. 397; Brace et al., 2009, p. 368).

Results of sequential multiple linear regression revealed a significant model for perception of health risk from chemical and nuclear risk factors, which was achieved in four steps and explained about 23.5% variance in the model. Statistically significant predictors of perception of health risk from chemical and nuclear risks are presented in Table 5.2. The main predictor of perception of health risk from chemical and nuclear risk factors was perception of health consequences that explained 21% variance, which was about 89% of the total variance explained, in the model. This is because the perception of health consequences is seen as an outcome usually described as harm in risk perception (Moller et al., 2006), it is therefore the main determinant of the perception of health risk (Ricci and Cirillo, 1985; Moller et al., 2006; Slimak and Dietz, 2006; Aven and Eidesen, 2007). The other significant predictors of perception of health risks from chemical and nuclear risk factors were the frequency of taking vigorous exercise, a balanced diet and value placed on good health. All these three predictors explained a total 2.5% variance, which was about 11% of the total variance explained, in the model. All of these four predictors were significant at all steps of the regression model. More interestingly, gender a well-documented predictor of health risk perception was not a significant predictor of health risk from chemical and nuclear risk factors.

5.2.6 Perception of health consequences

5.2.6.1 Perception of health consequences scale

The perception of health consequences scale comprised 22 known health risk factors that by nature can be categorised as environmental, lifestyle and non-ionising and ionising radiation risks. The reliability of this scale was determined by Cronbach's α that was .889, which was good (Field, 2009, p. 681) and greater than the lowest cut-off level of .70 required to establish internal consistency of a scale (Bowling, 2005, p. 397; Brace et al., 2009, p. 368). Thus, the internal consistency and validity of this scale were confirmed.

Bivariate Pearson correlations showed that this scale was significantly and positively correlated with the perception of health risk, gender and awareness of EHI, knowledge of EHI. This finding was important because these variables may act as significant predictors of perception of health consequences. For example gender which is a known predictor of perception of health risks (Flynn et al., 1994; Jardine et al., 2009; Krewski et al., 2009). In addition, health risk perception is recognised as a function of the harm (measured as health consequences in this study) and probability (Moller et al., 2006).

5.2.6.2 Rating of health consequences from risks

The results of physiotherapists' mean rating of their perceived health consequences for 22 risk items revealed that the highest health consequences were from smoking which is different from the findings of a similar study by Shields et al. (2005), who found highest health consequences to be from exposure to radioactive fallout from a nuclear power plant. In the present study, the lowest mean rating of perceived health consequences was for exposure to EMFs from hair dryers and hi fi systems, which was in agreement with the findings by Shields et al. (2005). In the present study, the mean rating of health consequences from exposure to EMFs in the physiotherapy department was ranked as 19th out of 22 from higher to low, which was lower than the mean rating of 18th for the same risk reported by Shields et al. (2005). This suggests that the sample of physiotherapists involved in the present study saw less health consequences from exposure to EMFs in physiotherapy departments compared to the physiotherapists who participated in a similar study conducted in the Republic of Ireland (Shields et al., 2005). It is possible that professionals working in the same profession but in different countries might have different perception of health risk and associated consequences due to geographical and cultural differences (Orton et al., 2001; Viklund, 2003; Slovic et al., 2004; Krewski et al., 2006; Schoell, 2009). In addition, risk perception is affected by psychological and societal factors (Rohrmann, 1994). Therefore, the above-mentioned factors might have led to differences in risk perception of physiotherapists in England and the Republic of Ireland.

In addition, results of this study show that top six risk factors, on the basis of the highest rating of perceived health consequences, were smoking, passive smoking, alcohol consumption up to and over the permissible (legal) limits, high fat diet and sedentary lifestyle that can be collectively defined as lifestyle or social risks. This in agreement with other studies that have reported lifestyle risks or social risks to be the most hazardous risks (Lemyre et al., 2006).

The present study found some similarities and differences in rating of health consequences by male and female physiotherapists. Overall, the mean ratings of health consequences by female physiotherapists were higher for all risk items except air travel, exposure to noise, train travel and exposure to EMFs from home microwave oven, which were rated higher by male physiotherapists. However, the t-test results using full sample (n =390 with male = 80 and female = 310) revealed that the mean ratings by male and female physiotherapists were significantly different for only 6 out of 22 items. These items included alcohol consumption per week over 21 units for men and 14 units for women (item hc3), alcohol consumption per week up to 21 units for men and 14 units for women (item hc4), high fat diet (item hc5) and living near a nuclear power plant (item hc8), an electricity sub-station (item hc9) and a mobile phone transmitter (item hc11).

In order to exclude the effect of unequal sample size of male (20%, n=80) and female (80%, n=310) physiotherapists that may have led to statistically significant differences in the mean ratings, t-tests were re-run with equal number (that varied for each risk item because of the non response and/or do not know score) of both male and female physiotherapists. The results of revised t-tests (Appendix XII, section 8.12.2) revealed that the mean ratings of male and female physiotherapists' were statistically significantly different for only four items (i.e. hc3, hc4, hc5 and hc8) out of six items identified during T-test with full sample. The mean rating of the two remaining items i.e. hc9 and hc11 were found statistically not significant in t-tests run with equal number of male and female participants. As mentioned earlier, the effect on T-test results due to change in the sample size of male and female participants is noteworthy.

Thus, it was found that female physiotherapists perceived statistically significant and higher health consequences from alcohol consumption, diet high in fat content, EMFs from outdoor sources and living near to nuclear power plants. According to Whitfield et al. (2009) gender, age and education have no impact on public attitudes towards nuclear power. However, Sjoberg and Drottz-Sjoberg (2009) reported that fear of exposure to radiation from nuclear waste significantly contributes to high risk perception from a nuclear power plant. In addition, Purvis-Roberts et al. (2007) reported that people other than nuclear scientists perceive high risk from living near to a nuclear power plant. Female physiotherapists' perception of high health consequences from high fat diet and alcohol consumption confirms that gender is an important factor in perception of health risk and associated consequences from obesity and alcohol consumption (Krewski et al., 2006; Kolbe-Alexander et al., 2008; Allman-Farinelli et al., 2010). In addition, obesity and alcohol consumption are major public health issues (James et al., 2001; van Baal et al., 2006; Flint et al., 2010), especially in the UK (National Audit Office, 2001; Department of Health, 2004; van Baal et al., 2006; Wanless et al., 2007; Martin, 2008) and in the NHS (Wanless et al., 2007; Boorman, 2009b).

In addition, the present study has revealed that the overall ranking for the mean ratings of perceived health consequences by male and female respondents could be similar or different depending on the nature of the risk item. Findings of the present study suggest that the average rating of perception of health consequences from risk factors differs by the gender of the respondent as well as by the nature of the risk factor.

5.2.6.3 Predictors of perception of health consequences

Results of a significant three step hierarchical multiple linear regression model showed that the gender, knowledge of EHI and perception of health risk were significant predictors of physiotherapists' perception of health consequences (Table 5.2. Gender and the knowledge of EHI explained 1.5 % and 1.4% of the variance, respectively, in the model and they were significant predictors; however in the third step when perception of the health risk variable was entered in the model they no longer remained significant, which might be due to the effect of the perception of health risk variable.

The finding of gender as a significant predictor of perception of health consequences is in agreement with other studies (Flynn et al., 1994; Davidson and Freudenburg, 1996; Bymes et al., 1999; Wester-Herber and Warg, 2002; Jardine et al., 2009). In addition, finding of the knowledge of EHI as a significant predictor of perception of health consequences was in agreement with earlier studies (Hay et al., 2005; Vandermoere, 2008).

The major significant predictor of perception of health consequences was perception of health risk, which explained 59% variance in the model. This may be due to the fact that the perception of health risk is explained by health consequences (Ricci and Cirillo, 1985; Slimak and Dietz, 2006; Aven and Eidesen, 2007); and therefore, the opposite can also be true and significant. This suggests that if the perception of health consequences expressed as harm is high then the perception of health risk will also be high and vice versa.

Overall, three predictors, mentioned above, when entered together in the regression equation explained about 62% variance in the perception of health consequences model, which was higher than the variance extracted in health risk perception models reported earlier (Sjoberg, 2000a). This was confirmed in regression path analysis using structural equation modelling. Goodness of fit statistics obtained for the 'perception of health consequences' model in SEM confirmed that the model fits to the data with Chi-square (χ^2) (1, N =361) = .519, p=.471, which was greater than p=.05, fit indices such as GFI, NFI, TLI, CFI, RFI and AGFI were > .90, PNFI was < .40 and RMSEA was = .000 (p=.638), which was less than the minimum required level of ≤.06 (p>.05) (Tabachnick and Fidell, 2007, p.716-17).

However, regression results in the SEM showed that only perception of health risk was significant predictor while gender and knowledge of EHI were not significant predictors. This finding was already observed in the results with linear multiple regression. The reason for the gender and knowledge of EHI becoming non-significant in the presence of perception of health risk was probably due to the strong correlation between the perception of health risk and perception of health consequences variables. However, there is a need for further study to know the reasons of non-significance of gender and knowledge of EHI in the presence of the perception of health risk variable.

5.2.6.4 Latent dimensions of perception of health consequences

Three latent (unmeasured) dimensions, also known as factors or constructs (Field, 2009; Hair et al., 2010) were identified by exploratory and confirmatory factor analyses of perception of health consequences from 21 risk factors. Identification of three latent dimensions / constructs confirmed constructs' unidimensionality

(Hair et al., 2010, p. 696), which is a part of construct validity, (Brace et al., 2009, p. 374). In addition, average variance extracted for each latent construct was higher than the squared inter construct correlations, which confirmed the divergent validity of the constructs (Fornell and Larcker, 1981; Farrell, 2010; Hair et al., 2010). After identification in the EFA and confirmation in the CFA, the latent dimensions were named as 'EMF and X-rays risks', 'lifestyle risks' and 'chemical and nuclear risks' on the basis of loaded items (Field, 2009).

5.2.6.4.1 EMF and X-ray risks

The EMF and X-ray risks construct consisted four items i.e. EMFs from home microwave, EMFs from hair dryers and hi fi systems, EMFs in physiotherapy departments and diagnostic chest X-ray (CXR). Significant loading of these items only on this construct showed unidimensionality of the construct (Hair et al., 2010, p. 696). The results revealed that Cronbach's α of this construct was .84 that was higher than the minimum Cronbach's α level of .70, which is required to confirm the reliability and internal consistency of a construct (Bowling, 2005, p. 397; Brace et al., 2009, p. 368); thus, the reliability and internal consistency of this construct was confirmed. In addition, the construct validity of this construct was .80, which established validity of the construct (Hair et al., 2010).

Findings of multiple linear regression showed that perception of health risk, perception of protection against risk, smoking and number of cigarettes smoked per day were statistically significant predictors during four steps in the model of perception of health consequences from 'EMF and X-ray' risks (Table 5.2). The perception of health risk was the major predictor of perception of health consequences from EMF and X-ray risks, which is in agreement with previous studies (Ricci and Cirillo, 1985; Moller et al., 2006; Slimak and Dietz, 2006;

Aven and Eidesen, 2007). All four predictors explained about 28% variance in the model and the perception of health risk contributed about 22% in the extracted variance, which is probably because risk is a function of harm and probability (Moller et al., 2006). Thus, the findings show that about 72% of variance in the model remained unexplained. There is therefore a need for further research to identify other predictors of perception of health consequences from EMF and X-rays risks.

5.2.6.4.2 Lifestyle risks

Lifestyle risks construct consisted of four items which included alcohol consumption up to and over the legal limit, obesity and passive smoking. Loading of all these items only on this construct confirmed unidimensionality of the construct (Hair et al., 2010, p. 696). Cronbach's α of this construct was .73, which was higher than the minimum Cronbach's α level of .70 required to confirm the reliability and internal consistency of a construct (Bowling, 2005, p. 397; Brace et al., 2009, p. 368). Thus, the reliability and internal consistency of the construct was established. The construct validity of this construct was .79, which was good and confirmed that the construct was valid (Hair et al., 2010).

Results of sequential multiple linear regression revealed a significant model of perception of health consequences from lifestyle risk factors, which was obtained in five steps and explained about 32% of the variance in the model. Predictors of perception of health consequences from lifestyle risks were gender, perception of protection from risk, quantity of alcohol consumed in a week, knowledge of EHI and perception of health risk (Table 5.2).

The main predictor of perception of health consequences from lifestyle risk factors was perception of health risk, which explained 17% variance, which was about 59% of the total variance explained in the final model. This was probably because the perception of health risk is the outcome of health consequences which is regarded as harm in risk perception; hence it determines the perception of health risk and vice versa.

Gender a well-known predictor of perception of health risk in general and lifestyle risks in particular (Lemyre et al., 2006) was significant up to step two; however, it became not significant at step three when quantity of alcohol consumption was entered into the model as well as in all subsequent steps. Knowledge of EHI was a significant predictor however it became not significant at the last (fifth) step when perception of health risk variable was entered into the model. Other significant predictor was perception of protection against health risk. It was interesting to find that quantity of alcohol consumed was negatively associated with perception of health consequences from lifestyle risk factors, which suggested that when the quantity of alcohol consumed increases the perception of health consequences decreases. Overall, lifestyle risks were found to be the highest rated risks with respect to the health consequences perspective, which is in agreement with previous studies that reported that lifestyle or social risks were the most hazardous risks (Lemyre et al., 2006).

5.2.6.4.3 Chemical and nuclear risks

The construct of perception of health consequences from chemical and nuclear risks comprised three items i.e. radioactive fallout from a nuclear power plant, exposure to industrial chemicals and living near to a nuclear power plant. The significant loading of all the three items only on this construct confirmed the unidimensionality of the construct (Hair et al., 2010, p. 696). The Cronbach's α of this construct was .74 which was higher than the minimum Cronbach's α level of

.70; hence, the reliability and internal consistency of this construct was confirmed (Bowling, 2005, p. 397; Brace et al., 2009, p. 368). The construct validity of this construct was .75, which was good and confirmed that the construct was valid (Hair et al., 2010).

Results of sequential multiple linear regression revealed a significant model for perception of health consequences from chemical and nuclear risk factors, which was achieved in three steps and explained about 25% of the variance in the model. Statistically significant predictors of perception of health consequences from chemical and nuclear risks are shown in Table 5.2. The main predictor of perception of health consequences from chemical and nuclear risks was perception of health risk, which explained about 22% of the variance, which was about 89% of the total variance explained, in the model. This is because the perception of health risk is seen as a function of health consequences, usually described as harm, from exposure to a risk factor (Moller et al., 2006). Therefore. it is the main determinant of the perception of health risk and vice versa. The other significant predictors of perception of health consequences from chemical and nuclear risks were smoking (Yes/No) and knowledge of EHI. All the predictors were significant through all steps of the regression model. It was interesting to find that smoking (Yes/No) was negatively associated with perception of health consequences from chemical and nuclear risks, which suggested that when smoking increases (which means non-smoking in this case) then the perception of health consequences decreases. This suggested that perception of health consequences from chemical and nuclear risks increase with smoking. More interestingly gender a well-known predictor of health risk was not a predictor of health consequences from chemical and nuclear risks.

5.2.7 Perception of protection against health risk

5.2.7.1 Perception of protection against health risk scale

The perception of protection from health risk scale comprised 15 risk items, which by nature were environmental and non-ionising and ionising radiation factors. The reliability of this scale was determined by Cronbach's α that was .786, which was good (Field, 2009, p. 681) and higher than the minimum cut-off level of .70 needed to establish the internal consistency and validity of a scale (Bowling, 2005, p. 397; Brace et al., 2009, p. 368); thus, internal consistency and validity of this scale was established.

Results of bivariate Pearson correlations showed that 'perception of protection from risk' was significantly and positively correlated only with 'perception of health risk' and significantly and negatively correlated only with 'highest education level'. These findings were important because these variables may act as significant predictors of perception of protection from health risk.

5.2.7.2 Rating of perception of protection against health risks

Results of physiotherapists' mean rating of their perceived protection against health risk from 15 risk factors revealed that the highest perception of protection against health risk was found for 'living near a nuclear power plant' which was different from the findings of a similar study by Shields et al. (2005), who found the highest perception of protection against health risk was from exposure to EMFs in the physiotherapy department. In the present study, the lowest mean rating of perceived protection against health risk was for 'radioactive fallout from a nuclear power plant', which is in agreement with the findings reported by Shields et al. (2005). In the present study, the mean rating of perceived protection against health risk from exposure to EMFs in the physiotherapy department was ranked as 2nd highest, which was one rank lower than the mean rating for the same risk factor reported by Shields et al. (2005).

The present study found some similarities and differences in the rating of perceived protection against health risk by male and female physiotherapists. Overall, the mean ratings of perceived protection against health risk by male physiotherapists were higher for all risk items except three items i.e. exposure to EMFs from home microwave oven, living near a mobile phone transmitter and exposure to EMFs from hair dryer and hi fi systems, which were rated higher by female physiotherapists. Statistically significant differences in average rating of perceived protection against health risk by male and female physiotherapists were determined by the t-tests (Orton et al., 2001).Using the full sample of research participants (N=390 with male =80 and female =310), t-test revealed a statistically and significant different mean rating only for exposure to radon gas (par11) (as mentioned earlier, all cases who reported ‘do not know’ for this item were excluded from analyses). The difference in mean ratings by male and female physiotherapists for all other items included in the perception of protection against health risk was not significant. To exclude the effect of unequal sample size of male and female physiotherapists, T-test for par11 (i.e. exposure to radon gas) was repeated using equal number of male and female physiotherapists. T-test results confirmed that the mean ratings by male and female physiotherapists for perception of protection against health risk from exposure to radon gas (par11) were statistically and significantly different (Appendix XII, section 8.12.3).

The present study also found that the overall ranking of rating for ten risk items was the same for both the male and female physiotherapists. In addition, the overall ranking of five items i.e. living near a mobile phone transmitter, EMFs from hair dryers and hi fi systems, living near an overhead power line, exposure to radon gas and radioactive fallout from a nuclear power plant was similar to the results found by Shields et al. (Shields et al., 2005).

Findings of the present study suggest that the average rating of perceived protection against health risk from risk factors differs by the gender of the respondent as well as by the nature of the risk factor. The present study has also revealed that the overall ranking for the mean ratings of perceived protection against health risk by male and female respondents could be similar as well as different depending on the nature of the risk item. However, the findings of the present study reveal that female physiotherapists perceived a low level of protection against risks, which confirms earlier findings that women perceive health risk higher than men (Hampson et al., 2000; Siegrist et al., 2005; Lemyre et al., 2006; Chauvin et al., 2007).

5.2.7.3 Predictors of perception of protection against health risks

Predictors of perception of protection from health risk were identified in a significant hierarchical multiple linear regression model which was achieved in four steps. Statistically significant predictors of perception of protection against risks are given in Table 5.2.

The findings showed that the major predictor of perception of protection from risk was the perception of health risk and a change of 1 SD in this variable increased perception of protection from health risk by .16 SD. The second most important predictor was the ‘highest education level achieved’; however, it was significantly and negatively associated with the ‘perception of protection against risk’, which suggested that when the education level increases the perception of protection from health risk decreases and vice versa. This confirms earlier findings that education was inversely related to the level of health risk perception (Slimak and Dietz, 2006; Chauvin et al., 2007). However, some research has reported that education has no impact on health risk perception (Yim and Vaganov, 2003), while other research (Al Shafaee et al., 2008) has found level of education to be a significant predictor of knowledge about risk factors and their complications as well as prevention. Another predictor that was negatively associated with the perception of protection against risk was gender (data for gender was coded as 1 = male and 2 = female), which suggested that perception of protection from health risk is lower in women compared to men. The finding of gender as a significant predictor of perception of health risk is in agreement with previous studies (Davidson and Freudenburg, 1996; Hampson et al., 2000; Siegrist et al., 2005; Lemyre et al., 2006; John and Mark, 2007; Blettner et al., 2009). The perception of value placed on health was significantly and positively correlated with the perception of protection against health risk and statistically and significantly contributed 1.2 % of the variance in the model. All predictors were significant in all four steps of the model, and when entered together in the regression equation explained about 6% variance (R^2 = .59) in the perception of protection from health risk model. This revealed that 94% of the total variance remained unexplained in the model; therefore, there is a need for a study to identify other statistically significant predictors that can explain the large variance in the perception of protection against specific health risks.

The regression path analysis using structural equation modelling (SEM) revealed goodness of fit statistics that confirmed the model fit to the data with Chi-square (χ^2) (4, N =361) = 3.093, p=.542, which was greater than p=.05, fit indices of GFI, NFI, TLI, CFI, and AGFI were > .90, RFI was .83, PNFI was .40 and RMSEA was = .000 (p=.841), which was less than the minimum required level of ≤.06 (p>.05) (Tabachnick and Fidell, 2007, p.716-17). In addition, all regression weights were significant (p<.05) in the model and confirmed extraction of 6% variance in the model, thus, SEM model confirmed the regression model of perception of protection against health risk.

5.2.7.4 Latent dimensions of perception of protection against health risk

Two latent dimensions, also known as factors or constructs (Field, 2009; Hair et al., 2010) were identified by exploratory and confirmatory factor analyses of perception of protection against health risk from 14 risk factors, which were environmental and electromagnetic radiation in nature. After identification in EFA and confirmation in CFA, the latent dimensions were named as 'Outdoor EMF risks' and 'Indoor EMF risks'' on the basis of items loaded on each construct (Field, 2009). Identification of the two latent dimensions / constructs confirmed unidimensionality of constructs (Hair et al., 2010, p. 696), which is a part of construct validity (Brace et al., 2009, p. 374). In addition, average variance extracted for each latent construct was higher than the squared correlations between the constructs, which confirmed the divergent validity of the constructs (Fornell and Larcker, 1981; Farrell, 2010; Hair et al., 2010).

5.2.7.4.1 Outdoor EMF risks

The outdoor EMF risks construct consisted of three items i.e. EMFs from mobile phone transmitter, overhead power lines and electricity sub-station. Significant loading of these items only on this construct showed unidimensionality of this construct (Hair et al., 2010, p. 696); hence, validity of the construct was confirmed (Brace et al., 2009, p. 374). Results revealed that Cronbach's α of this construct was .89 that was higher than the minimum Cronbach's α level of .70

required to confirm the reliability and internal consistency of a construct (Bowling, 2005, p. 397; Brace et al., 2009, p. 368); thus, the reliability and internal consistency of this construct was confirmed. In addition, the construct validity of this construct was .86, which confirmed that the construct was valid (Hair et al., 2010).

Results of bivariate Pearson correlations showed that 'perception of protection from outdoor EMF risks' was significantly and negatively correlated with the 'frequency of undertaking vigorous exercise', (which means that those who took vigorous exercise perceived less possibility to protect themselves from outdoor EMF risks), age (which means that older participants perceived less and younger participants perceived more possibility to protect themselves from outdoor EMF risks) and 'awareness of EHI' (which means those participants who were more aware of EHI perceived less possibility to protect themselves from outdoor EMF risks). These findings were important because the variables that were significantly correlated with perception of protection from outdoor EMF risks might act as significant predictors of it.

However, findings of multiple linear regression showed that age and highest education level were statistically significant and negatively associated predictors of perception of protection from outdoor EMF risks (Table 5.2). This confirmed findings of earlier studies that age and education were inversely related with the level of health risk perception (Slimak and Dietz, 2006; Chauvin et al., 2007) and with the perception of protection of health from risk revealed in this study. The two predictors explained about 5% variance in the model and the highest education level explained about 3% of the variance, which was about 74% of the total variance extracted in the model. The final model however revealed that age was the most important predictor, which was negatively correlated with the perception of protection from outdoor EMF risks. This suggested that when age increases, the perception of protection from outdoor EMF risks decreases. In other words, perception of protection from outdoor EMF risks is higher in young people compared to older people. The finding of age as the major predictor of perception of health risk is in agreement with previous studies (Ricci and Cirillo, 1985; Moller et al., 2006; Slimak and Dietz, 2006; Aven and Eidesen, 2007).

Overall, the findings of multiple regression showed that only 5% of the variance in the model of perception of protection against outdoor EMF risks was explained and 95% of the variance remained unexplained. There is therefore a need for a study to identify other predictors that can explain more variance in the perception of protection against health risk from outdoor EMFs.

5.2.7.4.2 Indoor EMF risks

The 'indoor EMF risks' construct consisted of three items i.e. EMFs from hair dryers and hi fi systems, EMFs from home microwave oven and EMFs in the physiotherapy department. Significant loading of these items only on this construct showed unidimensionality of this construct (Hair et al., 2010, p. 696); thereby confirmed validity of this construct (Brace et al., 2009, p. 374). Results revealed that Cronbach's α of this construct was .84 and was therefore higher than the minimum Cronbach's α level of .70 required to confirm the reliability and internal consistency of a construct (Bowling, 2005, p. 397; Brace et al., 2009, p. 368). In addition, the construct validity of this construct was .85, which confirmed that the construct was valid (Hair et al., 2010).

Results of bivariate Pearson correlations showed that 'perception of protection from indoor EMF risks' was significantly and positively correlated with the 'time since qualification', 'age', 'awareness of EHI' and 'knowledge of EHI'. These findings were important because the variables that were significantly correlated with perception of protection from indoor EMF risks might act as significant predictors.

Findings of multiple linear regression showed that 'age' and 'knowledge of EHI' were significant predictors of perception of protection from indoor EMF risks (Table 5.2). Both predictors were statistically significant and positively correlated with the outcome variable (i.e. indoor EMF risks) and they explained about 3.7% of the variance in the model. The 'knowledge of EHI' explained the highest the variance (about 2%) in the model. This confirms that knowledge, gained through education, was a significant predictor of risk perception (Zhang et al., 2011) and information seeking concerning risk factors (Al Shafaee et al., 2008). In addition, the knowledge (subjective, objective and expert) was a significant predictor of perception of hazard (Vandermoere, 2008) and the knowledge of risk factor(s) affects peoples' protective behaviour (van der Pligt, 1996). It is important to highlight that one of the items loaded onto the indoor EMFs model was exposure to EMFs in the physiotherapy department. Physiotherapists have knowledge about the issue of EMFs in the physiotherapy departments. Therefore, finding that 'knowledge of EHI' is a significant predictor of perception of protection against health risk is self-explanatory and acceptable.

Overall, the findings of multiple regression analysis showed that only about 4% variance was explained whereas about 96% of variance in the model of perception of protection against indoor EMF risks remained unexplained. There is therefore a need for a study to identify other predictors that can explain greater variance in the perception of protection against health risk from outdoor EMFs.

5.3 Limitations of Study

The present study has some limitations. The sample size of physiotherapy departments is small and limited to a few regions such as Greater London, south east and south west of England. The findings of the study therefore cannot be generalised to whole of England. In addition, all of these departments were in the NHS; therefore, the findings might reflect practices within the NHS hospitals and clinic. However, there is a substantial number (at least 360) of physiotherapy practices within the private sector in the UK (Private Healthcare UK, 2011) and the practices and procedure in these departments may be studied.

Similarly, risk perception survey involving 390 cannot be fully representative of either all physiotherapists working in the NHS or the all chartered physiotherapists registered with the CSP. In addition, physiotherapists working in the private sector were excluded hence their risk perception remain unknown.

Moreover, all items included in the perception of risk scale and perceptions of health consequences scale were not included in the perception of protection against risk scale such as the lifestyle related factors. Moreover, the number of risk factors for some categories of potential risk was very little for example there were only two travel related factors i.e. air and train travel. The risk perception questionnaire therefore needs addition of other risk factors, especially risk factors related to workplace and occupations.

5.4 Summary

This chapter provided discussion on the findings of this study with reference to other published studies. Findings of this study showed that study of the practices and procedures in physiotherapy departments has revealed ultrasound as the most commonly available and commonly used electrotherapy modality, a decline in the use of some electrotherapy modalities such as the CSWD, non-use despite availability of devices of some modalities such as PSWD, SCWD and laser, occurrence of EMI between electrotherapy devices and between electrotherapy devices and other electrical equipment were in agreement with previous studies. A new finding was the total absence and non-use of MWD equipment within the surveyed departments. This finding was novel because the researcher could not find any published literature that reported the none-availability and none-use of MWD prior to publishing of the findings of the present study in 2007 by the researcher (Shah et al., 2007). However, it might be possible that physiotherapists were aware about this issue; hence, this finding might not seem to be a novel finding for them.

Findings of risk perception survey showed that survey questionnaire was reliable and all items and scales were valid and possessed internal consistency. The mean ratings, on perception of health risk and health consequences scales, for exposure to EMFs in physiotherapy departments were lower than other EMF items except two items about exposure to EMFs at home. However, mean ratings of the perception of protection against health risk from exposure to EMFs in physiotherapy departments were higher than other items about EMFs. This suggested the participant physiotherapists in this study saw low health risk as well as low level of health consequence from exposure to EMF emissions arising from electrotherapy devices. In addition, this study has shown that the physiotherapists rated higher level of the protection against risk, which suggested that they saw self-protection usually possible from exposure to EMFs in physiotherapy department. Conclusions of this study and recommendations for future research are presented in the next chapter.

6 CONCLUSIONS, CONTRIBUTIONS AND RECOMMENDATIONS

This chapter presents conclusions and contributions of the present study and provides recommendations for future research.

6.1 Conclusions

The conclusions of this study are in two parts. The first part addresses the study of physiotherapists' practices and procedures within physiotherapy departments. The second part presents conclusions vis-à-vis physiotherapists' perception of health risk, health consequences and protection against risk from exposure to EMFs in physiotherapy departments and a number of other known health risk factors.

6.1.1 Physiotherapists' practices and procedures

6.1.1.1 Electrotherapy devices

Electrotherapy equipment availability and use varied with the types of EPAs and between physiotherapy departments. In this study, the use of MWD devices had ceased in the surveyed departments. Ultrasound devices were available in all departments in the present study and was the most frequently used EPA, although not used in all departments. The devices of all other EPAs were available and used to a varying degree in the departments. The overall order of the availability and frequency of use of EPA was ultrasound > interferential > PSWD > biofeedback > TENS > laser > CSWD > H-wave. In addition, there was non-use despite availability of some EPAs, in the order of CSWD > PSWD > laser and biofeedback. The non-use of laser and biofeedback was equal. Overall, the use of electrotherapy with diathermy modalities is declining, which is evident from the cessation of use of MWD and rare use of CSWD.

6.1.1.2 Physiotherapists' workplace

Physiotherapists' practices and procedures regarding their health and safety and use of electrotherapy were generally good. However, the audit of electrotherapy including equipment and physiotherapists' practices and procedures with respect to the use of electrotherapy is not common. This study found that a wooden plinth was not always used for electrotherapy with PSWD and CSWD and large metallic objects such as radiators and filling cabinets were present in some of the treatment cubicles / rooms that were used for electrotherapy.

6.1.2 Physiotherapists' perception of health risk

6.1.2.1 Risk perception questionnaire

The present study adapted a risk perception questionnaire and determined the reliability, internal consistency and validity of scales of perception of health risk, perception of health consequences and perception of protection against risk. The present study identified and confirmed latent factors of perception of health risk, perception of health consequences and perception of protection against risk.

6.1.2.2 Physiotherapists' general health status

The present study found that physiotherapists were conscious of their health, performed physical exercise regularly, placed good value on their current health status and reported that they had a balanced diet. They were mainly non-smokers but consumed alcohol. They reported that they were aware and knowledgeable about environmental and health issues, in general. The BMI statistics of physiotherapists showed that about 18.5% were overweight (BMI = 25-30) and 3.3% were obese (BMI>30) but these figures were less than the overweight and obesity in the general population in the country.

6.1.2.3 Physiotherapists' perception of health risk

Physiotherapists' rating of 23 risk factors revealed that they perceived the highest health risk from driving with twice the legal limit of alcohol, which was rated as a very high risk (mean = 4.8 ± 0.587) and the lowest health risk (mean =1.8 ±0.62) from exposure to EMFs from hair dryers and hi fi systems. Physiotherapists perceive a moderate health risk (mean = 2.4 ± 0.78) from exposure to EMFs in physiotherapy departments. Overall, physiotherapists perceive health risk from EMFs in physiotherapy departments (occupational risk) *lower* than risk from exposure to EMFs from living near to an electricity sub-station, overhead power lines, using mobile phones and living near to a mobile phone transmitter. Of the seven sources of EMFs asked about in the survey, physiotherapists perceive highest health risk (mean = 2.99 ±0.97) from living near to a mobile phone transmitter.

Multiple linear regression and structural equation modelling were used to identify any statistically significant models for perception of health risk, perception of health risk from EMFs, perception of health risk from lifestyle risks and perception of health risk from chemical and nuclear risks, along with statistically significant predictors. Gender was a statistically significant predictor of perception of health risk as well as perception of health risk from EMFs and perception of health risk from lifestyle risks; however, gender was surprisingly not a statistically significant predictor of perception of health risk from chemical and nuclear risks. Another statistically significant predictor of perception of health risk was the awareness and knowledge of environmental and health issues, which was a statistically significant predictor of perception of health risk from EMFs and perception of health risk from lifestyle risks; however, it was not a statistically significant predictor of perception of health risk from chemical and nuclear risks. More importantly, the perception of health consequences was found to be the major predictor of perception of health risk as well as the main predictor of perception of health risk from EMFs, lifestyle risks and chemical and nuclear risks.

The above-mentioned respective predictors explained a total 63% of the variance in the perception of health risk, 31% of the variance in the model of perception of health risk from EMFs, 24% of the variance in the perception of lifestyle risks, and 23.5% of the variance in the perception of chemical and nuclear risks.

6.1.2.4 Physiotherapists' perception of health consequences

Ratings of health consequences for 22 risk factors by physiotherapists revealed that physiotherapists perceive the highest health consequences from smoking, which was rated as very severe harm (mean = 4.5 ±0.62) and the lowest health consequences from exposure to EMFs in the home from hair dryers and hi fi systems, which was rated as low harm (mean = 1.7 ±0.69). Physiotherapists perceive health consequences from exposure to EMFs in physiotherapy departments as low harm (mean = 2.2 ±0.78). Physiotherapists perceive health consequences from exposure to EMFs in physiotherapy departments higher than from EMFs in the home from hair dryers and hi-fi systems and home microwave ovens but lower than from EMFs associated with living near to an electricity sub-station, overhead power lines, using mobile phones or living near to a mobile phone transmitter. Physiotherapists perceive the highest health consequences (mean = 2.7±1.04) from exposure to EMFs associated with living near to an electricity substation of the seven sources of exposure to EMFs included in this survey.

Statistically significant models and predictors of perception of health consequences from risk factors and the latent constructs i.e. EMFs and X-ray risks, lifestyle risks and chemical and nuclear risks, were identified using multiple linear regression and structural equation modelling.

Perception of health risk was the major predictor of perception of health consequences from risk factors, perception of health consequences from EMF and X-rays risks, perception of health consequences from lifestyle risks and perception of health consequences from chemical and nuclear risks. Gender and knowledge of EHI were weak predictors of perception of health consequences from risk factors, perception of health consequences from EMFs and X-rays risks and lifestyle risks. The perception of protection against risk was a significant predictor of perception of health consequences from EMF and X-ray risks and lifestyle health risks.

The total variance explained by the aforementioned respective predictors was 62% in the perception of health consequences model, about 26% in the perception of health consequences from EMFs and X-ray risks model, 32% in the perception of health consequences from lifestyle risks model and 27% in the perception of health consequences from the model for chemical and nuclear risks.

6.1.2.5 Physiotherapists' perception of protection against health risk

Physiotherapists’ perception of protection against health risk from exposure to 15 risk items included in this survey revealed that physiotherapists perceived protection against health risk as highest with respect to living near a nuclear power plant, with a mean rating of 3.65(±1.21), which suggested that protection is usually possible according to the scale values in the present study. Physiotherapists’ have the lowest perception of protection against health risk from exposure to radioactive fallout from a nuclear power plant with a mean ranking of 2.2 (±1.22), which means protection is rarely possible according to the scale values in the present study.

Overall, physiotherapists perceive the possibility of protection against health risk from EMFs in physiotherapy departments higher than the protection against health risk from the other five sources of exposure to EMFs i.e. living near an electricity sub-station, the home microwave, living near a mobile phone transmitter, hair dryers and hi-fi systems, and living near an overhead power line. Of the six items on sources of exposure to EMFs asking for physiotherapists' perception of protection against health risks, the highest mean rating was for exposure to EMFs in physiotherapy departments with a mean rating of 3.61(±.97) and the lowest mean rating was for living near an overhead power line with a mean rating of 3.17 (±1.16). According to the scale values used in this study, the above-mentioned mean values of physiotherapists' ratings show that physiotherapists perceive protection against health risks usually possible from exposure to EMFs in physiotherapy departments and protection against health risks sometimes possible from living near an overhead power line.

Significant models and predictors of 'perception of protection against risk' with the two latent constructs i.e. perception of protection against risk from indoor EMFs and perception of protection against risk from outdoor EMFs, were identified using multiple linear regression and structural equation modelling.

Statistically significant predictors of perception of 'perception of protection against risk' were 'perception of health risk,' gender, education and value placed on good health. Among these predictors, 'perception of health risk' was the major predictor, which was positively correlated with 'perception of protection against risk’. Gender (coded as male = 1 and female = 2) and education were negatively correlated with the perception of protection against health risk, which suggested that being female and having less education was associated with greater perception of protection against risk to health’.

Statistically significant predictors for perception of protection against risk from outdoor EMFs were age and highest education level. For perception of protection against risk from indoor EMFs, age and knowledge of environmental and health issues were statistically significant predictors. Among the aforementioned predictors, age was negatively correlated with perception of protection against health risk from outdoor EMFs (i.e. Exposure to EMFs from living near to a mobile phone transmitter, an overhead power line and an electricity sub-station) and perception of protection against health risk from indoor EMFs (i.e. exposure to EMFs in home from hair dryers, hi-fi systems and microwave ovens and EMFs in physiotherapy departments). The highest education level was a negatively correlated predictor of perception of protection against risk from outdoor EMFs, which suggested that those with the highest education had the lowest perception of protection. Knowledge of environmental and health issues was a significant and positively correlated predictor of perception of protection against risk from indoor EMFs, suggesting that those with the highest knowledge of environmental and health issues had the highest perception of protection from indoor EMFs.

The total variance extracted in the models of (and by the respective predictors of) perception of protection against health risk (in general) and its latent constructs i.e. perception of protection against risk from outdoor EMF risks and perception of protection against risk from indoor EMF risks was 6%, 4.3% and 3.7%, respectively. The total variances explained in the above-mentioned models show that the personal factors can explain only small variances (≤ 6%), which might suggest that variables explaining the largest variances in perception of protection against health risk in general and perception of protection against risk from specific exposures such as outdoor EMFs indoor EMFs are perhaps external to an individual's personal characteristics. It might be possible that external factors such as governments (local, regional and central) and other organisations might play a major role in explaining protection against health risk from different sources including outdoor and indoor EMFs.

6.2 Contributions

The present study has made following contributions to the body of knowledge.

a) Development, validation and successful application of the practices and procedures survey questionnaire for studying the availability and use of electrotherapy equipment, physiotherapists' practices and procedures in the safe use of electrotherapy and physiotherapy workplace issues from the occupational health and safety perspective.

b) Contributions to the body of knowledge by updating literature on the use of electrotherapy by studying equipment availability, use and non-use despite equipment being available in NHS physiotherapy departments / clinics in southeast and southwest of England.

c) Contributions to the occupational health and safety literature by the study of the safe practices in the use of electrotherapy devices, safety of users (physiotherapists) of electrotherapy equipment with respect to professional guidelines regarding safe use of electrotherapy, and physical features of physiotherapy workplace from the physiotherapists' occupational health and safety perceptive.

d) Adaption, validation and application of the health risk perception questionnaire from occupational health and safety perspective of physiotherapists.

e) Contributions to the body of knowledge through the literature on health risk perception by studying NHS physiotherapists' perception of health risk, perception of health consequences and perception of protection against risk to health from exposure to a number of hazards.

f) Systematic and statistical identification and confirmation of latent dimensions / constructs of perception of health risk (i.e. EMF risks, lifestyle risks and chemical and nuclear risks), perception of health consequences (i.e. EMF and X-rays risks, lifestyle risks and chemical and nuclear risks) and perception of protection against health risk (i.e. outdoor EMF risks and indoor EMF risks).

g) Statistical modelling of physiotherapists' perception of health risk, perception of health consequences and perception of protection against health risk and the latent dimensions / constructs (as mentioned in bullet point (f) above) from hypothesis development through to confirmation by statistically significant regression models and structural equation models,.

h) Identification of statistically significant predictors of physiotherapists' perception of health risk, perception of health consequences and perception of protection against health risk and latent dimensions, as mentioned above.

i) Development and successful application of a multi method research design for studying occupational health and safety of workers, particularly healthcare professionals who are exposed to EMFs such as MRI operators

6.3 Recommendations

In the light of the findings of this study, a number of recommendations for further research are as follows.

6.3.1 Occupational health and safety

6.3.1.1 Occupational health and safety in private physiotherapy practices

Generally, studies on electrotherapy equipment availability and use conducted in the UK did not include private physiotherapy practices. There are about 360 physiotherapy practices (Private Healthcare UK, 2011) and about 4000 physiotherapists working in the private sector in the UK (Physio First, 2011). Therefore, future research may study practices and procedures in the use of electrotherapy in private physiotherapy practices from the occupational health and safety perspective.

6.3.2 Perception of health risk

The following are recommendations for further research in the field of health risk perception. These recommendations are focused on health risk perception and health and safety research in general.

6.3.2.1 Risk perception questionnaire

The risk perception questionnaire used in the present study has a maximum of 23 different risk factors that can be broadly divided into three categories i.e. EMF risks, lifestyle risks and chemical and radiation risks. There is therefore a need to expand it by including other risk factors related to the above-mentioned three types of risks as well as the addition of risk factors related to other types of risks such as exposure to EMFs from MRI machine and photocopiers. In addition, this questionnaire needs addition of other variables such as trust and locus of control as these are well known predictors of risk perception. Further studies will be required for validation if the risk perception questionnaire is revised.

6.3.2.2 Perception of health risks

The findings of the present study show that about 69% of variance in the model of perception of health risks from EMFs remained unexplained; therefore, there is a need for further research to identify other statistically significant predictors of perception of the health risk from exposure to EMFs, particularly in the workplace.

6.3.2.3 Perception of health consequences

In the present study, the regression model of perception of health consequences showed that gender and the knowledge of environmental and health issues were statistically significant predictors that explained 1.5 % and 1.4% of the variance, respectively, in the model. However, when perception of the health risk variable was entered into the model gender and the knowledge of environmental and health issues were not statistically significant, which might be due to the effect of the perception of the health risk variable. However these only explained 1.5% and 1.4% of the variance; hence, there is a need for further study to identify other statistically significant predictors of perception of health consequences from exposure to risk factors.

The findings of the present study also revealed that about 72% of the variance in the model of perception of health consequences from EMF and X-rays risks remained unexplained. There is therefore a need for further research to identify other statistically significant predictors of the perception of health consequences from EMF and X-rays risks.

6.3.2.4 Perception of protection against risk

The present study revealed that in the model of perception of protection from health risk only 6% of the variance was explained while 94% of the variance remained unexplained. There is therefore a need for further research to identify other statistically significant predictors that can explain large variance in the perception of protection against health risk.

In addition, the findings of the present study showed that only 5% of the variance in the multiple regression model of perception of protection against outdoor EMF risks could be explained while 95% of the variance remained unexplained. There is therefore a need for a study to identify other statistically significant predictors that can explain more variance in the perception of protection against health risk from outdoor EMFs.

6.4 Summary

Physiotherapy departments report good and safe practices and procedures during treatment with electrophysical agents. However, observations of the physiotherapy workplace can identify that electrotherapy with PSWD and CSWD is not always given on a wooden plinth or couch. In addition, large metallic objects e.g. radiators and filling cabinets, are present in the treatment cubicles / rooms that are used for electrotherapy with PSWD and CSWD, which can lead to reflection and enhancements of RF EMF emissions from the devices of the aforementioned diathermy modalities. The above-mentioned two factors might become a source of health risk to physiotherapists and patients within the treatment cubicles / rooms during electrotherapy with shortwave diathermy.

Physiotherapists are generally conscious of health, safety and fitness issues and the presence of overweight and obesity among most is lower than in the general population in the UK. Physiotherapists generally perceive a moderate health risk and health consequences (harm) from exposure to EMFs in physiotherapy departments. In addition, physiotherapists perceive that protection against health risk from EMFs at their workplace is usually possible. Therefore, it can be concluded that physiotherapists are generally not worried about their exposure to EMFs in their occupational environment because of their expertise in their field.

The present study has contributed to the body of knowledge by development and validation of a questionnaire about physiotherapists' practices and procedures in the safe use of electrotherapy; survey of electrotherapy equipment availability; use and non-use despite equipment availability in NHS physiotherapy departments; study of physiotherapist's workplace and use of electrotherapy equipment from the occupational health and safety perspective. The other contributions include adaption and application of a risk perception questionnaire; study of physiotherapists' perception of health risk from exposure to 23 hazards, perception of health consequences from exposure to 22 hazards and perception of protection against risk from exposure to 15 hazards. In addition, identification and confirmation of three latent dimensions / constructs from 23 items included in the perception of health risk, three latent dimensions from 22 items included in perception of health consequences and two latent dimensions from 15 items included in the perception of protection against health risk. Additional contributions are development of statistical significant regression and structural equation models of summated variables and latent dimensions of perception of health risk, perception of health consequence and perception of protection against health risk and identification of statistically significant predictors of summated variables and latent dimensions of perception of health risk, perception of health consequence and perception of protection against health risk.

Future research may include a study of private physiotherapy practices from the occupational health and safety perspective and further studies to identify predictors that can better explain the variance in the perception of health risk, perception of health consequences and perception of protection against health risk from occupational exposure to EMF risks, nuclear and radiation risks, and chemical risks.

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8 APPENDICES

8.1 Appendix I: Research Grant Letter

Brunel Enterprise Centre

BRUNEL UNIVERSITY

Uxbridge, Middlesex, UB8 3PH
United Kingdom
Direct Telephone +44 (0) 1895 816273
Switchboard: +44 (0) 1895 274000
Fax: +44 (0) 1895 203099

Richard Thorpe
Research Strategy Unit
Health & Safety Executive
PO Box 1064
Sheffield
S3 7YB

22 March 2002

Dear Richard,

Re: Research Contract (4371/R47.022) 'Assessment of EmF Exposures of Physiotherapists Working in Hospital Departments

Thank you for your offer of contract on 12th March. I can confirm that the University wishes to accept the offer, please find enclosed the two signed agreements as Brunel's acceptance.

Further to our acceptance, I must confirm that it is unlikely that Dr Alex Farrow will be able to appoint the Research Assistant in time for the agreed project start date of 15th April. Under normal HEI recruitment procedure this could take up to three months, although, it is hoped that an appointment can be made at an earlier date. I understand from yourself that because of the delay in the issue of the contract to the University, the Executive will allow the Research Assistant to start after the 15th April provided that the this does not delay the delivery of the first HSE report due within the first five months of the project - Dr A Farrow confirms that the research will commence on the 15th April and that accordingly the reporting will be produced in accordance with the project schedule.

Finally, on behalf of the University I would like to take this opportunity to thank the Executive for its support of this research project. I now look forward to receiving a countersigned copy of the Agreement from the Executive shortly.

Yours faithfully,

Patrick Meaney
Research Contracts Officer

Enc: 2 signed copies of the contract
Cc: Dr A Farrow, Dept. of Health & Social Work
File

8.2 Appendix II: Ethics Approval by NHS Research Ethics Committee

APPENDIX 1

Multi-Centre Research Ethics Committee for Wales

MREC for WALES

Pwyllgor Ymchwil Ethegau Aml-Ganolfan yng Nghymru

Chairman/Cardeirydd: Dr John Saunders

Administrator/Gweinyddes: Corinne Scott

Temple of Peace and Health, Cathays Park, Cardiff CF10 3NW
Teml Heddwch ac Iechyd, Parc Cathays, Caerdydd CF10 3NW

WHTN 0 1809 Telephone enquiries to: 029 2040 2455 Fax No. 029 2040 2504

MREC website: http://ds.dial.pipex.com/mrec
e-mail : corinne.scott@bro-taf-ha.wales.nhs.uk

Dr. Alexandra Farrow,
Department of Health and Social Care,
Brunel University,
Brough Road,
Isleworth TW7 5DU

March 26th 2002

Dear Dr. Farrow,

Research Protocol MREC 02/9/04 (Please quote this in all correspondence)
Assessment of Electric and Magnetic Field Exposure of Physiotherapists

I have reviewed the documents submitted in response to the MREC for Wales decision made at its meeting held on March 14th 2002, and set out in our letter dated March 20th 2002.

The documents reviewed were as follows:
(By full Committee at its meeting held on March 14th 2002)

- Full application form, including Annexe C
- Full protocol and references
- ~~Letter of invitation to physiotherapists, undated~~ **Superseded**
- ~~Perception of Risk Questionnaire, dated 2002~~ **Superseded**
- Curriculum Vitae for Principal Researcher, Dr. Alexandra Farrow.

(By Chairman)

- Revised letter to Physiotherapists
- Perception of Risk Questionnaire 2002

As Chairman, acting under delegated authority, I am satisfied that these accord with the decision of the Committee and agree that there is no objection on ethical grounds to the proposed study. I am, therefore, happy to give you our approval on the understanding that you will follow the conditions of approval set out below. A full record of the review undertaken by the MREC is contained in the attached Response Form. The project must be started within three years of the date on which MREC approval is given.

- You must follow the protocol agreed and any changes to the protocol will require prior MREC approval.
- If projects are approved before funding is received, the MREC must see, and approve, any major changes made by the funding body. The MREC would expect to see a copy of the final questionnaire before it is used.
- You must promptly inform the MREC of:

(i) deviations from or changes to the protocol which are made to eliminate immediate hazards to the research subjects;
(ii) any changes that increase the risk to subjects and/or affect significantly the conduct of the research;
(iii) all adverse drug reactions that are both serious and unexpected;
(iv) new information that may affect adversely the safety of the subjects or the conduct of the trial.

- You must complete and return the standard progress report form to the MREC one year from the date on this letter and thereafter on an annual basis. This form should also be used to notify the MREC when your research is completed.

While the MREC has given approval for the study on ethical grounds, it is still necessary for you to obtain management approval from the relevant Clinical Directors and/or Chief Executive of the Trusts (or Health Boards/HAs) in which the work will be done.

LREC Review

When undertaking the review of your project the MREC observed that this study falls under the Supplementary Operational Guidelines for NHS Research Ethics Committees, published in November 2000. This study is classed as Category C research, and therefore does not require LREC review.

For this reason you are asked to only inform the appropriate LREC of the project by sending a copy of this letter and also **giving the name and contact details of the local clinician involved.** If (unusually) the LREC has any reason to doubt that the local clinician is competent to carry out the tasks required, it will inform the clinician and the MREC that gave ethical approval giving full reasons.

You are not required to wait for confirmation from the LREC before starting your research.

Whilst the MREC would like as much information as possible about local sites at the time you apply for ethical approval it is understood that this is not always possible. You are asked, however, to send details of local sites as soon as a researcher has been recruited. This is essential to enable the MREC to monitor the research it approves.

The MRECs are fully compliant with the International Conference on Harmonisation/Good Clinical Practice (ICH GCP) Guidelines for the Conduct of Trials Involving the Participation of Human Subjects as they relate to the responsibilities, composition, function, operations and records of an Independent Ethics Committee/Independent Review Board. To this end it undertakes to adhere as far as is consistent with its Constitution, to the relevant clauses of the ICH Harmonised Tripartite Guideline for Good Clinical Practice, adopted by the Commission of the European Union on 17 January 1997. The Standing Orders and a Statement of Compliance were included on the computer disk containing the guidelines and application form and are available on request or on the Internet at http://dspace.dial.pipex.com/mrec.

Yours sincerely,

Dr. John Saunders
Chairman
MREC for Wales

ENCS : MREC Response Form and Attendance List for MREC Meeting of March 14th 2002.

8.3 Appendix III: Ethics Approval by Brunel University

APPENDIX 2

Faculty of Life Sciences
Head of Department of Health and Social Care
Professor Lorraine De Souza PhD, MSc, BSc, GradDipPhys, FCSP, SRP
Chair of Rehabilitation

BRUNEL UNIVERSITY

Osterley Campus
Borough Road
Isleworth, Middlesex TW7 5DU
United Kingdom
Telephone (020) 8891 0121
Fax (020) 8847 2030

4 March 2002

Departmental Research Ethics Advisory Committee
Department of Health & Social Care
Faculty of Life Sciences

To Whom It May Concern

Re: Research Proposal: Assessment of Electric and Magnetic Field Exposure of Physiotherapists Currently Working in Hospital Departments

Principal Investigator: Dr A Farrow

By this letter, notification is provided that the research proposal detailed as above has satisfied the requirements of the Departmental Research Ethics Advisory Committee.

Yours Sincerely,

D. Anderson - Ford

David Anderson-Ford
Chair, Departmental Research Ethics Advisory Committee
Department of Health & Social Care

8.4 Appendix IV: Introductory Letter to Physiotherapy Managers

Department of Health & Social Care,
Brunel University,
Osterley Campus,
TW7 5DU
Tel:0208-891-0121 ext. 2523
Fax: 0208-847-2030
Date ……………

……………………………
Physiotherapist Manager
………………..…Hospital,
………………………….
…………………………..

Dear ……………

Further to my telephone call today, I am writing with further details of a study of physiotherapy departments in the UK where the therapists' immediate environment is being investigated for the use of electrotherapy equipment such as shortwave or ultrasound. The study is sponsored by a research grant from the Health and Safety Executive and is being carried out at Brunel University in the Department of Health and Social Care. It has been approved by a multi-centre research ethics committee (Research protocol 02/9/04) and is also supported by the CSP.

The research involves completion of a questionnaire and observations in 46 physiotherapy departments that use any electrotherapeutic modalities, (even though this may be infrequent). The researcher visiting the Department will be Dr Shah, a medical research fellow who is directly employed on the project.

We will send a questionnaire if you are happy to take part. We hope it can be completed by consensus by physiotherapists who use electrotherapy equipment. The visit by Dr Shah would involve about 30 minutes for discussion and observations in the part of the department where electrotherapy (interferential, shortwave, ultrasound etc.) takes place. It is not necessary for electrotherapy to be in use during the visit but it would be useful to talk to a physiotherapist who has used the equipment. During the visit information on the number of machines, size of room, partitions between machines, other electrical equipment in place, interference when the modality is in use, number of people in the room, etc. would be ascertained. Dr Shah will also answer any questions that arise from the questionnaire.

If you would like to discuss this with me in more detail, please telephone me on the above number. If you are happy to proceed, please complete the attached form and return it to me by fax or in the enclosed envelope. I will then contact you to make an appointment for the visit that we would like to make as soon as possible.

Thank you for your help.

Yours sincerely,

Dr Alexandra Farrow (BSc, MSc, PhD, MRSC)
Senior Lecturer, Department of Health & Social Care
e-mail: alexandra.farrow@brunel.ac.uk

8.5 Appendix V: Consent Form

Department of Health & Social Care,
Brunel University,
Osterley Campus,
TW7 5DU
Tel: 0208-891-0121 ext. 2523
Fax: 0208-847-2030

Date …………..

Study of Electrotherapy Environment in Physiotherapy Departments

I am able to consent to this physiotherapy department taking part in the above study.

I understand that information from this study will only be used for the purposes of research, will remain strictly confidential and all departments will remain anonymous.

Name ____

Signature ____

Date ____

Hospital(s) ____

8.6 Appendix VI: Practices and Procedures Questionnaire

Assessment of Electromagnetic Field Exposure

of

Physiotherapists Working in Hospital Departments

Practices and Procedures Questionnaire

2002-03

Please complete and return to

Dr Alex. Farrow

Department of Health and Social Care

Brunel University, Osterly Campus

Isleworth, Middlesex

TW7 5DU

Name of Department-- Date---

Please complete appropriate box for each modality

Date		Short-wave Diathermy		Interferential	Microwave Diathermy	LASER	Ultrasound	TENS	Biofeedback	H-wave
		Continuous Diathermy	Pulsed Diathermy							
1	Number of machines in the department									
2	Machine Make and Model									
3	Machine Manufacturer									
4	Mode and Output									
5	Order of use (1= most commonly used, 9=least used)									
6	Length of treatment time (average min)									
7	Operator distance from machine when in use (metres)									
8	Near metallic surfaces (Yes/No)									
	- If yes, distance from machine being used									
9	Type of partition between units (wall, curtain, other)									
10	No. of persons in room (patients & staff) during use									
11	Size of cubicle / room for treatment (metres)									
12	How often equipment is maintained									
13	Who is responsible for maintenance?									
14	Ever seen /used handbook or manual on device use									
15	Ever had safety training or instructions for safe use									
16	Treatment plinth/chair/stool (circle) (Metal =M / Wood =W)	M / W	M / W	M / W	M / W	M / W	M / W	M / W	M / W	M / W

7. How many times a month do you use continuous short wave diathermy?

Every day ☐ 2/3 days a week ☐ 1 / week ☐ less than 1 / week ☐ Never ☐

17a. If NEVER, please comment on why ……

18. How many times a month do you use pulsed shortwave diathermy?

Every day ☐ 2/3 days a week ☐ 1 / week ☐ less than 1 / week ☐ Never ☐

18a. If NEVER, please comment on why ……

19. What method of application / electrodes do you use most commonly for any shortwave diathermy?

Monode / circuplode ☐ Flexi electrode ☐ Rigid ☐ Combination of flexi / rigid ☐

20. Which technique do you most commonly use?

Contraplaner ☐ Coplaner ☐ Monode ☐

21. What parameters do you normally use for your PSWD treatment?

Acute Pulse width………………Pulses per second……………………………Power setting………………….

Sub-acute Pulse width………………Pulses per second……………………………Power setting………………….

Chronic Pulse width………………Pulses per second……………………………Power setting………………….

22. At what mean intensity do you think a thermal effect occurs. In Watts…………

23. Any restrictions / contraindications to shortwave/pulsed shortwave diathermy? If yes then please state……………………………………………………………..

24. Why would you choose SWD/PSWD in preference to other modes of treatment? Please comment...

25. **Contraindications for Patients and Physiotherapists using the specific modality**

Please tick only those that apply

	Pulsed Short-wave Diathermy		*Continuous Short-wave Diathermy*		*LASER*		*Biofeedback*		*TENS*	
	Patient	*Physiotherapist*	*Patient*	*Physiotherapist*	*Patient*	*Physiotherapist*	*Patient*	*Physiotherapist*	*Patient*	*Physiotherapist*
Infection / TB (active)										
Pregnancy										
Skin conditions										
Anticoagulants										
DVT										
Malignancy*										
Metal in tissues										
Cardiac pacemaker										
Fever										
Menstruation										
Epilepsy										
Cardiac arrhythmia										

	Microwave diathermy		*Ultrasound*		*Interferential*		*H-wave*		
	Patient	*Physiotherapist*	*Patient*	*Physiotherapist*	*Patient*	*Physiotherapist*	*Patient*	*Physiotherapist*	
Infection / TB (active)									
Pregnancy									
Skin conditions									
Anticoagulants									
DVT									
Malignancy*									
Metal in tissues									
Cardiac pacemaker									
Fever									
Menstruation									
Epilepsy									
Cardiac arrhythmia									

* Past or present

8.7 Appendix VII: Practices and Procedures Questionnaire – Revised

Assessment of Electromagnetic Field Exposure

of

Physiotherapists Working in Hospital Departments

Practices and Procedures Questionnaire

2002-03

Please complete and return to

Dr Alex. Farrow

Department of Health and Social Care

Brunel University, Osterly Campus

Isleworth, Middlesex

TW7 5DU

Please complete appropriate box for each modality

Date		*Continuous Shortwave diathermy*	*Pulsed Shortwave diathermy*	*Interferential Therapy*	*Microwave Diathermy*	*Biofeedback*	*Ultra-sound*	*TENS*	*LASER*	*H-wave*
		1	2	3	4	5	6	7	8	9
1	Number of machines in the department									
2	Put in order modality most commonly used (1) to the least used (9)									
3	How often maintained (six monthly, annually or....)?									
4	Who is responsible for maintenance?									
5	Do you have the manufacturers' manual available?									
6	Length of treatment time (average minutes)									
7	Operator distance from machine when in use (metres)									
8	Near metallic surfaces (Yes/No)									
8a.	If yes, distance from machine being used									
9	Type of partition between units (wall, curtain, other)									
10	No. of persons in room (patients & staff) during use									
11	Size of cubicle / room for treatment (metres)									
12	Nature of treatment plinth/chair/stool Please circle: Metal (M) / Wood (W)	M / W	M / W	M / W	M / W	M / W	M / W	M / W	M / W	M / W
13	Any interference with telephone, computers, etc.									

14	Ever had training or instructions for the use of these modalities? If yes, when was the last time (Date)?									
15	Number of Physiotherapists working in the Department at present: ……………………………………..									
16	How many patients are seen per week in the Department (average)? …………………….									
17	How many patients per week are given Electrotherapy (average)? …………………………									
18	How often is continuous short wave diathermy used in the Department (average)?									
	Each day = ☐ 2/3 days a week = ☐ 1/ week = ☐ less than 1/ week = ☐ Never = ☐									
18a	If NEVER, why? ……………………………..									
19	How often is pulsed short wave diathermy used in the Department? (average)									
	Each day= ☐ 2/3 days a week = ☐ 1/ week = ☐ less than 1/ week = ☐ Never = ☐									
19a	If NEVER, why? ………………………….									
20	Which technique / method of electrode application is most commonly used for any shortwave diathermy? Monode / circuplode = ☐ Flexi electrode = ☐ Rigid = ☐ Combination of flexi / rigid = ☐									
21	When was the last electrotherapy audit done in your department (Date)?									

22. Any contraindications for the Physiotherapists' safety using the specific modality

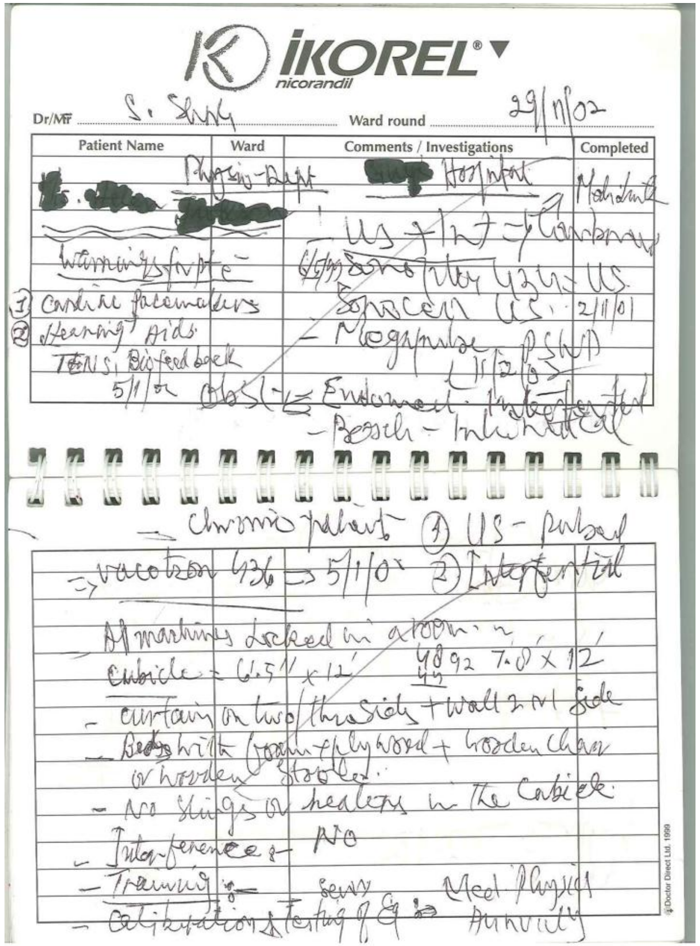
Please tick only those that apply

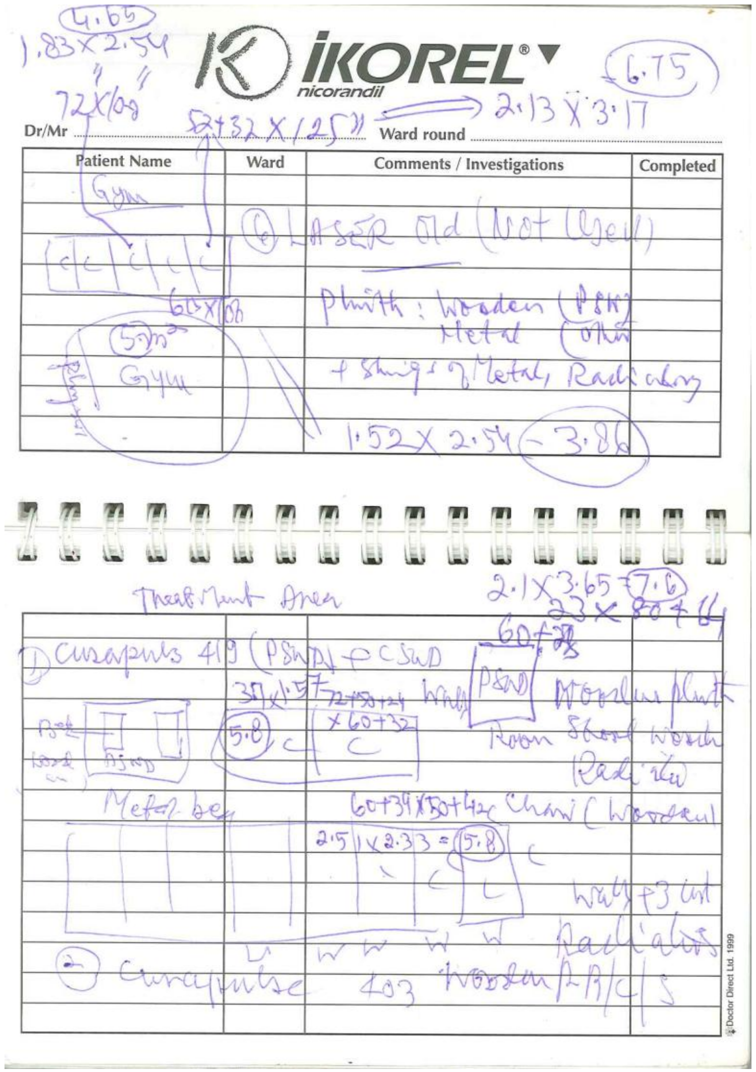
	Pulsed Short-wave Diathermy	*Continuous Short-wave Diathermy*	*LASER*	*Biofeedback*	*TENS*
Infection / TB (active)					
Pregnancy					
Skin conditions					
Anticoagulants					
DVT					
Malignancy*					
Metal in tissues					
Cardiac pacemaker					
Fever					
Menstruation					
Epilepsy					
Cardiac arrhythmia					

	Microwave diathermy	*Ultrasound*	*Interferential*	*H-wave*	
Infection / TB (active)					
Pregnancy					
Skin conditions					
Anticoagulants					
DVT					
Malignancy*					
Metal in tissues					
Cardiac pacemaker					
Fever					
Menstruation					
Epilepsy					
Cardiac arrhythmia					

* Past or present

8.8 Appendix VIII: Example of Diary Tool Used for Observational Study





1.83 X 2.54 (4.65)

72 X 108

(6.75) 2.13 X 3.17

iKOREL nicorandil

Dr/Mr

Ward round

Patient Name	Ward	Comments / Investigations	Completed
Gym			
		LASER Old (Not Used)	
60 X 108		plinth : Wooden (PSK)	
(5.9 m²)		Metal (other)	
Gym		+ string of Metal, Radiators	
		1.52 X 2.54 (= 3.86)	

Treatment Area

2.1 X 3.65 = 7.6

1 Curapulse 419 (PSWD) + CSWD			
		Wooden plinth	
	(5.8)	Room Shared Wooden	
		Radiator	
Metal bed		Chair (Wooden)	
		2.5 X 2.33 = (5.8)	
		Wall + 3 cot	
		Radiators	
2 Curapulse		403 Wooden	

© Doctor Direct Ltd. 1999

7/3/03 iKOREL® 9.00 AM

Patient Name [illegible] persons Ward | Comments

Metal slings / grids bars, curtains 3 + wall

usage of signs for cardiac pacemakers + hearing aids

+ Metal + wooden furniture

[Full Time / Students]

Reception → Telephone + PCs in close proximity with treatment ~~too~~ cubicles.

Interference?

EMRs exposure?

→ Precaution?

→ Pregnant physios?

→ Size of cubicle

→ STng [?] + Audit

8.9 Appendix IX: Risk Perception Questionnaire

Brunel University, Department of Health Studies & Social Care
Perception of Risk Questionnaire 2003

1. BACKGROUND QUESTIONS: please tick or circle where appropriate

1. Are you:

Male		Female	

2. What is your marital status:

Single		Married		Separated		Divorced		Widowed		Cohabiting	

3. Education/qualifications: (Please tick the highest level achieved)

3a.

Diploma		Master's degree (MA, MSc)		University graduate		Higher degree (PhD, MD/ other)	

3b. How long have you been qualified for the job you are presently doing?.......................................

4. Do you smoke?

YES		NO	

4a. If YES how many do you smoke in a typical day (including evening)

5. Do you drink alcohol?

YES		NO	

5a. If YES how many units do you usually drink during a typical week? (1 unit = 1/2 pint of lager, 1 glass of wine, 1 shot of spirits, etc.)

5b. On average how many days in a week do you drink alcohol?

6. Exercise

6a. How often do you undertake vigorous exercise for more than 30 minutes at a time (where you sweat)?

6-7 days/wk		4-5 days		2-3 days/wk		Once a week		Never	

6b. How often do you undertake mild exercise (for example, a brisk 20-minute walk)?

6-7 days/wk		4-5 days		2-3 days/wk		Once a week		Never	

7. Diet

7a. Do you have a special diet for health reasons? YES ☐ NO ☐

If YES, please give brief details..

7b. Do you believe that you eat the right amount of food for you?	Always		Usually		Sometimes		Never	
7c. Do you believe you currently have a balanced diet?	Always		Usually		Sometimes		Never	

7d. What is your **weight?** _____ kg *or* _____lbs *or* ________stone

7e. What is your **height**? _______ft _____inches *or* _______ cm

8. Please tick your age group

Under 20 yrs		21-25 yrs		26-30 yrs		31-35 yrs		36-40 yrs		41-45 yrs	
46-50 yrs		51-55 yrs		56-60 yrs		61-65 yrs		+ 65 yrs			

9. Health status

9a. How would you describe your current state of health on a scale from 1 to 6 (1 = very poor; 6 = excellent) please circle

Very poor					*Excellent*
1	*2*	*3*	*4*	*5*	*6*

9b. What value do you place upon your good health on a scale from 1 to 6 (1 = None; 6 = very high) please circle

None					*Very High*
1	*2*	*3*	*4*	*5*	*6*

10. General questions:

10a. How aware are you, in general, of Environment and Health Issues, on a scale of 1 to 6? (1 = not aware; 6= very aware) please circle

Not at all					Very aware
1	*2*	*3*	*4*	*5*	*6*

10b. How do you PERCEIVE your general knowledge of Environment and Health Issues? (1 = no knowledge; 6= very knowledgeable) please circle

No knowledge					*Very knowledgeable*
1	*2*	*3*	*4*	*5*	*6*

2. RISK PERCEPTION

This section aims to **assess <u>your perception</u> of <u>risk</u>**. For each item, please rate how risky **you perceive** that item to be. ***Tick only ONE box in each row.***

	No Risk	Low Risk	Moderate Risk	High Risk	Very High Risk	Don't Know
1. The smoking of tobacco?	☐	☐	☐	☐	☐	☐
2. Passive exposure to tobacco smoke?	☐	☐	☐	☐	☐	☐
3. Alcohol consumption per week <u>OVER</u> 21 units for men and 14 units for women?	☐	☐	☐	☐	☐	☐
4. Alcohol consumption per week UP TO 21 units for men and 14 units for women?	☐	☐	☐	☐	☐	☐
5. A high fat diet?	☐	☐	☐	☐	☐	☐
6. Leading a sedentary lifestyle (no exercise)?	☐	☐	☐	☐	☐	☐
7. Exposure to chemicals released by industry?	☐	☐	☐	☐	☐	☐
8. Living near a nuclear power plant?	☐	☐	☐	☐	☐	☐
9. Living near an electricity sub station?	☐	☐	☐	☐	☐	☐
10. Radioactive fallout from a nuclear power plant?	☐	☐	☐	☐	☐	☐
11. Living near a mobile phone transmitter?	☐	☐	☐	☐	☐	☐
12. Living near an overhead power line?	☐	☐	☐	☐	☐	☐
13. Using a mobile phone?	☐	☐	☐	☐	☐	☐
14. Exposure to electromagnetic fields in your workplace?	☐	☐	☐	☐	☐	☐

	No Risk	Low Risk	Moderate Risk	High Risk	Very High Risk	Don't Know
15. Exposure to electromagnetic fields in the home e.g. hair dryers, hi fi's?	☐	☐	☐	☐	☐	☐
16. Other sources of electromagnetic fields at home e.g. microwave?	☐	☐	☐	☐	☐	☐
17. Exposure to radon gas?	☐	☐	☐	☐	☐	☐
18. Exposure to noise?	☐	☐	☐	☐	☐	☐
19. Exposure to poor air quality?	☐	☐	☐	☐	☐	☐
20. Driving with twice the legal limit of alcohol?	☐	☐	☐	☐	☐	☐
21. Air travel?	☐	☐	☐	☐	☐	☐
22. Train travel?	☐	☐	☐	☐	☐	☐
23. Exposure to radiation from a single chest X-ray?	☐	☐	☐	☐	☐	☐

3.HEALTH CONSEQUENCES:

In this section you will be asked to rate **your perception** of the **health consequences** that might develop as a result of exposure to each of the following. Tick **only ONE box** in each row

	No Harm	Low Harm	Moderate Harm	Severe Harm	Very Severe Harm	Don't Know
1. The smoking of tobacco?	☐	☐	☐	☐	☐	☐
2. Passive exposure to tobacco smoke?	☐	☐	☐	☐	☐	☐
3. Alcohol consumption per week OVER 21 units for men and 14 units for women?	☐	☐	☐	☐	☐	☐
4. Alcohol consumption per week UP TO 21 units for men and 14 units for women?	☐	☐	☐	☐	☐	☐
5. A high fat diet?	☐	☐	☐	☐	☐	☐
6. Leading a sedentary lifestyle (no exercise)?	☐	☐	☐	☐	☐	☐
7. Exposure to chemicals released by industry?	☐	☐	☐	☐	☐	☐
8. Living near a nuclear power plant?	☐	☐	☐	☐	☐	☐
9. Living near an electricity sub station?	☐	☐	☐	☐	☐	☐
10. Radioactive fallout from a nuclear power plant?	☐	☐	☐	☐	☐	☐
11. Living near a mobile phone transmitter?	☐	☐	☐	☐	☐	☐
12. Living near an overhead power line?	☐	☐	☐	☐	☐	☐
13. Using a mobile phone?	☐	☐	☐	☐	☐	☐

	No Harm	Low Harm	Moderate Harm	Severe Harm	Very Severe Harm	Don't Know
14. Exposure to electromagnetic fields in your workplace?	☐	☐	☐	☐	☐	☐
15. Exposure to electromagnetic fields in the home e.g. mixers, Hair dryers?	☐	☐	☐	☐	☐	☐
16. Other sources of electromagnetic fields at home e.g. microwave?	☐	☐	☐	☐	☐	☐
17. Exposure to radon gas?	☐	☐	☐	☐	☐	☐
18. Exposure to noise?	☐	☐	☐	☐	☐	☐
19. Exposure to poor air quality?	☐	☐	☐	☐	☐	☐
20. Air travel?	☐	☐	☐	☐	☐	☐
21. Train travel?	☐	☐	☐	☐	☐	☐
22. Exposure to radiation from a single chest X-ray?	☐	☐	☐	☐	☐	☐

4. PROTECTION AGAINST RISK :In this section, please rate the extent to which you feel it is possible as an individual under normal circumstances to protect against risk from the following. *Tick only ONE box in each row.*

	Never Possible	Rarely Possible	Sometimes Possible	Usually Possible	Always Possible	Don't Know
1. Passive exposure to tobacco smoke?						
2. Exposure to chemicals released from industry?						
3. Living near a nuclear power plant?						
4. Living near an electricity sub station?						
5. Radioactive fallout from a nuclear power plant?						
6. Living near a mobile phone transmitter?						
7. Living near an overhead power line?						
8. Exposure to electromagnetic fields in your workplace?						
9. Electromagnetic fields at home from appliances e.g. hair dryer, hi fi's?						
10. Other sources of electromagnetic fields in the home e.g. microwave?						
11. Exposure to radon gas?						
12. Exposure to noise?						
13. Exposure to poor air quality?						
14. Air travel?						
15. Train travel?						

Thank you for your time helping with this research. Please return the completed questionnaire in the stamped addressed envelope provided

8.10 Appendix X: Letter to Physiotherapy Managers about Risk Perception Survey

Department of Health & Social Care,
Brunel University, Osterley Campus,
TW7 5DU
Tel:0208-891-0121 ext. 2523
Fax: 0208-847-2030
Date ……………

……………………………
Superintendent/Manager
Physiotherapist Department
………………..…Hospital,
………………………….

Dear ……………..,

Thank you for taking part in the Health & Safety Executive study of electrotherapy equipment. The first part of the project is now completed and we will have final results in due course. This final stage involves completion of an anonymous questionnaire by each physiotherapist in the department. (These are included in this envelope). Questions refer to an individual's perception of risk in specific situations. Similar research has been conducted on the general public and interest is now focussing on health care workers.

There are some general background questions, how risk is rated for particular factors and the extent to which the individual feels able to protect themselves from these risks. The questionnaire requires no name or any other information by which a person can be identified. Once returned, there will be no method of identifying which questionnaire relates to an individual physiotherapist or department. Completing it should take no longer than 10 minutes and participation is purely voluntary. If there is no wish to take part, the questionnaire should not be completed.

However we would be most grateful if you could encourage your staff to take part in this final part of the Health & Safety Executive project and answer questions spontaneously without thinking for too long about the response. The questionnaires should then be returned as soon as possible in the addressed envelope provided with each questionnaire. We would like to analyse the data by the end of September. If further information is required about the study, please contact Dr Shah or me at the above or by e-mail. Thank you for your time in helping with this research and when it is completed we will be happy to give you the results.

Yours sincerely,

Dr Alexandra Farrow (BSc, MSc, PhD, MRCS) [alexandra.farrow@brunel.ac.uk]
Dr S. G. S. Shah, Research Fellow (MBBS, RMP, MSc) [sarwar.shah@brunel.ac.uk]

8.11 Appendix XI: Letter to Physiotherapists regarding Risk Perception Survey

Faculty of Life Sciences
Head of Department of Health and Social Care
Professor Lorraine De Souza PhD, MSc, BSc, GradDipPhys, FCSP, SRP
Chair of Rehabilitation

BRUNEL UNIVERSITY

Osterley Campus
Borough Road
Isleworth, Middlesex TW7 5DU
United Kingdom
Telephone (020) 8891 0121
Fax (020) 8847 2030
Ext 2523

August 11th 2003

Dear Physiotherapist,

Your physiotherapy department has taken part in the Health & Safety Executive study of electrotherapy equipment. This first part of the project has now been completed with our visits to each physiotherapy department. The final stage involves completion of the attached anonymous questionnaire. This is requesting information on your individual perception of risk in specific situations. Similar research has been conducted on the general public and interest is now focussing on health care workers.

There are some general background questions, how you rate risk for particular factors and the extent to which you feel able to protect yourself from these risks. The questionnaire requires no name or any other information by which you can be identified. Completing the questionnaire should take no longer than 10 minutes. Once you have returned it, there will be no method of identifying which questionnaire relates to you. Your participation is purely voluntary. If you do not wish to take part, do not complete the questionnaire.

If you do take part, please answer all questions spontaneously (don't think for too long about the response). Return the questionnaire in the return addressed envelope provided as soon as possible. We would like to analyse the data by the end of September. If further information is required about the study, please contact Dr. Shah or me at the above. Thank you for your time in helping with this research.

Yours sincerely,

Dr. Alexandra Farrow (BSc., MSc., PhD., MRCS)
Dr S.G. S. Shah, Research Fellow (MBBS, RMP, MSc.,)

8.12 Appendix XII: T-Tests

8.12.1 T-Tests: Perception of Health Risk Items

T TEST WITH FULL SAMPLE (N =390)

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=rp_1 rp_2 rp_3 rp_4 rp_5 rp_6 rp_7 rp_8 rp_9 rp_10 rp_11 rp_12 rp_13 rp_14 rp_15 rp_16 rp_17 rp_18
rp_19 rp_20 rp_21 rp_22 rp_23
  /CRITERIA=CI(.95).
```

T-Test

```
[DataSet2] C:\Users\...\Documents\390 rp data.sav
```

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_1	Equal variances assumed	6.123	.014	-1.666	388	.096	-.133	.080	-.291	.024
	Equal variances not assumed			-1.536	111.888	.127	-.133	.087	-.306	.039
rp_2	Equal variances assumed	4.348	.038	-3.229	388	.001	-.315	.097	-.506	-.123
	Equal variances not assumed			-3.085	116.346	.003	-.315	.102	-.516	-.113
rp_3	Equal variances assumed	.456	.500	-3.050	385	.002	-.287	.094	-.471	-.102
	Equal variances not assumed			-3.049	121.077	.003	-.287	.094	-.473	-.101
rp_4	Equal variances assumed	1.068	.302	-3.655	384	.000	-.407	.111	-.626	-.188
	Equal variances not assumed			-3.642	120.709	.000	-.407	.112	-.629	-.186
rp_5	Equal variances assumed	5.588	.019	-2.858	387	.004	-.240	.084	-.405	-.075
	Equal variances not assumed			-2.870	123.734	.005	-.240	.084	-.405	-.074

rp_6	Equal variances assumed	1.083	.299	-1.812	387	.071	-.180	.099	-.375	.015
	Equal variances not assumed			-1.770	119.571	.079	-.180	.102	-.381	.021
rp_7	Equal variances assumed	1.310	.253	-1.874	379	.062	-.215	.115	-.440	.011
	Equal variances not assumed			-1.775	114.188	.079	-.215	.121	-.455	.025
rp_8	Equal variances assumed	.078	.781	-3.748	375	.000	-.520	.139	-.793	-.247
	Equal variances not assumed			-3.692	118.002	.000	-.520	.141	-.799	-.241
rp_9	Equal variances assumed	.229	.633	-3.808	366	.000	-.501	.132	-.760	-.243
	Equal variances not assumed			-3.944	125.196	.000	-.501	.127	-.753	-.250
rp_10	Equal variances assumed	2.149	.143	-.560	378	.576	-.072	.129	-.326	.182
	Equal variances not assumed			-.527	111.428	.599	-.072	.137	-.345	.200
rp_11	Equal variances assumed	3.086	.080	-2.776	352	.006	-.352	.127	-.602	-.103
	Equal variances not assumed			-2.643	101.868	.010	-.352	.133	-.617	-.088
rp_12	Equal variances assumed	.424	.515	-1.593	366	.112	-.196	.123	-.437	.046
	Equal variances not assumed			-1.538	112.115	.127	-.196	.127	-.448	.056

rp_13	Equal variances assumed	.385	.535	-2.992	376	.003	-.285	.095	-.472	-.098
	Equal variances not assumed			-2.764	103.914	.007	-.285	.103	-.489	-.080
rp_14	Equal variances assumed	1.144	.285	-4.276	381	.000	-.416	.097	-.607	-.225
	Equal variances not assumed			-4.106	111.741	.000	-.416	.101	-.616	-.215
rp_15	Equal variances assumed	1.888	.170	-3.075	380	.002	-.241	.078	-.395	-.087
	Equal variances not assumed			-3.269	124.752	.001	-.241	.074	-.386	-.095
rp_16	Equal variances assumed	4.599	.033	-3.116	381	.002	-.279	.089	-.455	-.103
	Equal variances not assumed			-3.187	122.971	.002	-.279	.087	-.452	-.106
rp_17	Equal variances assumed	.527	.468	-.869	241	.386	-.151	.174	-.494	.191
	Equal variances not assumed			-.845	77.997	.401	-.151	.179	-.507	.205
rp_18	Equal variances assumed	3.950	.048	-2.504	386	.013	-.239	.095	-.427	-.051
	Equal variances not assumed			-2.771	142.740	.006	-.239	.086	-.410	-.069
rp_19	Equal variances assumed	.002	.969	-1.516	387	.130	-.147	.097	-.339	.044
	Equal variances not assumed			-1.454	117.017	.149	-.147	.101	-.348	.053

rp_20	Equal variances assumed	14.713	.000	-2.230	385	.026	-.163	.073	-.307	-.019
	Equal variances not assumed			-1.987	108.273	.049	-.163	.082	-.326	.000
rp_21	Equal variances assumed	11.011	.001	-1.584	388	.114	-.116	.073	-.259	.028
	Equal variances not assumed			-1.753	142.236	.082	-.116	.066	-.246	.015
rp_22	Equal variances assumed	9.575	.002	-1.578	387	.115	-.113	.072	-.255	.028
	Equal variances not assumed			-1.670	133.089	.097	-.113	.068	-.248	.021
rp_23	Equal variances assumed	.002	.961	-1.563	386	.119	-.143	.091	-.322	.037
	Equal variances not assumed			-1.497	116.892	.137	-.143	.095	-.331	.046

T TESTS WITH EQUAL SAMPLE OF MALE AND FEMALE PARTICIPANTS (PHYSIOTHERAPISTS)

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=rp_2
  /CRITERIA=CI(.95).
```

T-Test

```
[rp_2] C:\Users\...\Documents\ rp_2 t test male female 80.sav
```

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_2	Male	80	3.55	.825	.092
	Female	80	3.88	.877	.098

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_2	Equal variances assumed	.190	.664	-2.414	158	.017	-.325	.135	-.591	-.059
	Equal variances not assumed			-2.414	157.421	.017	-.325	.135	-.591	-.059

```
T-TEST GROUPS=gender_1(1 2)

  /MISSING=LISTWISE
  /VARIABLES=rp_3
  /CRITERIA=CI(.95).
```

T-Test

```
[rp_3] C:\Users\...\Documents\ rp_3 t test male female equal 79.sav
```

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_3	Male	79	3.78	.745	.084
	Female	79	4.05	.732	.082

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_3	Equal variances assumed	1.110	.294	-2.261	156	.025	-.266	.118	-.498	-.034
	Equal variances not assumed			-2.261	155.949	.025	-.266	.118	-.498	-.034

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=rp_4
  /CRITERIA=CI(.95).
```

T-Test

[rp_4] C:\Users\...\Documents\ rp_4 t test male female equal 79.sav

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_4	Male	79	2.67	.888	.100
	Female	79	3.05	.973	.109

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_4	Equal variances assumed	.009	.926	-2.563	156	.011	-.380	.148	-.672	-.087
	Equal variances not assumed			-2.563	154.709	.011	-.380	.148	-.672	-.087

```
T-TEST GROUPS=gender_1(1 2)

  /MISSING=LISTWISE
  /VARIABLES=rp_5
  /CRITERIA=CI(.95).
```

T-Test

```
[rp_5] C:\Users\...\Documents\ rp_5 t test male female equal 80 each.sav
```

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_5	Male	80	4.01	.665	.074
	Female	80	4.22	.656	.073

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_5	Equal variances assumed	2.056	.154	-2.035	158	.044	-.212	.104	-.419	-.006
	Equal variances not assumed			-2.035	157.964	.044	-.212	.104	-.419	-.006

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=rp_8
  /CRITERIA=CI(.95).
```

T-Test

```
[rp_8] C:\Users\...\Documents\ rp_8 t test male female equal 78 each.sav
```

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_8	Male	78	3.1410	1.11337	.12606
	Female	78	3.7564	1.09528	.12402

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_8	Equal variances assumed	.193	.661	-3.480	154	.001	-.61538	.17684	-.96473	-.26604
	Equal variances not assumed			-3.480	153.959	.001	-.61538	.17684	-.96473	-.26604

```
T-TEST GROUPS=gender_1(1 2)

  /MISSING=LISTWISE
  /VARIABLES=rp_9
  /CRITERIA=CI(.95).
```

T-Test

```
[rp_9] C:\Users\...\Documents\ rp_9 t test male female equal 77 each.sav
```

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_9	Male	77	2.5714	.97911	.11158
	Female	77	3.1688	.96522	.11000

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_9	Equal variances assumed	.007	.931	-3.813	152	.000	-.59740	.15668	-.90696	-.28785
	Equal variances not assumed			-3.813	151.969	.000	-.59740	.15668	-.90696	-.28785

```
T-TEST GROUPS=gender_1(1 2)

  /MISSING=LISTWISE
  /VARIABLES=rp_11
  /CRITERIA=CI(.95).
```

T-Test

```
[rp_11] C:\Users\...\Documents\ rp_11 t test male female equal 71 each.sav
```

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_11	Male	71	2.70	1.020	.121
	Female	71	3.06	.984	.117

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_11	Equal variances assumed	1.260	.264	-2.094	140	.038	-.352	.168	-.685	-.020
	Equal variances not assumed			-2.094	139.822	.038	-.352	.168	-.685	-.020

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=rp_13
  /CRITERIA=CI(.95).
```

T-Test

[rp_13] C:\Users\...\Documents\ rp_13 t test male female equal 75 each.sav

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_13	Male	75	2.2933	.81826	.09448
	Female	75	2.5333	.70391	.08128

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_13	Equal variances assumed	.364	.547	-1.926	148	.056	-.24000	.12464	-.48629	.00629
	Equal variances not assumed			-1.926	144.769	.056	-.24000	.12464	-.48634	.00634

```
T-TEST GROUPS=gender_1(1 2)

  /MISSING=LISTWISE
  /VARIABLES=rp_14
  /CRITERIA=CI(.95).
```

T-Test

```
[rp_14] C:\Users\...\Documents\ rp_14 t test male female equal 77 each.sav
```

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_14	Male	77	2.10	.804	.092
	Female	77	2.53	.821	.094

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_14	Equal variances assumed	1.391	.240	-3.273	152	.001	-.429	.131	-.687	-.170
	Equal variances not assumed			-3.273	151.940	.001	-.429	.131	-.687	-.170

```
T-TEST GROUPS=gender_1(1 2)

  /MISSING=LISTWISE
  /VARIABLES=rp_15
  /CRITERIA=CI(.95).
```

T-Test

```
[rp_15] C:\Users\...\Documents\ rp_15 t test male female equal 76 each.sav
```

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_15	Male	76	1.6316	.56195	.06446
	Female	76	1.8158	.60466	.06936

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_15	Equal variances assumed	.752	.387	-1.945	150	.054	-.18421	.09469	-.37131	.00288
	Equal variances not assumed			-1.945	149.202	.054	-.18421	.09469	-.37131	.00289

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=rp_16
  /CRITERIA=CI(.95).
```

T-Test

[rp_16] C:\Users\...\Documents\ rp_16 t test male female equal 78 each.sav

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_16	Male	78	2.00	.684	.077
	Female	78	2.27	.750	.085

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_16	Equal variances assumed	3.519	.063	-2.342	154	.020	-.269	.115	-.496	-.042
	Equal variances not assumed			-2.342	152.691	.020	-.269	.115	-.496	-.042

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=rp_18
  /CRITERIA=CI(.95).
```

T-Test

[rp_18] C:\Users\...\Documents\ rp_18 t test male female equal 80 each.sav

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_18	Male	80	2.3750	.66323	.07415
	Female	80	2.6875	.75630	.08456

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_18	Equal variances assumed	.559	.456	-2.779	158	.006	-.31250	.11246	-.53463	-.09037
	Equal variances not assumed			-2.779	155.351	.006	-.31250	.11246	-.53466	-.09034

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=rp_20
  /CRITERIA=CI(.95).
```

T-Test

```
[rp_20] C:\Users\...\Documents\ rp_20 t test male female equal 80 each.sav
```

Group Statistics

	Gender?	N	Mean	Std. Deviation	Std. Error Mean
rp_20	Male	80	4.6500	.67693	.07568
	Female	80	4.8500	.53011	.05927

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
rp_20	Equal variances assumed	15.106	.000	-2.081	158	.039	-.20000	.09613	-.38986	-.01014
	Equal variances not assumed			-2.081	149.413	.039	-.20000	.09613	-.38995	-.01005

8.12.2 T-Tests: Perception of Health Consequences Items

T TEST WITH FULL SAMPLE (N =390)

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=hc1 hc2 hc3 hc4 hc5 hc6 hc7 hc8 hc9 hc10 hc11 hc12 hc13 hc14 hc15 hc16 hc17 hc18 hc19 hc20 hc21 hc22
  /CRITERIA=CI(.95).
```

T-Test

```
[DataSet2] C:\Users\...\Documents\390 hc data.sav
```

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hc1	Equal variances assumed	.037	.847	-1.156	388	.248	-.090	.078	-.242	.063
	Equal variances not assumed			-1.169	124.649	.245	-.090	.077	-.242	.062
hc2	Equal variances assumed	2.704	.101	-1.304	388	.193	-.143	.110	-.358	.073
	Equal variances not assumed			-1.207	112.400	.230	-.143	.118	-.377	.092
hc3	Equal variances assumed	12.170	.001	-3.502	386	.001	-.338	.097	-.528	-.148
	Equal variances not assumed			-3.122	108.282	.002	-.338	.108	-.553	-.124
hc4	Equal variances assumed	5.521	.019	-2.020	385	.044	-.244	.121	-.482	-.007
	Equal variances not assumed			-1.832	110.231	.070	-.244	.133	-.508	.020
hc5	Equal variances assumed	6.081	.014	-2.384	388	.018	-.228	.096	-.416	-.040
	Equal variances not assumed			-2.260	115.320	.026	-.228	.101	-.428	-.028

hc6	Equal variances assumed	5.523	.019	-.849	388	.396	-.088	.104	-.293	.116
	Equal variances not assumed			-.755	107.919	.452	-.088	.117	-.320	.144
hc7	Equal variances assumed	7.377	.007	-.070	382	.944	-.008	.111	-.226	.210
	Equal variances not assumed			-.063	107.067	.950	-.008	.124	-.254	.238
hc8	Equal variances assumed	.623	.430	-3.282	375	.001	-.460	.140	-.736	-.185
	Equal variances not assumed			-3.046	110.135	.003	-.460	.151	-.760	-.161
hc9	Equal variances assumed	.161	.689	-2.254	362	.025	-.300	.133	-.561	-.038
	Equal variances not assumed			-2.181	115.019	.031	-.300	.137	-.572	-.028
hc10	Equal variances assumed	1.968	.161	-.709	378	.479	-.088	.125	-.334	.157
	Equal variances not assumed			-.657	107.859	.512	-.088	.134	-.355	.178
hc11	Equal variances assumed	3.937	.048	-2.508	354	.013	-.309	.123	-.551	-.067
	Equal variances not assumed			-2.253	97.529	.026	-.309	.137	-.581	-.037
hc12	Equal variances assumed	2.609	.107	-.521	364	.603	-.066	.128	-.317	.184
	Equal variances not assumed			-.467	101.785	.642	-.066	.142	-.349	.216

hc13	Equal variances assumed	1.336	.249	-1.543	370	.124	-.167	.109	-.381	.046
	Equal variances not assumed			-1.362	94.844	.177	-.167	.123	-.412	.077
hc14	Equal variances assumed	.002	.965	-1.859	374	.064	-.186	.100	-.384	.011
	Equal variances not assumed			-1.827	111.434	.070	-.186	.102	-.389	.016
hc15	Equal variances assumed	.617	.433	-.463	371	.643	-.042	.090	-.219	.135
	Equal variances not assumed			-.460	108.829	.646	-.042	.091	-.221	.138
hc16	Equal variances assumed	1.411	.236	.016	376	.988	.001	.094	-.184	.187
	Equal variances not assumed			.014	103.261	.989	.001	.103	-.203	.206
hc17	Equal variances assumed	3.507	.062	-.979	235	.329	-.169	.172	-.509	.171
	Equal variances not assumed			-.893	69.211	.375	-.169	.189	-.546	.208
hc18	Equal variances assumed	.008	.928	.017	384	.987	.002	.098	-.190	.193
	Equal variances not assumed			.017	120.260	.987	.002	.098	-.193	.196
hc19	Equal variances assumed	1.956	.163	-.755	388	.451	-.077	.102	-.278	.124
	Equal variances not assumed			-.696	111.866	.488	-.077	.111	-.296	.142

hc20	Equal variances assumed	6.160	.013	1.080	386	.281	.154	.143	-.126	.435
	Equal variances not assumed			.972	107.479	.333	.154	.159	-.160	.468
hc21	Equal variances assumed	1.878	.171	.617	386	.538	.083	.134	-.181	.347
	Equal variances not assumed			.577	111.877	.565	.083	.143	-.201	.367
hc22	Equal variances assumed	.793	.374	.012	385	.990	.001	.100	-.195	.197
	Equal variances not assumed			.012	112.194	.991	.001	.106	-.210	.212

T TESTS WITH EQUAL SAMPLE OF MALE AND FEMALE PARTICIPANTS (PHYSIOTHERAPISTS)

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=hc3
  /CRITERIA=CI(.95).
```

T-Test

```
[hc3] C:\Users\...\Documents\ hc3 t test male female 80 each.sav
```

Group Statistics

	gender_1	N	Mean	Std. Deviation	Std. Error Mean
hc3	Male	80	3.69	.894	.100
	Female	80	4.11	.675	.075

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hc3	Equal variances assumed	12.398	.001	-3.393	158	.001	-.425	.125	-.672	-.178
	Equal variances not assumed			-3.393	146.947	.001	-.425	.125	-.673	-.177

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=hc4
  /CRITERIA=CI(.95).
```

T-Test

[hc4] C:\Users\...\Documents\ hc4 t test male female 80 each.sav

Group Statistics

	gender_1	N	Mean	Std. Deviation	Std. Error Mean
hc4	Male	80	2.76	1.094	.122
	Female	80	3.11	1.019	.114

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hc4	Equal variances assumed	.617	.433	-2.095	158	.038	-.350	.167	-.680	-.020
	Equal variances not assumed			-2.095	157.211	.038	-.350	.167	-.680	-.020

```
T-TEST GROUPS=gender_1(1 2)

  /MISSING=LISTWISE
  /VARIABLES=hc5
  /CRITERIA=CI(.95).
```

T-Test

```
[hc5] C:\Users\...\Documents\ hc5 t test male female 80 each.sav
```

Group Statistics

gender_1		N	Mean	Std. Deviation	Std. Error Mean
hc5	Male	80	3.75	.819	.092
	Female	80	4.10	.686	.077

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hc5	Equal variances assumed	6.485	.012	-2.930	158	.004	-.350	.119	-.586	-.114
	Equal variances not assumed			-2.930	153.296	.004	-.350	.119	-.586	-.114

```
T-TEST GROUPS=gender_1(1 2)

  /MISSING=LISTWISE
  /VARIABLES=hc8
  /CRITERIA=CI(.95).
```

T-Test

```
[hc8] C:\Users\...\Documents\ hc8 t test male female 80 each.sav
```

Group Statistics

	gender_1	N	Mean	Std. Deviation	Std. Error Mean
hc8	Male	78	2.95	1.216	.138
	Female	78	3.55	1.136	.129

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hc8	Equal variances assumed	.036	.850	-3.199	154	.002	-.603	.188	-.975	-.230
	Equal variances not assumed			-3.199	153.290	.002	-.603	.188	-.975	-.230

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=hc9
  /CRITERIA=CI(.95).
```

T-Test

[hc9] C:\Users\...\Documents\ hc9 t test male female 75 each.sav

Group Statistics

	gender_1	N	Mean	Std. Deviation	Std. Error Mean
hc9	Male	75	2.47	1.095	.126
	Female	75	2.67	1.119	.129

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hc9	Equal variances assumed	.185	.667	-1.106	148	.270	-.200	.181	-.557	.157
	Equal variances not assumed			-1.106	147.928	.270	-.200	.181	-.557	.157

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=hc11
  /CRITERIA=CI(.95).
```

T-Test

[hc11] C:\Users\...\Documents\hc11 t test male female 75 each.sav

Group Statistics

	gnder_1	N	Mean	Std. Deviation	Std. Error Mean
hc11	Male	72	2.43	1.072	.126
	Female	72	2.72	.773	.091

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hc11	Equal variances assumed	7.646	.006	-1.872	142	.063	-.292	.156	-.600	.016
	Equal variances not assumed			-1.872	129.112	.063	-.292	.156	-.600	.017

8.12.3 T-Tests: Perception of Protection against Risk items

T TEST WITH FULL SAMPLE (N =390)

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=par1 par2 par3 par4 par5 par6 par7 par8 par9 par10 par11 par12 par13 par14 par15 rpx
  /CRITERIA=CI(.95).
```

T-Test

```
[DataSet2] C:\Users\...\Documents\390 par data.sav
```

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
par1	Equal variances assumed	2.075	.151	1.364	388	.173	.124	.091	-.055	.302
	Equal variances not assumed			1.241	110.328	.217	.124	.100	-.074	.321

par2	Equal variances assumed	4.009	.046	.419	375	.676	.054	.128	-.198	.305
	Equal variances not assumed			.390	110.451	.698	.054	.137	-.219	.326
par3	Equal variances assumed	9.385	.002	.097	370	.923	.015	.154	-.287	.317
	Equal variances not assumed			.086	103.915	.932	.015	.173	-.328	.358
par4	Equal variances assumed	4.603	.033	.165	368	.869	.025	.149	-.269	.318
	Equal variances not assumed			.150	106.718	.881	.025	.164	-.300	.350
par5	Equal variances assumed	1.173	.279	.591	359	.555	.093	.157	-.217	.403
	Equal variances not assumed			.560	110.481	.577	.093	.166	-.236	.422
par6	Equal variances assumed	.033	.856	-1.189	370	.235	-.170	.143	-.452	.111
	Equal variances not assumed			-1.144	111.178	.255	-.170	.149	-.465	.125
par7	Equal variances assumed	4.492	.035	.865	374	.388	.128	.148	-.163	.420
	Equal variances not assumed			.806	108.763	.422	.128	.159	-.187	.444
par8	Equal variances assumed	.067	.797	.409	381	.683	.051	.124	-.193	.294
	Equal variances not assumed			.414	118.962	.680	.051	.122	-.192	.293

par9	Equal variances assumed	3.440	.064	-.034	373	.973	-.005	.155	-.311	.300
	Equal variances not assumed			-.032	110.537	.974	-.005	.165	-.331	.321
par10	Equal variances assumed	3.031	.083	-.089	374	.929	-.013	.144	-.296	.270
	Equal variances not assumed			-.083	109.016	.934	-.013	.154	-.319	.293
par11	Equal variances assumed	2.611	.108	2.424	215	.016	.468	.193	.087	.849
	Equal variances not assumed			2.248	74.584	.028	.468	.208	.053	.883
par12	Equal variances assumed	4.970	.026	1.596	384	.111	.179	.112	-.042	.400
	Equal variances not assumed			1.472	110.374	.144	.179	.122	-.062	.421
par13	Equal variances assumed	9.550	.002	.930	384	.353	.097	.104	-.108	.303
	Equal variances not assumed			.820	107.259	.414	.097	.119	-.138	.332
par14	Equal variances assumed	.026	.872	.499	382	.618	.084	.169	-.247	.416
	Equal variances not assumed			.490	116.511	.625	.084	.172	-.256	.425
par15	Equal variances assumed	.004	.951	.596	380	.552	.102	.172	-.235	.440
	Equal variances not assumed			.590	116.005	.556	.102	.173	-.241	.445

T TESTS WITH EQUAL SAMPLE OF MALE AND FEMALE PARTICIPANTS (PHYSIOTHERAPISTS)

```
T-TEST GROUPS=gender_1(1 2)
  /MISSING=LISTWISE
  /VARIABLES=par11
  /CRITERIA=CI(.95).
```

T-Test

```
[par11] C:\Users\...\Documents\ par11 t test male female 51 each.sav
```

Group Statistics

	gender_1	N	Mean	Std. Deviation	Std. Error Mean
par11	Male	51	3.37	1.341	.188
	Female	51	2.73	1.150	.161

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
par11	Equal variances assumed	1.743	.190	2.615	100	.010	.647	.247	.156	1.138
	Equal variances not assumed			2.615	97.734	.010	.647	.247	.156	1.138