

Health wearables in adolescents: Implications for body satisfaction, motivation and physical activity

Abstract

Significant proportions of adolescents do not meet recommended physical activity levels. Finding new ways to motivate adolescents to be active is important for physical and psychological well-being. Health and fitness wearables such as the Fitbit have the potential to motivate young people to be active. The aim of this study is to explore if wearing a Fitbit for 5 weeks impacted adolescents (14-15 year olds) body satisfaction, physical activity motivation and objective physical activity. The study was conducted with 62 (38 boys, 24 girls) pupils aged 14-15, from five high school physical education classes, in one high school in the United Kingdom. Pupils wore a Fitbit Charge HR for five weeks. Pupils wore an accelerometer for 7 days pre and post the five-week period to explore changes in physical activity levels. Pupils also completed pre-post-test questionnaires to measure body satisfaction and physical activity motivation. Data was analysed using a repeated measures MANOVA to explore differences in scores between time and sex. After wearing the Fitbit, the pupils experienced declines in autonomous motivation and increases in both amotivation and controlled motivation, but these differences were not significant. In line with these negative motivational outcomes, pupils engaged in significantly less moderate to vigorous physical activity after wearing the Fitbit. Significant increases in body satisfaction were also experienced by pupils after wearing the Fitbit. These findings suggest that without support Fitbits may make pupils less motivated to be active and decrease the physical activity levels of adolescents.

Keywords:

Fitbit, Health Wearables, Physical Activity, Body Satisfaction, Motivation

Introduction

Regular physical activity in adolescents is associated with a range of physical and psychological health benefits, such as reduced obesity and depression (Janssen and LeBlanc, 2010). It is recommended that children and adolescents aged 5-15 years engage in at least 60 minutes of moderate activity on a daily basis (Department of Health, 2013). However, it is widely acknowledged that young people are not meeting these targets. For example, the Department of Health (2013) reported that only 16% of girls and 21% of boys in the United Kingdom are achieving the recommended physical activity. A review study has suggested that on average young people aged 2-18 engage in approximately 30 minutes of moderate to vigorous physical activity on a daily basis (Ekelund, Tomkinson and Armstrong, 2011). The adolescent period is of particular interest for physical activity promotion due to the declines in physical activity levels that are reported throughout early to late adolescence (Faroq et al. 2017; Nelson et al. 2006). Finding ways to combat the decline in physical activity during adolescence should have a positive impact on various health outcomes (Belton et al. 2014).

Health Wearables

Technology has a potential role to play in the physical activity promotion strategies of adolescents. Physical activity and health promotion programmes have been constructed with a focus on using technology such as social media (Shaw et al. 2015), exergames (Zen and Gao, 2016), and mobile applications (Muntander, Vidal-Conti and Palou, 2015). Health wearables such as the Fitbit are also a technology being marketed to promote physical activity. Activity trackers such as pedometers and accelerometers have been available for physical activity promotion for a substantial period of time, however, these devices were generally not commercially available. The introduction of the Fitbit in 2007 saw the first

commercially available health wearable device and thus the potential for widespread accessibility. Many varieties of health wearables exist with slight variations in their functional capabilities (Piwek et al. 2016). Wearables such as the Fitbit are watch like devices with visual displays that connect to an app on a mobile device. The user gets information on step count, heart calories burnt and floors climbed. The app allows the individual to access and tailor their health goals and also connect with other users.

Health wearables and Motivation

Little is known about how health wearables can be used in adolescent physical activity promotion. One of the objectives of health wearables is to increase motivation to be physically active. An individual is said to be motivated when they are moved to execute a particular behaviour (Deci and Ryan, 2000), or in this context, moved to engage in physical activity. In a sample of 42 adults, participants experienced increases in the motivational constructs of enjoyment, challenge, affiliation and positive health motivation after eight weeks of wearing a Nike Fuelband (Brice et al. 2016). Qualitative evidence from children aged 11-12 suggest that features of the Fitbit such as competition and real-time feedback can enhance physical activity motivation (Schaefer et al. 2016). Whereas, contrasting evidence suggests that the competitive features of the Fitbit may negatively impact physical activity motivation (Kerner and Goodyear, 2017).

The current study will use a self-determination theory approach to explore physical activity motivation. Self-determination theory (SDT) is a macro-theory of human motivation, which allows an understanding of the initiation and maintenance of behaviours (Deci and Ryan, 2012) The theory suggests that the type of motivation is of greater importance than the quantity of motivation for explaining human actions (Deci and Ryan, 2000). Behaviours can be represented along a self-determination continuum, ranging from higher to lower levels of

self-determination, depending on the extent to which the behaviour is volitional. Six different types of motivation exist along the continuum, which can further be divided into autonomous motivation, controlled motivation and amotivation (Haerens et al., 2010). Autonomous motivation is the most self-determined and is a combination of intrinsic motivation (undertaking an activity for the inherent pleasure of and interest in the activity itself), integrated regulation (undertaking an activity because it fits the different goals and values you have in life), and identified regulation (when the outcome of the behaviour is personally important) (Ryan and Deci, 2007). Controlled motivation is a combination of introjected regulation (an individual engages in a behaviour to avoid guilt or obtain social approval) and external regulation (an individual engages in a behaviour to avoid punishment or obtain a reward) (Ryan and Deci, 2007). Autonomous motivation is based on values or personal interests, whereas, controlled motivation is less self-determined and based on demands that are either externally or internally imposed (Van den Berge et al., 2014). Amotivation is at the end of the continuum and is evident when an individual is neither intrinsically nor extrinsically motivated, thus, lacks motivation and volition (Deci and Ryan, 1985).

According to self-determination theory (Ryan and Deci, 2000), the Fitbit may act as a source of external control that undermines autonomous motivation (Kerner and Goodyear, 2018). Thus, after wearing the Fitbit, pupils may be less likely to engage in physical activity volitionally. Qualitative evidence suggests that pupils may experience a ‘novelty period’ of approximately five weeks, after which, young people become disengaged with the device and physical activity motivation declines (Kerner and Goodyear, 2017). Identifying the period at which declines in motivation occur would allow for the development and implementation of support strategies. The current study will extend previous research by exploring if changes in motivation after wearing a Fitbit also results in changes in physical activity levels.

Health wearables and Motivation

A physical activity review study explored the feasibility and effectiveness of health wearables and identified five studies that had explored the use of these devices in young people (Ridgers, McNarry and Mackintosh, 2016). Of these five studies only three had focused specifically on the Fitbit, with sample sizes ranging from six (Hayes and Van Camp, 2015) to 34 participants (Schaefer et al. 2016). The review argued that young people generally have positive reactions towards health wearables and they have potential for promoting physical activity (Ridgers, McNarry and Mackintosh, 2016). For example, increases in step count were identified in a sample of six eight-year old girls across 22 recess periods (Hayes and Van Camp, 2015). Similarly, when a Fitbit Flex was used as part of a four-week multicomponent intervention with 11 participants with Attention Deficit Hyperactivity Disorder, significant increases in step count were also identified (Schoenfelder et al. 2017). However, the most likely way in which young people are using health wearables is not within an intervention based setting. It is therefore important to obtain a naturalistic understanding of the impact of these devices on young people's behaviours. The Fitbit is argued to be one of the market leaders in wearable devices (Bai et al., 2018), therefore, as many young people are using Fitbits with the aim of changing health behaviours, there is a research need to explore the impact of the Fitbit on health behaviours, such as physical activity. To the authors knowledge, there is no published research to date that assesses changes in objectively measured physical activity as a result of wearing a Fitbit in a naturalistic setting. Objective physical activity measures record the real-time physiological or biomechanical outcomes associated with movement, thus, overcome the issues associated with self-report measures, such as recall errors and reporting bias (Trost and O'Neil, 2014). It is important from a health promotion perspective to understand if devices such as Fitbits change actual physical activity levels.

Health Wearables and Body satisfaction

Body satisfaction is an important variable associated with physical activity participation in adolescents (Kerner, Harens and Kirk, 2017, Kerner et al., 2018). Meta-analysis has confirmed that exercise interventions can have a positive impact on body image outcomes in adults (Campbell and Hausenblas, 2009). Campbell and Hausenblas (2009) argue that possible mechanisms through which body satisfaction may increase in exercise interventions include changes in body composition and changes in physical self-perceptions e.g. strength. Thus, if the Fitbit does act as a tool to increase physical activity, body satisfaction may be increased through these mechanisms. Another potential mechanism for increased body satisfaction after wearing a Fitbit, could be due to the potential emphasis that wearing the device may place on functional aspects of the body (e.g. physical activity and movement). This can be explained in the context of body conceptualisation theory (Franzoi, 1995). According to body conceptualisation theory there are two ways in which the body can be viewed. Firstly, the body can be considered as a passive object, in which the aesthetic values of the body are emphasised. Alternatively, the body can be viewed as an active entity or a process in which the functional qualities of the body are the focus. Body functionality interventions in adult women have led to increases in body satisfaction (Alleva et al. 2018). In this regard, wearing the Fitbit may lead to greater value being placed on functional qualities, and a decrease in importance on aesthetic qualities. However, in contrast to this, Simpson and Mazzeo (2017) discuss how media reports have outlined the negative aspects of health trackers and the potential associations between use of health trackers and increased body image concerns. The monitoring and quantification of health may be the mechanism through which health trackers impact self-worth (Simpson and Mazzeo, 2017). There is no empirical evidence to support the impact that health wearables have on young people's body satisfaction. Given the limited evidence exploring the impact of Fitbits on young people's

health and well-being in a naturalistic setting, the aim of this study is to explore if wearing a Fitbit for five weeks, impacts adolescent boys' and girls' objective physical activity levels, physical activity motivation and body satisfaction.

Materials and Methods

Participants

The participants consisted of 62 (38 boys, 24 girls) pupils aged 14-15, from five physical education classes, in one secondary school in the North West of England. Year 10 pupils (age 14-15) were selected due to the evidenced declines in physical activity in this age group (Health Survey for England, 2012). All pupils and parents/carers were provided with information sheet outlining the requirements of the study. Prior to data collection, university ethical approval was granted and informed consent was obtained from the participants parents/guardians. Assent from the pupils was also obtained.

Procedures

Data was collected across a seven-week period in the winter school term. The study was a pre-post intervention design, with assessments of physical activity motivation, body satisfaction and physical activity. At the start of the study pupils completed a paper and pen questionnaire package to assess their physical activity motivation and body satisfaction. The questionnaires were completed with support from the research team and teachers. Pupils wore an ActiGraph GT9X triaxial accelerometer (ActiGraph, Pensacola, FL, USA) on their non-dominant wrist for seven consecutive days. Following this assessment of baseline physical activity, the pupils were provided with a Fitbit Charge HR to wear for a five-week period. Pupils were provided with instructions on the how to use the device (e.g. how to charge the device, how to use the app, how to change physical activity goals) and were asked to wear the device for the five-week period. A five-week period was selected as this has been identified

as an important period for pupil's motivation when using health wearables (Kerner and Goodyear, 2017). At the end of the five weeks all pupils repeated the completion of the baseline paper and pen questionnaire package. Pupils also wore the accelerometer device for seven days, following the same protocol as baseline.

Measures

Physical Activity Motivation

Pupils completed pre and post-test assessments of physical activity motivation using the Behavioural Regulations in Exercise Questionnaire II (Markland and Tobin, 2004). The BREQ II consists of 19 items that represent five different subscales that include amotivation (e.g. I don't see why I should have to do physical activity), external regulation (e.g. I feel under pressure from my friends/family to do physical activity), introjected regulation (e.g. I feel guilty when I don't do physical activity), identified regulation (e.g. I value the benefits of physical activity) and intrinsic regulation (e.g. I do physical activity because it's fun). Participants were asked to respond to each item on a five-point scale ranging from zero (not true for me) to four (very true for me). For data analysis mean scores for autonomous motivation, controlled motivation and amotivation were calculated.

Body dissatisfaction: In order to assess body dissatisfaction, the BMI-based Silhouette Matching Test (Peterson et al. 2003; 2004) was completed by all pupils before and after wearing the Fitbit Charge HR. The measure is a figural rating scale derived from anthropometric data of 9th-12th grade Canadian male and female adolescents (Paterson et al. 2003). Participants were presented with a gender scale consisting of four silhouette drawings with a 27 interval scale. The four silhouette images provide visual reference points and represent BMI values of 18, 24, 30 and 36. Participants were asked to place an 'X' in one of the 27 boxes on the scale which best reflects their current appearance and an 'X' in the box

that represents their ideal appearance. Body dissatisfaction was determined by a discrepancy between the perceived current and ideal physique.

Physical activity

Accelerometers were distributed to pupils to measure physical activity at baseline and after wearing the Fitbit. The researchers introduced the device to the pupils, completed demonstration and provided instructions on how to wear them. Pupils wore an ActiGraph GT9X triaxial accelerometer (ActiGraph, Pensacola, FL) on their non-dominant wrist for seven consecutive days. Pupils were instructed to wear the accelerometer all the time (24 h/day-1) except when engaging in water-based activities such as bathing and swimming. The ActiGraph GT9X accelerometer uses the same validated MEMS sensor as the ActiGraph GT3X+ model (Hanngi et al. 2013) which has been used extensively in child physical activity research (Cain et al. 2013). Log sheets were provided for children to record times when the accelerometer was removed and replaced. Accelerometers were set to record using a 10 second epoch (Cain et al. 2013). The mean daily minutes spent in moderate-to-vigorous physical activity (MVPA) was estimated using the validated cut points, derived by Evenson et al. (2008) for adolescents in this age group: $MVPA \geq 2296$ counts/min. The minimum number of valid days required for inclusion in analysis was three weekdays, and one weekend day, a day was deemed valid (and therefore included in analysis) if there was a minimum of 10 hours recorded wear-time per day (Mattocks et al. 2008). Despite daily reminders to wear the device from the class teacher, only a total of twenty-eight of the pupils had valid accelerometer wear time.

Fitbit Charge HR

All pupils received a Fitbit Charge HR device. The device has a MEMS 3-axis accelerometer that measures motion patterns to determine steps taken, distance travelled, active minutes,

heart rate and calories burned. It also monitors sleep duration and sleep quality but these features were not the focus of the current study. The Fitbit Charge includes an interactive app for use with mobile device. The app can be used to log workouts, compete with friends, tailor physical activity goals and it displays individualised results. Pupils were provided with instructions on how to use the device and were asked to wear the device for five weeks, although their engagement time with the Fitbit was not recorded in the current study.

Data Analysis

Data was analysed using the Statistical Package for the Social Sciences (SPSS) version 22. Descriptive statistics were calculated for all dependent variables using mean and standard deviations. In order to assess if there were changes in the dependent variables, differences across sex and any interactions between pre-post test scores and sex a repeated measure Multivariate Analysis of Variance (MANOVA) was conducted. Statistical significance was determined by $p < 0.05$. For physical activity data, analysis was completed for the 28 participants with valid wear time.

Results

Descriptive statistics for body satisfaction, motivation and physical activity for boys and girls, pre and post Fitbit can be found in table 1. To investigate differences in autonomous motivation, controlled motivation, amotivation, body satisfaction and MVPA between boys and girls and pre and post intervention mixed design factorial design ANOVA were conducted.

The interaction effect between pupil sex and pre-post Fitbit scores of autonomous motivation ($F(1, 56) = 0.24, p = 0.88, \eta^2 = 0.00$), controlled motivation ($F(1, 56) = 1.71, p = 0.20, \eta^2 = 0.03$) and amotivation ($F(1, 56) = 0.15, p = 0.70, \eta^2 = 0.00$) were insignificant. This indicates

that motivation scores pre and post intervention did not differ significantly between boys and girls. For the main effect of sex, there were no significant differences in autonomous motivation ($F(1, 56) = 0.52, p = 0.47, \eta^2 = 0.01$), controlled motivation ($F(1, 56) = 1.71, p = 0.20, \eta^2 = 0.03$) and amotivation ($F(1, 56) = 0.71, p = 0.41, \eta^2 = 0.01$) between boys and girls. Furthermore, for the main effect of time, there were no significant differences in autonomous motivation ($F(1, 56) = 2.31, p = 0.13, \eta^2 = 0.04$), controlled motivation ($F(1, 56) = 0.00, p = 0.98, \eta^2 = 0.00$) and amotivation ($F(1, 56) = 3.87, p = 0.054, \eta^2 = 0.07$) pre and post Fitbit.

The interaction effect between pupil sex and pre-post Fitbit scores of body dissatisfaction was non-significant, $F(1, 56) = 3.71, p = 0.06, \eta^2 = 0.08$. This indicates that body dissatisfaction scores pre and post intervention did not differ significantly between boys and girls. For the main effect of sex, there was no significant difference in body dissatisfaction scores between boys and girls, $F(1, 56) = 2.99, p = 0.09, \eta^2 = 0.05$. However, for the main effect of time, body dissatisfaction scores were significantly lower post Fitbit, $F(1, 56) = 4.52, p = 0.04, \eta^2 = 0.08$.

The interaction effect between pupil sex and pre-post Fitbit scores of total MVPA was non-significant, $F(1, 26) = 6.90, p = 0.01, \eta^2 = 0.21$. This indicates that total MVPA pre and post intervention did not differ significantly between boys and girls. For the main effect of sex, there was no significant difference in total MVPA between boys and girls $F(1, 26) = 0.82, p = 0.38, \eta^2 = 0.03$. However, for the main effect of time, total MVPA was significantly lower post Fitbit, $F(1, 26) = 6.90, p = 0.01, \eta^2 = 0.21$.

Discussion

The aim of this study was to explore if wearing a Fitbit for five weeks impacted adolescents' physical activity motivation, body satisfaction and physical activity levels. This extends the

findings of previous research by exploring if a Fitbit influences actual objective physical activity levels and levels of body satisfaction.

In line with the findings of other research (Kerner and Goodyear, 2017; Goodyear, Kerner and Quennerstedt, 2017) wearing the Fitbit led to declines in autonomous motivation and increases in amotivation for both boys and girls. However, in the current study, the changes in motivation from pre to post Fitbit were non-significant. Decreases in autonomous motivation suggests that, the pupils were less likely to engage in physical activity through their own volition after wearing the Fitbit. Using self-determination theory, it could be argued that the Fitbits acted as an external source of control, encouraging physical activity participation through external means (e.g. by badges and rewards), which undermined self-determination and autonomous motivation (Ryan and Deci, 2000).

Controlled motivation slightly increased in boys and slightly decreased in girls, with no significant differences pre-post Fitbit. Given the Fitbit is an external physical activity motivator, that encourages physical activity through rewards and feedback, it might be expected that controlled forms of motivation would increase after wearing the Fitbit. The Fitbit may act as a tool that increases both internal pressure (e.g. guilt) and external pressure (e.g. reward), however, these increases in controlled motivation were not apparent in the current study. Nonetheless, the declines in autonomous motivation mean that after wearing the Fitbit, pupils were less likely to engage in physical activity through self-determined reasons and more likely to lack the motivation to be active. Previously these, motivational outcomes have been explained by features of the Fitbit undermining pupils' basic psychological needs (Kerner and Goodyear, 2017). For example, features such as competitions within the app and predetermined physical activity targets such as achieving 10,000 steps may impact perceived competence, which subsequently lowers levels of self-determination. These motivational implications are important for behavioural outcomes

because low autonomous motivation and high amotivation are associated with lower physical activity levels (Owen et al. 2014).

Extending the findings of previous literature, this study also measured changes in MVPA pre and post Fitbit. Alongside the declines in autonomous motivation and increases in amotivation, MVPA also significantly declined by over nine minutes per day (9.53min/day). According to self-determination theory, the declines in autonomous motivation could have contributed to the reductions in MVPA (Teixeria et al. 2012). Self-determination theory proposes that a more self-determined form of motivation (e.g. autonomous motivation), leads to positive outcomes such as increased physical activity, whereas, amotivation is associated with lower physical activity levels (Owen et al. 2014). These findings suggest that the Fitbit may not be a suitable physical activity intervention tool for young people, as it undermines self-determination and reduces physical activity levels.

The study also explored changes in body satisfaction, due to the established positive associations between exercise interventions and increased body satisfaction (Campbell and Hausenblas, 2009), therefore, it might be expected that if the Fitbit led to decreased physical activity levels, body satisfaction may also have decreased. However, the study identified significant increases in body satisfaction, after wearing the Fitbit for five weeks, with the biggest increases being in boys, compared to girls. Given the declines in physical activity and motivation, it might be expected that body satisfaction would also decline; however, this was not the case in the current study. These changes can be explained by applying body conceptualisation theory (Franzoi, 1995). It may be that wearing the Fitbit led to a greater appreciation and value for physical movement and the functional capabilities of the body that led them to place less value and emphasis on aesthetic qualities, such as body shape and size. This is supported by body functionality interventions in women that have led to improved

body image (Alleva et al. 2018), however, more research is needed to confirm these proposed mechanisms in relation to the current study.

Limitations and Future Research

The authors acknowledge the small sample size used in the current study, which is a result of financial limitations. Future research may also consider midpoint assessments of the study variables to identify important points of change. Furthermore, follow up procedures to review the longer-term implications of health wearables upon adolescents would be beneficial in future research. Future studies may also consider tracking the pupils' engagement with the devices, to understand how varying levels of engagement may impact outcomes.

Furthermore, incentives could be used to increase accelerometer wear time (Audrey et al. 2013).

Conclusion

Gaining an understanding of the impacts of health wearables in a naturalistic setting is important for both educators and parents. Health wearables such as the Fitbit may not be an effective 'stand-alone' tool for promoting physical activity in young people. For example, if young people are provided with a Fitbit as gift, with the intention of increasing physical activity, the findings suggest that in a naturalistic setting physical activity levels may actually decline. It is important, therefore, to consider the negative implications of providing young people with health wearables outside of structured interventions.

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Table 1: Means and standard deviations for motivation, body satisfaction and physical activity scores for boys, girls and all pupils' pre and post Fitbit

Variable name	Pre Fitbit			Post Fitbit		
	Boys	Girls	All	Boys	Girls	All
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Autonomous Motivation	2.94 (.86)	2.79 (.57)	2.88 (.76)	2.81 (.86)	2.69 (.74)	2.77 (.75)
Controlled Motivation	0.97 (.62)	1.22 (.58)	1.07 (.61)	1.06 (.77)	1.13 (.68)	1.09 (.73)
Amotivation	0.34 (.64)	0.20 (0.40)	0.28 (.56)	0.43 (.64)	0.33 (.61)	0.39 (.63)
Body dissatisfaction	3.23 (2.57)	3.96 (3.04)	3.52 (2.76)	2.34 (2.07)	3.91 (2.92)	2.97 (2.54)
Daily MVPA	187.46 (46.93)	202.44 (32.53)	194.42 (40.87)	179.73 (39.90)	190.85 (35.06)	184.89 (37.47)

