ADDICTION
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Is it cost-effective to provide internet-based interventions to complement the current provision of smoking cessation services in the Netherlands? An analysis based on the EQUIPTMOD

Kei-Long Cheung[1], Ben F. M. Wijnen[1,2], Mickaël Hiligsmann[1], Kathryn Coyle[4], Doug Coyle[3,4], Subhash Pokhrel[4], Hein de Vries[5], Maximilian Präger[6] & Silvia M. A. A. Evers[1,7]

Department of Health Services Research, CAPHRI, Maastricht University, Maastricht, the Netherlands,[1] Department of Research and Development, Epilepsy Center Kempenhaeghe, Heeze, the Netherlands,[2] School of Epidemiology, Public Health and Preventive Medicine, University of Ottawa, Ottawa, Canada,[3] Health Economics Research Group, Brunel University London, Uxbridge, UK,[4] Department of Health Promotion, CAPHRI, Maastricht University, Maastricht, the Netherlands,[5] Institute of Health Economics and Health Care Management, Helmholtz Zentrum München (GmbH)—German Research Center for Environmental Health, Comprehensive Pneumology Center Munich (CPC-M), Member of the German Center for Lung Research (DZL), Neuherberg, Germany[6] and Trimbos Institute, National Institute of Mental Health and Addiction, Utrecht, the Netherlands[7]

ABSTRACT

Background and aim The cost-effectiveness of internet-based smoking cessation interventions is difficult to determine when they are provided as a complement to current smoking cessation services. The aim of this study was to evaluate the cost-effectiveness of such an alternate package compared with existing smoking cessation services alone (current package). **Methods** A literature search was conducted to identify internet-based smoking cessation interventions in the Netherlands. A meta-analysis was then performed to determine the pooled effectiveness of a (web-based) computer-tailored intervention. The mean cost of implementing internet based interventions was calculated using available information, while intervention reach was sourced from an English study. We used EQUIPTMOD, a Markov-based state-transition model, to calculate the incremental cost-effectiveness ratios [expressed as cost per quality-adjusted life years (QALYs) gained] for different time horizons to assess the value of providing internet-based interventions to complement the current package.). Deterministic sensitivity analyses tested the uncertainty around intervention costs per smoker, relative risks, and the intervention reach. **Results** Internet-based interventions had an estimated pooled relative risk of 1.40; average costs per smoker of €2.71; and a reach of 0.41% of all smokers. The alternate package (i.e. provision of internet-based intervention to the current package) was dominant (cost-saving) compared with the current package alone (0.14 QALY gained per 1000 smokers; reduced health-care costs of €602.91 per 1000 smokers for the life-time horizon). The alternate package remained dominant in all sensitivity analyses. **Conclusion** Providing internet-based smoking cessation interventions to complement the current provision of smoking cessation services could be a cost-saving policy option in the Netherlands.

Keywords Economic evaluation, EQUIPTMOD, internet-based, model, smoking cessation, tobacco.

Correspondence to: Kei-Long Cheung, Department of Health Services Research, CAPHRI, Maastricht University, Duboisdomein 30, 6229 GT Maastricht, P.O. Box 616, 6200 MD Maastricht, the Netherlands. E-mail: kl.cheung@maastrichtuniversity.nl
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INTRODUCTION

In order to reduce the impact of smoking (which is related to various smoking-related diseases such as lung cancer, heart diseases and stroke), the Framework Convention on Tobacco Control (FCTC) was signed in 2003 by the World Health Organization (WHO) and many countries, including the Netherlands, with the aim to tackle the consequences of tobacco smoking in the European Community at all levels [1]. World-wide, each year tobacco smoking is associated with more than 5 million deaths which are attributable to direct smoking [2]. Moreover, as a result of second-hand smoke, it is estimated that smoking leads to at least 600 000 additional deaths among non-smokers each year in the world [2]. In the Netherlands alone, 19 000 deaths were attributable to smoking-related diseases in 2013 [3]. Smoking also represents a substantial economic burden for society, with estimated costs of smoking tobacco being just above 1% of the European Union gross domestic product in 2000 [4]. Hence, many smoking cessation interventions have been developed [5–7]; maximizing implementation of these interventions can save more life-years and provide greater economic benefits than most medical interventions for smoking-related diseases [8]. Many cessation interventions have been shown to be effective, especially the more intensive interventions, such as one-to-one behavioural therapy [9]. These interventions, however, are often expensive, inconvenient for the recipient (e.g. waiting-list and the need to take time off work) and reach only a small proportion of smokers [10].

Internet-based interventions are relatively new innovations and have the potential to reach many smokers due to low costs per smoker, their accessibility (e.g. home, work and public access points) and their availability 24 hours a day [10]. More and more people have access to the internet world-wide, with approximately 94% of the Dutch population as a whole and 98.6% of the youngsters (i.e. aged between 12 and 25 years) [11,12]. Especially for youngsters, the internet provides opportunities, as some existing smoking cessation interventions, such as nicotine replacement therapy (NRT), are underutilized in this group [13]. An internet-based intervention has opportunities to be interactive and provide tailored messages to individuals, which has been shown to be effective in changing health behaviours, including enhancing smoking cessation [14]. A Cochrane review, however, showed inconsistent results [10]. Recently, internet-based interventions have been shown to be effective for smoking cessation [15,16]. Many effective internet-based interventions in the Netherlands were individually computer-tailored interventions, where health messages are tailored to input provided by the smokers via questionnaires [10,15,17]. Due to low costs per person and high reach, these interventions have a reasonable chance to be cost-effective even if the effect size is small [18]. Cost-effectiveness information is used increasingly to inform policymaking, as budget holders need to know whether societal benefits of interventions are worth the investments. To our knowledge, no study has yet estimated to what extent these internet-based interventions are cost-effective when they are used to complement the current provision of smoking cessation interventions [19]. The aim of this study was therefore to evaluate the cost-effectiveness of this alternate practice in the Netherlands.

METHODS

While evidence of the effectiveness of digital mobile applications in general is less robust due to large heterogeneity [20], it was deemed important to identify specific types and elements of on-line interventions that could drive the effectiveness. Therefore, a separate literature search and review were conducted first to identify effective on-line smoking cessation interventions that were relevant specifically to the Dutch context. A meta-analysis was then performed to determine the pooled effectiveness of internet-based interventions. Secondly, we used a return on investment tool, the EQUIPTMOD, a Markov-based state-transition model developed by the European study on Quantifying Utility of Investment in Protection from Tobacco (EQUIPT), to assess the economic value of smoking cessation interventions in five European countries, including the Netherlands [21]. The model allowed us to consider internet-based interventions to complement the current package and thus we were able to compare this alternative package to the current provision of smoking cessation services in the Netherlands. For this, EQUIPTMOD required us to specify effectiveness, costs and reach of internet-based interventions, keeping all other interventions in the model at their current levels of input estimates. As EQUIPTMOD is designed to allow a 'mix and match' of various interventions to create an alternative package, it was assumed that the cost and effectiveness of existing services would remain unchanged once internet-based smoking cessation interventions are included in the model. Input estimates (e.g. costs, reach) used in the EQUIPTMOD are described elsewhere [20,22]. A health-care perspective with different time horizons (i.e. 2, 5 and 10 years and life-time) was used in this study.

Literature search

This study focused on internet-based smoking cessation interventions which are currently available in the Netherlands. We therefore searched for interventions (final inclusion criteria) that: (1) are internet-based, (2) are directed at improving smoking cessation, (3) are Dutch, either developed in the Netherlands or adapted from an international internet-based intervention and (4) report at least 12 months of follow-up using Dutch trial data. In searching for these interventions, we began by exploring a systematic review by Cochrane [10]—regarding the effectiveness of internet-based interventions—to screen for the Dutch interventions. As the review was last updated in 2013, we then conducted an additional systematic literature search up to July 2016 to explore recent internet-based smoking cessation interventions in the Netherlands.

Similar to the Cochrane review [10], we based our search strategy on the specialized register of the Cochrane Tobacco Addiction Group, including the terms 'internet', 'www', 'web', 'net' or 'online' in the title, abstract or as keywords, between January 2013 and July 2016. Databases of Cochrane Central Register of Controlled trials (CENTRAL), MEDLINE and EMBASE were searched via OVID. For full search strategies, see the Tobacco Addiction Group Module

[23]. The search led to a total of 651 papers (CENTRAL = 96; MEDLINE = 163; and EMBASE = 392), from which two researchers (K.L.C. and B.W.) screened independently for title and abstract. For the title and abstract screening, the inclusion criteria were: (1) smoking cessation intervention, (2) eHealth [i.e. internet, mobile, short messaging service (SMS) or computer] and (3) English or Dutch language. The two researchers resolved disagreements through discussion, resulting in 74 potentially relevant papers. For the full-text screening, a fourth criterion was added: studies needed to include effectiveness values of 12-month follow-up, consistent with assumptions from the return on investment (ROI) model (see economic model below). Life-style and prevention interventions were excluded. The authors searched through the full text papers and the Cochrane review [10] for the relevant Dutch interventions, which led to the selection of five internet-based smoking cessation interventions [15,17,24]. Further details on the literature search for Dutch internet-based smoking cessation interventions are provided elsewhere [25].

On-line smoking cessation intervention

The five included interventions on the effectiveness or cost-effectiveness of on-line smoking cessation interventions were similar [15,17,24]; all were computer-tailored interventions and based on the Integrated Change (I-Change) model [15,26–28]. As described in a recent systematic review in the Netherlands, all Dutch internet-based smoking cessation interventions (with a follow-up of 12 months) were shown to be effective and incorporated messages tailored to the individual [25]. Computer tailoring is an effective technique for health education and combines information or change strategies to the outcome of interest. The information or change strategies used are intended to reach one specific person and are based on individual-specific characteristics derived from individual assessment [29,30]. Hence, computer-tailored messages are personalized, which attracts attention and includes less unnecessary information than non-tailored materials [31]. Consequently, compared to non-tailored materials, computer-tailored messages are better read, saved, memorized and discussed with others [14,32,33]. The I-Change model has been used for several previous studies investigating the determinants of adopting a smoking cessation intervention [34–37]. The I-Change model integrates concepts of various cognitive models, such as Ajzen's Theory of Planned Behaviour [38] and the Health Belief Model [39]. The intention is assumed to be an immediate antecedent of behaviour [38]. The I-Change model explains the adoption of health behaviour and health behavior-promoting policies in (at least) three phases (i.e. awareness, motivation and action phase). Each phase has phase-specific determinants, such as knowledge and risk perceptions for understanding awareness; attitudes, social support and self-efficacy for understanding motivation; and action planning and skills to understand the final step from intentions to behaviour. The web-based computer-tailored interventions from the included studies typically asked users to complete an on-line questionnaire and to set a quit date. The intervention then personalizes its feedback to the user regarding demographic characteristics (e.g. gender) and I-Change model constructs (e.g. attitude, social influence, self-efficacy, intention to quit smoking, action planning and smoking behaviour).

Relative risk, costs and reach of the pooled intervention

The economic model requires several input parameters regarding the internet-based smoking cessation interventions, including the relative risk of smoker cessation (RR), the costs per smoker per intervention and the reach. Given the similarities of the included studies, we investigated the impact of a web-based computer-tailored interventionwith a pooled effect size. Effectiveness in terms of smoking cessation was expressed as abstinence rates at the 12-month follow-up (using the most conservative cessation outcomes). A meta-analysis was conducted for the five included interventions, using the Mantel–Haenszel fixed-effect model for the relative risk of the pooled intervention. Abstinence rates and group sizes were obtained from all interventions. This resulted in a pooled RR of 1.40 [95% confidence interval (CI) = 1.18–1.66] (see forest plot in Fig. 1). Moreover, while the random-effects model allows the study outcomes to vary in a normal distribution between studies, the I^2 statistic (i.e. the percentage of variation across studies due to heterogeneity) was zero (0.0%, $P = 0.83$), indicating the appropriateness of a fixed-effects model [40]. Annual costs per respondent (smoker) were obtained where available [15,24], which were then averaged for the pooled costs of €2.71 per person, ranging from €0.22 to 7.70. Costs attributable to delivery of the intervention (e.g. hosting for the web-based intervention) were included, whereas research and development costs (one-off costs) and promotional costs were excluded. There is some indication from UK data that 1.4% of quit attempts involve website or smartphone interventions [41]. This was multiplied to the percentage of smokers intending to make a quit attempt in the next 12 months (29%) [42], resulting in an estimated reach of 0.41% of all smokers for on-line smoking cessation interventions. All these input estimates were changed in sensitivity analyses to assess their impact on results.

Current package

The EQUIPTMOD includes by default top-level interventions, behavioural support and pharmaceuticals in the

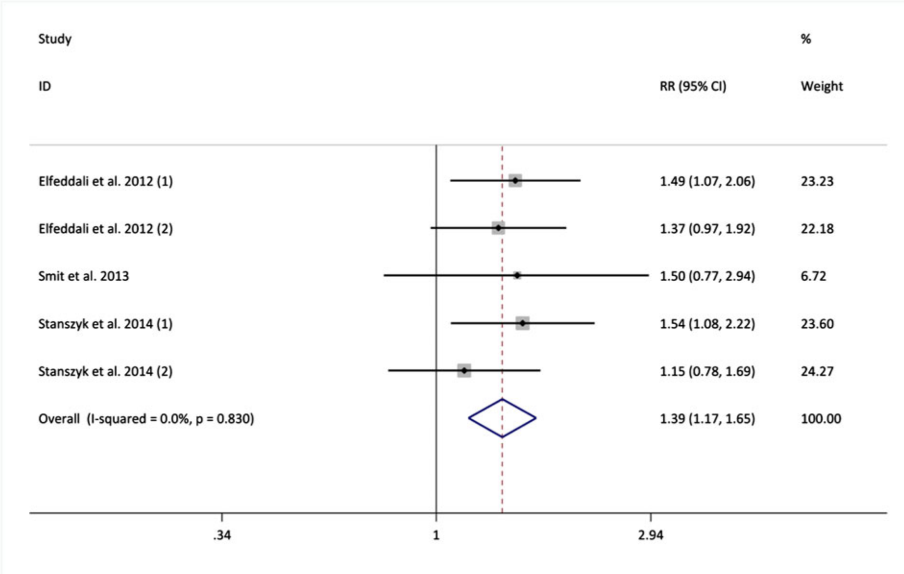

Figure 1 Forest plot of the meta-analysis. Relative risk (RR) and its 95% confidence interval (CI)

current package. Top-level interventions increase the number of quit attempts, enhancing the use of cessation interventions. Top-level interventions included in the model are social marketing and brief physician advice. Moreover, taxation on tobacco and an indoor smoking ban in public places are categorized as top-level interventions. In the Netherlands, visits to a general practitioner (GP) are reimbursed [43], which guide the patients towards the cessation support. The GP may prescribe behavioural support (i.e. one-to-one behavioural support, group-based behavioural support, telephone support, SMS text messaging or printed self-help materials), and optionally pharmaceuticals (i.e. single mono nicotine replacement therapy (mono NRT), a combination of NRTs (combo NRT), varenicline (standard duration or extended duration) or bupropion) [6,44]. Data were derived from literature reviews and randomized controlled trials regarding effectiveness and cost-effectiveness, searched by the EQUIPT team [21]. Costs, effects and reach of the current package are included in Table 1. A list of parameter sources is detailed elsewhere [45].

Economic model

We used the EQUIPTMOD, described elsewhere in more detail [22], which is a Markov-based state-transition cohort model with a cycle length of 1 year. Smokers older than 16 years were included in the model in which there are three health states: 'smoker', 'former smoker' and 'death'.

Table 1 Costs, effects and reach of the interventions in current package.

Interventions	*Costs per smoker per intervention (€)*	*Effect*[a]	*Reach as % of smokers*[b]
Top-level interventions			
Brief physician advice	33.00 [62]	1.40 [63]	21.00
Pharmaceutical interventions			
Rx mono nicotine Replacement (NRT)	225.05 [64]	1.60 [65]	5.00
Rx combo nicotine Replacement (NRT)	465.24 [64]	2.14 [65]	2.00
Varenicline (standard duration)	325.71 [64]	2.30 [66]	5.00
Varenicline (extended duration)	612.42 [64]	2.76 [67]	1.00
Bupropion	175.78 [64]	1.60 [68]	1.00
Behavioural interventions			
Specialist behavioural support: one-to-one	465.00 [62]	1.40 [9]	2.00
Specialist behavioural support: group-based	41.90 [62]	2.00 [9]	1.00
Telephone support: proactive	119 [62]	1.40 [69]	0.50
SMS text messaging	23.68[c]	1.71 [61]	0.50
Printed self-help materials	1.21 [6]	1.19 [70]	1.00

[a]For top-level interventions, effect is relative increase in the percentage of smokers making a quit attempt in the next 12 months. For pharmaceutical and behavioural interventions effect is relative effect of a quit attempt to be successful versus an unassisted quit rate; [b]reach was taken from England data; [c]costs are equated to England data. NRT = nicotine replacement therapy; SMS = short message service.

A cohort of smokers enters the model in the smoker category. On successful quit (predicted by reach and effectiveness of cessation interventions), current smokers move to the 'former smoker' state, and remain there for the first year. Subsequent to the first year, a background quit rate was applied in all years, which reflects the balance of quitting and relapsing over the life-time of the cohort. The model also includes an absorbing state, 'death', which is predicted by age- and sex-specific mortality rates, adjusted for smoking status. Two separate models were created to simulate the effects on health of either quitting or not quitting smoking during the first cycle of the model. The separate models combine the results by weighting the outputs of the models by the country-specific population and the package effectiveness and reach. The model includes four smoking-related diseases (i.e. lung cancer, coronary heart disease, chronic obstructive pulmonary disease and stroke). Utility values by smoking status and utility decrements associated with these smoking-related diseases were assigned to the relevant proportion of the cohort within each state in order to estimate the QALYs. The input data used in the model for the Netherlands included smoking prevalence [46], relative risks of smoking-related diseases [47–49], cost of smoking-related diseases [47,50] and the background quit rate [51]. The list of parameter estimates is detailed elsewhere [45].

Analysis

First, the pooled internet-based intervention was added to the model as a behavioural support intervention, with its relative risk, costs and reach estimates. Adding this intervention into the model led to the creation of the alternate package. We estimated the differences in costs and outcomes between the alternate package and the current package. Costs and average QALYs were calculated for each time horizon (i.e. 2, 5 and 10 years and life-time). To estimate whether the alternate package is cost-effective compared to the current package, the incremental cost-effectiveness ratio (ICER) expressed in costs per QALY gained was calculated. The ICER represents the additional cost of the alternate package compared with the current package per QALY gained. If an intervention is associated with higher QALYs and lower costs, it is said to be 'cost-saving'. Discount rates of 4.0 and 1.5% were used for costs and effects, respectively [52]. Uncertainty around input estimates was investigated using deterministic sensitivity analyses. A series of deterministic sensitivity analyses was conducted for the life-time horizon to assess the impact on the ICER of changes in RRs, costs and reach of the pooled web-based computer-tailored intervention. The RR of 1.39 varied from 1.18 to 1.65, based on its 95% CI. A range of costs was used, varying from €0.22 to 7.70. Half and double the reach estimate (0.41%) were used as lower and upper bounds in the sensitivity analysis. A conservative cost-effectiveness threshold of €20 000 was used [53]. Furthermore, we conducted a threshold analysis to estimate the cost (including promotional and implementation activities) at which internet-based smoking cessation interventions yield cost-effective results. This was performed by increasing the costs of the intervention per person up to the point where net incremental benefit was zero.

RESULTS

Costs, average QALYs and ICERs

Costs and average QALYs for the current package and the alternate package are shown in Table 2. Compared to the current package, the alternate package was dominant for all time horizons, i.e. the alternate package is associated with more QALYs and lower costs. For instance, the alternative package dominated the current package with 0.14 QALY gained per 1000 smokers and reduced healthcare costs of €602.91 per 1000 smokers for the lifetime horizon.

Sensitivity analyses

Sensitivity analyses were conducted, varying intervention costs per smoker, RRs and reach for the life-time horizon (see Table 3; sensitivity analyses using low and high ends

Table 2 Costs, QALYs and ICERs per 1000 smokers comparing alternative package versus current package.

	Horizon	*Average total costs (€ per 1000 smokers)*	*Average QALYs (per 1000 smokers)*	*Incremental cost-effectiveness ratio (€ per QALY gain)*
Current package	2 years	1 468 783.00	1611.13	–
	5 years	3 507 385.08	3877.85	–
	10 years	6 612 182.46	7260.26	–
	Life-time	18 301 798.23	20 953.69	–
Alternative package	2 years	1 468 729.32	1611.13	Dominant
	5 years	3 507 241.88	3877.86	Dominant
	10 years	6 611 913.37	7260.29	Dominant
	Life-time	18 301 195.32	20 953.83	Dominant

ICER = ; incremental cost-effectiveness ratio; QALYs = quality-adjusted life years.

Table 3 Sensitivity analysis: intervention costs per smoker, RRs and reach for life-time horizon.

	Range	Average total costs (€ per 1000 smokers)	Average QALYs (per 1000 smokers)	Incremental cost-effectiveness ratio (€ per QALY gain)
Current package	–	18 301 798.23	20 953.69	–
Base case (alternative package)		18 301 195.32	20 953.83	Dominant
Intervention costs per smoker (€)	0.22	18 301 185.11	20 953.83	Dominant
	7.70	18 301 215.78	20 953.83	Dominant
Relative risk	1.18	18 301 536.79	20 953.75	Dominant
	1.65	18 300 790.39	20953.93	Dominant
Reach (%)	0.20	18 301 499.72	20 953.76	Dominant
	0.81	18 300 604.17	20 953.97	Dominant

RR = relative risk; QALY = quality-adjusted life years.

of the ranges). In all scenarios, the alternate package remained dominant (higher QALYs, lower costs) compared to the current package, with minor differences observed for the average total costs and average QALYs. Note that the average total costs per 1000 smokers changed with different values of RRs and reach estimates, as different values of effect size combined with different values of reach led ultimately to different number of quitters and hence and different treatment costs attributable to smoking-attributable diseases. In addition, the annual maximum costs per 1000 smokers that would be cost-effective to spend on internet-based interventions were approximately €149 000.

DISCUSSION

This study showed that providing internet-based smoking cessation interventions to complement the current provision of smoking cessation services is cost-saving in the Netherlands, resulting in more QALYs gained at a lower cost. The incremental costs per QALY gain were not sensitive to the time horizon, the intervention costs per smoker, RRs and the reach.

This study adds to the current literature that shows that internet-based health promoting interventions may have policy appeal. Our finding is comparable with a systematic review in that making internet-based interventions available to smokers actively seeking to quit is highly likely to be cost-effective [54]. Whereas several studies have demonstrated that these interventions can be effective and cost-effective, this study extended this body of literature by showing explicitly the value of internet-based interventions to complement the current provision of smoking cessation interventions (i.e. this alternate provision is less costly and more effective). Low average costs to deliver these interventions is a notable driver of cost-effectiveness [18].

Consistent with trial-based economic evaluations of internet-based smoking cessation interventions [15,17,24,55], this study showed some benefits of using such interventions in the short term. It is important, however, to note that trial-based studies may not capture long term cost-effectiveness, as the impact of cessation may need longer than a 12-month follow-up to improve QALYs of the ex-smokers [24,56]. It has therefore been suggested that the impact of these interventions be evaluated using longer time horizons [24]. This study is the first to incorporate a life-time horizon using a model to evaluate the cost-effectiveness of internet-based interventions in the Netherlands. Many other smoking cessation interventions tend to be cost-effective well below the €25 000 threshold [6]. Internet-based interventions, if added to the current provision of services, could be cost-saving compared to the current practice alone. This seems to be due to low costs per person to deliver these interventions, but an observed high impact upon cessation outcome [18].

This study provides policymakers in the Netherlands with the financial argument to implement and promote internet-based smoking cessation interventions. Despite previous evidence, the implementation of internet-based interventions in the Netherlands has been limited, and many are no longer publicly available [15,24]. Our findings therefore provide an incremental approach to policy-making in which internet-based interventions could be used to complement the current package. Moreover, for internet-based interventions to affect smoking behaviour, it is important to enhance its reach by investing in promotional and implementation activities. Although these costs were excluded in our main analysis, the threshold analysis indicated that an additional cost of up to €149/recipient on promotional and implementation activities could be spent to yield cost-effective results.

A few limitations of this study are worth mentioning. First, given data gaps, the effectiveness estimates of the current provision of interventions were derived from international meta-analyses. While deriving the mean effectiveness values, however, we considered the extent to which such estimates were transferable to the Netherlands. Secondly, while our analysis included potential increase in 'within-model costs' of implementing internet-based interventions (i.e. intervention cost per person), we acknowledge that there might be additional potential ‘outside-model’ costs related to implementation (e.g. cost of policy change such as changing guidelines and promotion activities among local community health services). Thirdly, this model incorporated the health-care perspective, which may be considered as limiting in the Netherlands [57,58]. Our estimates are therefore conservative, as work-place productivity is increased and absenteeism is decreased among former smokers compared to current smokers [59]. This may lead to productivity gains which decrease the societal burden. Fourthly, a probabilistic sensitivity analysis (PSA), that addresses the uncertainty around the model results by defining probability distributions for the input estimates instead of point estimates [60], could not be conducted, as the EQUIPTMOD was developed primarily to underpin an ROI tool for decision-making purposes [22]. This objective inevitably required the model to have the restricted PSA functionality (allowing a comparison between current and no investment only), thereby leading us to conduct a deterministic sensitivity analysis instead for this purpose. Fifthly, while including internet-based interventions in the model to complement the current package, we assumed the costs and effects of existing control measures will remain unchanged. It is reasonable to argue that provision of additional support for quitting (in the form of internet-based interventions) might lead to change in the costs and outcomes of existing services. However, with no supporting data in hand it was not possible to implement this argument into our analyses. Finally, in this study only on-line tailored interventions based on the I-Change model were identified as effective in the long term in the Netherlands, while other types of intervention may be available. This may thus not be generalizable to general internet-based smoking cessations in a global context. Hence, further investigation on the (cost-) effectiveness of these other interventions is needed. Moreover, in everyday life the usage of mobile phones is becoming increasingly important, indicating that internet-based smoking cessation interventions (developed to be accessed via a computer) may also need to function on a mobile platform. A Cochrane review indicated that no Dutch mobile phone-based interventions were tested for their effectiveness [61]. Hence, there may be a need to transfer effective internet-based smoking cessation interventions to the mobile phone-based platform. This creates opportunities for future research to explore this issue, such as investigating the differences in usage and effectiveness of interventions between different platforms.

CONCLUSIONS

A policy to provide internet-based smoking cessation interventions to complement the current provision of smoking cessation services in the Netherlands would be cost-saving from a health-care perspective—it would reduce health-care costs and result in QALY gains. Findings of this study may therefore provide policy/decision-makers with financial justifications for implementing internet-based interventions.

Declaration of interests

None.

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References

1. World Health Organization (WHO). WHO Framework Convention on Tobacco Control. 2003. Available at: http://www.who.int/fctc/en/ (accessed 1 August 2016) (Archived at http://www.webcitation.org/6unmquPJf on 7 November 2017).
2. World Health Organization (WHO). Tobacco facts. Geneva, Switzerland: WHO.
3. Sterftecijfers: CBS doodsoorzakenstatistiek [Mortality rates: CBS causes of death statistics]. The Hague: Statistics Netherlands (CBS). Available at: https://www.volksgezondheidenzorg.info/onderwerp/roken/cijfers-context/oorzaken-en-gevolgen#node-sterfte-en-verloren-levensjaren-door-roken (Accessed 8 November 2017).
4. ASPECT Consortium Tobacco or Health in the European Union: Past, Present and Future. Brussels, Belgium: European Commission, Directorate General for Health and Consumer Protection. 2004.
5. Cremers H.-P., Mercken L., Oenema A., de Vries H. A web-based computer-tailored smoking prevention programme for primary school children: intervention design and study protocol. *BMC Public Health* 2012; **12**: 277.
6. Feenstra T. L., Hamberg-van Reenen H. H., Hoogenveen R. T., Rutten-van Mölken M. P. M. H. Cost-effectiveness of face-to-face smoking cessation interventions: a dynamic modeling study. *Value Health* 2005; **8**: 178–90.
7. Song F., Raftery J., Aveyard P., Hyde C., Barton P., Woolacott N. Cost-effectiveness of pharmacological interventions for smoking cessation: a literature review and a decision analytic analysis. *Med Decis Making* 2002; **22**: S26–S37.
8. Coleman T. Cessation interventions in routine health care. *BMJ* 2004; **328**: 631–3.

9. Lancaster T., Stead L. F. Individual behavioural counselling for smoking cessation. *Cochrane Database Syst Rev* 2005 Apr **18**;(2):CD001292.
10. Civljak M., Sheikh A., Stead L. F., Car J. Internet-based interventions for smoking cessation. *Cochrane Database Syst Rev* 2013 Jul **10**;(7):CD007078. https://doi.org/10.1002/14651858.CD007078.pub4.
11. Internet; access, use and facilities; t/m 2016. Centraal Bureau voor de Statistiek, Den Haag/Heerlen 19-8-2016. Available at: http://statline.cbs.nl/Statweb/publication/?VW=T&DM=SLNL&PA=83429ned&D1=0&D2=0,3-6&D3=0&D4=a&HD=160819-1301&HDR=T&STB=G1,G2,G3 (accessed 19 August 2016).
12. Statistics Netherlands Statline. Internet; access, use and facilities. The Hague: Statistics Netherlands Statline; 2016.
13. Rodgers A., Corbett T., Bramley D., Riddell T., Wills M., Lin R.-B. *et al*. Do u smoke after txt? Results of a randomised trial of smoking cessation using mobile phone text messaging. *Tob Control* 2005; **14**: 255–61.
14. de Vries H., Brug J. Computer-tailored interventions motivating people to adopt health promoting behaviours: introduction to a new approach. *Patient Educ Couns* 1999; **36**: 99–105.
15. Smit E. S., Evers S. M. A. A., de Vries H., Hoving C. Cost-effectiveness and cost–utility of internet-based computer tailoring for smoking cessation. *J Med Internet Res* 2013; Mar 14;**15**(3):e57. https://doi.org/10.2196/jmir.2059.
16. Brendryen H., Drozd F., Kraft P. A digital smoking cessation program delivered through internet and cell phone without nicotine replacement (happy ending): randomized controlled trial. *J Med Internet Res* 2008; **10**: e51.
17. Elfeddali I., Bolman C., Candel M. J. J. M., Wiers R. W., de Vries H. Preventing smoking relapse via web-based computer-tailored feedback: a randomized controlled trial. *J Med Internet Res* 2012; **14**: e109.
18. Swartz L. H., Noell J. W., Schroeder S. W., Ary D. V. A randomised control study of a fully automated internet based smoking cessation programme. *Tob Control* 2006; **15**: 7–12.
19. Park A.-L., McDaid D., Weiser P., Von Gottberg C., Becker T., Kilian R. Examining the cost effectiveness of interventions to promote the physical health of people with mental health problems: a systematic review. *BMC Public Health* 2013; **13**: 1–17.
20. West R., Coyle K., Owen L., Coyle D., Pokhrel S. Estimates of effectiveness and reach for 'return on investment' modelling of smoking cessation interventions using data from England. *Addiction* 2017; https://doi.org/10.1111/add.14006.
21. Pokhrel S., Evers S. M., Leidl R., Trapero-Bertran M., Kalo Z., de Vries H. *et al*. EQUIPT: protocol of a comparative effectiveness research study evaluating cross-context transferability of economic evidence on tobacco control. *BMJ* 2014; **4**: e006945.
22. Coyle K., Coyle D., Lester-George A., West R., Nemeth B., Hiligsmann M. *et al*. Development and application of an economic model (EQUIPTMOD) to assess the impact of smoking cessation. *Addiction* 2017; https://doi.org/10.1111/add.14001.
23. Lancaster T. S. L., Cahill K., Lindson-Hawley N., Hartmann-Boyce J., West R., Aveyard P. N. *et al*. Cochrane tobacco addiction group. About the Cochrane Collaboration. Cochrane Review Groups (CRGs), Issue 7, Art. no.: Tobacco, 2013.
24. Stanczyk N. E., Smit E. S., Schulz D. N., de Vries H., Bolman C., Muris J. W. M. *et al*. An economic evaluation of a video- and text-based computer-tailored intervention for smoking cessation: a cost-effectiveness and cost–utility analysis of a randomized controlled trial. *PLOS ONE* 2014; **9**: e110117.
25. Cheung K. L., Wijnen B., de Vries H. A review of the theoretical basis, effects, and cost effectiveness of online smoking cessation interventions in the Netherlands: a mixed-methods approach. *J Med Internet Res* 2017; Jun 23;**19**(6): e230. https://doi.org/10.2196/jmir.7209.
26. de Vries H., Eggers S. M., Bolman C. The role of action planning and plan enactment for smoking cessation. *BMC Public Health* 2013; **13**: 393.
27. de Vries H., Eggers S. M., Jinabhai C., Meyer-Weitz A., Sathiparsad R., Taylor M. Adolescents' beliefs about forced sex in KwaZulu-Natal, South Africa. *Arch Sex Behav* 2014 Aug; **43**(6):1087–95. https://doi.org/10.1007/s10508-014-0280-8. Epub 2014 Apr 12.
28. de Vries H., Mudde A., Leijs I., Charlton A., Vartiainen E., Buijs G. *et al*. The European smoking prevention framework approach (EFSA): an example of integral prevention. *Health Educ Res* 2003; **18**: 611–26.
29. Kreuter M. W., Bull F. C., Clark E. M., Oswald D. L. Understanding how people process health information: a comparison of tailored and nontailored weight-loss materials. *Health Psychol* 1999; **18**: 487–94.
30. Kreuter M. W., Farrell D. W., Olevitch L. R., Brennan L. K. *Tailoring Health Messages: Customizing Communication With Computer Technology*. Routledge, New York; 2013.
31. Kreuter M. W., Oswald D. L., Bull F. C., Clark E. M. Are tailored health education materials always more effective than non-tailored materials? *Health Educ Res* 2000; **15**: 305–15.
32. Campbell M. K., DeVellis B. M., Strecher V. J., Ammerman A. S., DeVellis R. F., Sandler R. S. Improving dietary behavior: the effectiveness of tailored messages in primary care settings. *Am J Public Health* 1994; **84**: 783–7.
33. Smeets T. Towards a healthy lifestyle: the development and evaluation of a computer tailored lifestyle intervention. PhD thesis. Maastricht: Maastricht University 2006.
34. Bolman C., de Vries H., Mesters I. Factors determining cardiac nurses' intentions to continue using a smoking cessation protocol. *Heart Lung* 2002; **31**: 15–24.
35. Hall S., Vogt F., Marteau T. M. A short report: survey of practice nurses' attitudes towards giving smoking cessation advice. *Fam Pract* 2005; **22**: 614–6.
36. Leitlein L., Smit E. S., de Vries H., Hoving C. Factors influencing Dutch practice nurses' intention to adopt a new smoking cessation intervention. *J Adv Nurs* 2012; **68**: 2185–94.
37. Segaar D., Bolman C., Willemsen M. C., de Vries H. Determinants of adoption of cognitive behavioral interventions in a hospital setting: example of a minimal-contact smoking cessation intervention for cardiology wards. *Patient Educ Couns* 2006; **61**: 262–71.
38. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process* 1991; **50**: 179–211.
39. Janz N. K., Becker M. H. The health belief model: a decade later. *Health Educ Behav* 1984; **11**: 1–47.
40. Higgins J. P., Thompson S. G., Deeks J. J., Altman D. G. Measuring inconsistency in meta-analyses. *BMJ* 2003; **327**: 557.
41. Beard E., Brown J., Michie S., Kaner S., Meier P., West R. Use of aids for smoking cessation and alcohol reduction: a population survey of adults in England. *BMC Public Health* 2016; **16**: 1237.
42. Trimbos Institute. Factsheet continu onderzoek rookgewoonten 2014 [Factsheet continuous research, smoking habits]. Utrecht, the Netherlands; Trimbos Institute; 2014.

43. Het Nederlandse Zorgstelsel [The Dutch Healthcare System]. The Hague, the Netherlands: Ministerie van Volksgezondheid, Welzijn en Sport; 2016.
44. Chavannes H., Kaper J., Frijling D., Van der Laan R., Jansen M., Guerrouj S. *et al*. *NHG-Standard Smoking cessation. NHG-Standards 2009*. New York, NY: Springer; 2009, pp. 1434–49.
45. The EQUIPT Study Group 2016. EQUIPTMOD technical annex. Available at: http://www.equipt.eu/deliverables/ (accessed 8 August 2017) (Archived at http://www.webcitation.org/6ungspAKu on 7 November 2017).
46. Health survey/Lifestyle monitor. Statistics Netherlands (CBS) and Dutch National Institute for Public Health and the Environment (RIVM). Available at: https://www.volksgezondheidenzorg.info/content/gezondheidsenqu%C3%AAte-ge-leefstijlmonitor-lsm (accessed April 2016) (Archived at http://www.webcitation.org/6unn42QXa on 7 November 2017).
47. Cost of Illness database. Dutch National Institute for Public Health and the Environment (RIVM) 2013. Available at: https://www.volksgezondheidenzorg.info/kosten-van-ziekten#!nodezorgkosten-nederland (accessed April 2016) (Archived at http://www.webcitation.org/6unhNmV5Z on 7 November 2017).
48. Causes of death statistics. Statistics Netherlands (CBS), not dated. https://bronnen.zorggegevens.nl/Bron?naam=Doodsoorzakenstatistiek (accessed April 2016) (Archived at http://www.webcitation.org/6unhzGPWH on 7 November 2017).
49. Nationaal Kompas Volksgezondheid: Volksgezondheid Toekomstverkenning. versie 4.17. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu 2014. Available at: http://www.nationaalkompas.nl (accessed April 2016) (Archived at http://www.webcitation.org/6uni4V4zO on 7 November 2017).
50. Suijkerbuijk A. W., De Wit G., Wijga A. H., Heijmans M., Hoogendoorn M., Rutten-van Mölken M. *et al*. Societal costs of asthma, COPD and respiratory allergy. *Ned Tijdschr Geneeskd* 2013; **157**: 1–8.
51. West R. Background smoking cessation rates in England. 2006. Available at: http://www.smokinginengland.info/Ref/paper2.pdf (accessed April 2016).
52. Hakkaart-van Roijen L., van der Linden N., Bouwmans C., Kanters T. and Tan S.S. Cost guideline, Cost research methodology and reference prices for economic evaluations in health care. National Health Care Institute: Diemen; 2015.
53. Zinnige en duurzame zorg. Raad voor Volksgezondheid en Samenleving 2006. https://www.raadrvs.nl/publicaties/item/zinnige-en-duurzame-zorg (accessed April 2016) (Archived at http://www.webcitation.org/6unmhqiRZ on 7 November 2017).
54. Aveyard P., Madan J., Chen Y., Wang D., Yahaya I., Munafo M. *et al*. Effectiveness and cost-effectiveness of computer and other electronic aids for smoking cessation: a systematic review and network meta-analysis. *Health Technol Assess* 2012; **16**(38):1–205, iii-v. https://doi.org/10.3310/hta16380.
55. Te Poel F., Bolman C., Reubsaet A., de Vries H. Efficacy of a single computer-tailored e-mail for smoking cessation: results after 6 months. *Health Educ Res* 2009; **24**: 930–40.
56. Quist-Paulsen P., Lydersen S., Bakke P. S., Gallefoss F. Cost effectiveness of a smoking cessation program in patients admitted for coronary heart disease. *Eur J Cardiovasc Prev Rehabil* 2006; **13**: 274–80.
57. Jönsson B. Ten arguments for a societal perspective in the economic evaluation of medical innovations. *Eur J Health Econ* 2009; **10**: 357–9.
58. Knies S., Severens J. L., Ament A. J. H. A., Evers S. M. A. A. The transferability of valuing lost productivity across jurisdictions. Differences between national pharmacoeconomic guidelines. *Value Health* 2010; **13**: 519–27.
59. Halpern M. T., Shikiar R., Rentz A. M., Khan Z. M. Impact of smoking status on workplace absenteeism and productivity. *Tob Control* 2001; **10**: 233–8.
60. Briggs A. H. Handling uncertainty in cost-effectiveness models. *Pharmacoeconomics* 2000; **17**: 479–500.
61. Whittaker R., McRobbie H., Bullen C., Borland R., Rodgers A., Gu Y. Mobile phone-based interventions for smoking cessation. *Cochrane Database Syst Rev* 2012 Nov 14;**11**:CD006611. https://doi.org/10.1002/14651858.CD006611.pub3.
62. Hakkaart-van Roijen L., Tan S., Bouwmans C. Guideline for cost research: Methods and standard cost-price for economic evaluations in health care. 2010.
63. Aveyard P., Begh R., Parsons A., West R. Brief opportunistic smoking cessation interventions: a systematic review and meta-analysis to compare advice to quit and offer of assistance. *Addiction* 2012; **107**: 1066–73.
64. *Pharmacotherapeutic compass*. Diemen: Dutch Health Care Insurance Board; 2006. https://www.farmacotherapeutischkompas.nl/ (accessed December 2015) (Archive at http://www.webcitation.org/6unmnxCMe on November 2017).
65. Stead L. F., Perera R., Bullen C., Mant D., Hartmann-Boyce J., Cahill K. *et al*. Nicotine replacement therapy for smoking cessation. *Cochrane Database Syst Rev* 2012 Nov 14;**11**:CD000146. https://doi.org/10.1002/14651858.CD000146.pub4.
66. Cahill K., Stead L. F., Lancaster T. Nicotine receptor partial agonists for smoking cessation. *Cochrane Database Syst Rev* 2008 Jul **16**;(3):CD006103. https://doi.org/10.1002/14651858.CD006103.pub3.
67. Tonstad S., Tønnesen P., Hajek P., Williams K. E., Billing C. B., Reeves K. R. *et al*. Effect of maintenance therapy with varenicline on smoking cessation: a randomized controlled trial. *JAMA* 2006; **296**: 64–71.
68. Hughes J. R., Stead L. F., Hartmann-Boyce J., Cahill K., Lancaster T. Antidepressants for smoking cessation. *Cochrane Database Syst Rev* 2014 Jan **8**;(1):CD000031. https://doi.org/10.1002/14651858.CD000031.pub4.
69. Stead L. F., Lancaster T. Group behaviour therapy programmes for smoking cessation. *Cochrane Database Syst Rev* Apr **18**;(2):CD001007.
70. Hartmann-Boyce J., Lancaster T., Stead L. F. Print-based self-help interventions for smoking cessation. *Cochrane Database Syst Rev* 2014 Jun **3**;(6):CD001118. https://doi.org/10.1002/14651858.CD001118.pub3

