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Original Article

The effect of a wearable physical activity monitor (Fitbit One) on physical activity behaviour in women: A pilot study

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ABSTRACT

Introducion. With wearable technology topping both the 2016 and 2017 American College of Sports Medicine (ACSM) Fitness Trends survey, research in this area is needed to help determine the importance of such devices. Purpose. To determine the effect of wearing a popular, commercially-available wearable activity monitor (i.e., Fitbit One) upon physical activity behaviour relative to a group who was not utilizing such a monitor. Methods. A sample of 19 healthy adult women completed the Human Activity Profile survey to assess physical activity behaviour pre – and post – intervention. For the intervention, nine participants received a Fitbit One accelerometer to wear for six weeks, while the remaining participants (control group) did not receive an accelerometer. Results. There were no significant differences ($p \geq 0.16$) in physical activity. However, the control group reduced physical activity by $\geq$20% from pre to post intervention whereas the Fitbit One group was largely unchanged (0.5% - 2.4% decrease). Conclusion. While wearing a physical activity monitor did not increase physical activity behaviour it may help maintain it. **Key words:** WEARABLE MONITORS, PHYSICAL ACTIVITY, BEHAVIOUR.

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INTRODUCTION

Wearable physical activity monitors are one of the most popular, widely-used exercise devices, to the point “wearable technology” topped the 2016 and 2017 American College of Sports Medicine (ACSM) Fitness Trends (Thompson, 2015; Thompson 2016). These devices typically interface with both mobile-phone-based and personal-computer-based software which provide a variety of functions including, but not limited to, allowing the user to monitor their physical activity behaviour, establish goals for greater physical activity and electronically share their physical activity achievements with peers. There is evidence to support the validity of many wearable physical activity monitors to accurately estimate physical activity (Lee, Kim, & Welk, 2014; McMinn, Rowe, Stark, & Nicol, 2010; Silva, Mota, Esliger, & Welk, 2010; Nelson, Kaminsky, Dickin, & Montoye, 2016). Additionally, there is evidence the use of such devices may promote greater physical activity in the wearer (Araiza, Hewes, Gashetewa, Vella, & Burge, 2006; Lyons, Lewis, Mayrsohn, & Rowland, 2014; Nowicki, Murlikiewicz, & Jagodizinska, 2010).

Physical inactivity is increasingly a global problem (Dumith, Hallal, Reis, & Kohl, 2011) and the consequences of inadequate physical activity are well documented (Fishman et al., 2016, Preston & Stokes, 2011). As such research examining why individuals are physically inactive is of importance. Extant evidence has identified several factors that can contribute to physical inactivity such as poor social support and a lack of motivation (Conroy, Hyde, Doerksen, & Ribeiro, 2010; Litt, Iannotti, & Wang, 2011; Power, Ullrich-French, Steele, Daratha, & Bindler, 2011). Wearable physical activity monitors allow the user to interact with peers and share their physical activity goals and behaviours. This function may, in part, explain why these devices have shown promise as an avenue for increasing physical activity behaviour. If the wearer is receiving feedback from the device and their peers, this may serve to increase extrinsic motivation to be physically active.

While there is promising evidence that certain wearable physical activity monitors and the corresponding software functions (e.g., proving feedback, peer interaction) may promote greater physical activity, this research is limited. There has been a proliferation in the number of these devices that are marketed directly to the user and much of the existing research on wearable activity monitors is limited to devices that were designed for research purposes (Ferguson, Rowlands, Olds, & Maher, 2015; Paschali, Goodrick, Kalantzi-Azizi, Paadatou, & Balasubramanyam, 2005). Therefore, additional research on the efficacy of these newer devices that are marketed for personal use, is warranted. One such device, the Fitbit One (San Francisco, California, USA), is marketed as “one powerful, motivating tracker” as it provides feedback regarding the wearer’s physical activity behaviour (e.g., steps taken, miles travelled, stairs climbed, calories expended) and allows that data to be shared with “friends and family” (retrieved September 24, 2016 from https://www.fitbit.com/one). While there is evidence supporting the ability of the Fitbit One to accurately assess physical activity (Diaz et al., 2016) there are no studies we are aware of to assess the ability of this device to increase the physical activity behaviour of the wearer.

Purpose

The purpose of this pilot study was to examine the effect of a popular, commercially-available, wearable physical activity monitor (i.e., Fitbit One) upon physical activity behavior in a group of healthy female adults. This effect was assessed for statistical significance and if significance was not achieved, the number of participants required to achieve significance was calculated via power analyses. This is the first study to assess the effect of this validated physical activity monitor upon physical activity behavior of the wearer. We hypothesized that the use of this physical activity monitor would increase physical activity behavior. This was based on previous research that demonstrated that the use of similar wearable activity monitors did lead to an increase in the physical activity of the wearers (Araiza et al., 2006; Lyons et al., 2014; Nowicki, et al., 2010).

METHODS

Participants

Participants (*N* = 19 females) in this study consisted of staff and faculty from a large, public university in the Central United States. Participants were recruited though campus-wide email. Participants were required to be between 18-50 years old. Prior to beginning the study, each participant completed an informed consent and health history questionnaire and those identified as high risk or had other contraindications for exercise were excluded from the study. No other inclusion or exclusion criteria were included. All study procedures were approved by the Institutional Review Board.

Procedure

Each of the participants completed the Human Activity Profile survey (Daughton, Fix, Kass, McDonald, & Stevens, 1983) to determine baseline activity status. After completing the survey, subjects were randomly assigned to either the control (*n* = 10) or the Fitbit group (*n* = 9). Participants in the Fitbit group were asked to wear the accelerometer during waking hours and were given instructions on how to sync the activity monitor with the computer software in order to download their activity data. All participants returned to the laboratory six weeks later to complete the post-intervention survey (i.e. Human Activity Profile).

Instruments

The Human Activity Profile was developed by Daughton et al., (1983) and is a 94 - question survey that was created to assess changes in physical activity. Activities increase in intensity as the survey progresses, beginning with number one, "Getting in and out of a chair or bed" and ending with number ninety-four, "Running or jogging three miles in thirty minutes or less". The survey has three different answer columns that indicated whether the subject is: "*still doing the activity (*completed the activity unassisted the last time they had the need or opportunity to do so*); has stopped doing this activity (*engaged in the activity in the past, but they probably would not perform the activity today even if the opportunity should arise*); and never did this activity (*never engaged in the specific activity*).*" Table 1 explains each of the subsets of the instrument.

Table 1. *Outline of HAP Scores and Classifications*

Scores and Classifications	Definition	Formula	Interpretation
Maximum Activity Score (MAS)	Highest oxygen-demanding activity that the respondent still performs	MAS = Highest item number answered *Still Doing*	Best estimate of highest level of energy expenditure
Adjusted Activity Score (AAS)	A measure of usual daily activities	AAS = MAS minus total number of *Stopped Doing* responses below MAS (i.e., with lower item numbers)	Best estimate of average level of energy expenditure

Adopted from Daughton, et al., 1988

The Human Activity Profile was chosen for use in this research because of its reliability, validity and responsiveness to measure change (Bilek, Venema, Camp, Lyden, & Meza, 2005). It was found to be significantly correlated ($r = 0.48$, $p < 0.05$) with a pulmonary function test (FEV1) test in measuring activity levels (Daughton, et al., 1983). Bastone et al. (2014) also found a moderate to large correlation between the Human Activity Profile survey and accelerometer data ($r = .45\text{-}.75$, $p < 0.001$) in older, community-dwelling women.

Once each participant completed the Human Activity Profile, the subset category scores (the maximum activity score and the adjusted activity score) were determined as described in Table 1. The maximum activity score represented the greatest activity level an individual could perform. This was the maximum score that could be obtained on the Human Activity Profile. The adjusted activity score is the difference between the maximum activity score and the total number of "Stopped Doing" responses below the maximal activity score.

The Fitbit One is a commercially-available, wearable physical activity monitor/accelerometer that is worn on the wrist. The device is capable of monitoring steps taken, floors climbed, distance travelled, and caloric expenditure. The device can also distinguish minutes spent at various physical activity intensities (e.g., light, moderate, vigorous) throughout the day. The Fitbit One automatically and wirelessly syncs to tablets, computers, and smartphones using a supplied wireless sync dongle and Bluetooth 4.0 technology. There are at least two studies that have assessed the validity of the Fitbit One as a physical activity monitor (Diaz et al., 2016; Takacs et al., 2014). Diaz et al. (2016) evaluated the validity of the Fitbit One using thirteen female adult subjects that completed a four-phase treadmill test. Their results concluded that the Fitbit One was able to determine an accurate step count across different walking and running speeds. Takacs et al. (2014) conducted a similar study with 30 healthy adults where these researchers evaluated the validity of the Fitbit One across five different treadmill speeds. They concluded that the Fitbit One is valid and reliable device for counting steps in healthy, young adults.

Statistical Analysis

Two group (Fitbit One, Control) by two time (zero, six weeks) analyses of variance (ANOVAs) with repeated measures on time were performed to assess changes in physical activity variables (maximum activity and adjusted activity scores) across time and between groups. All analyses were performed using SPSS version 18 with an a-priori $\alpha \leq 0.05$. Subsequent power analyses were then performed to determine the effect sizes and number of participants needed to achieve statistical significance given the present results.

RESULTS

There were no significant ($p \geq 0.16$) main or interaction effects by group or by time for either maximum activity score or adjusted activity score (Table 2). While there were no significant effects from the ANOVA subsequent power analysis of the change in maximum activity score from week zero to week six for the Fitbit One group (Δ maximum activity score = -2.1 ± 2.2) versus the control group (Δ maximum activity score = -17.5 ± 27.8) yielded an effect size of Cohen's $d = 0.78$ and would require a sample size of $n = 15$ per group to illustrate a significant effect assuming power ≥ 0.80 and $\alpha \leq 0.05$. A similar power analysis was performed for differences in adjusted activity scores between the Fitbit One group (Δ adjusted activity score = -0.4 ± 1.3) and the control group (Δ adjusted activity score = -16.8 ± 34.6) and yielded an effect size of Cohen's $d = 0.67$ which would require a sample size of $n = 19$ per group to illustrate a significant effect assuming power ≥ 0.80 and $\alpha \leq 0.05$.

Table 2. *Descriptive Means of the HAP Survey by Group*

Variable	Fitbit		Control	
	Pre (SD)	Post (SD)	Pre (SD)	Post (SD)
MAS	86.2 (6.5)	84.1 (7.1)	78.2 (29.9)	60.7 (45.6)
AAS	83.5 (7.4)	83.1 (7.0)	77.4 (29.9)	60.6 (45.6)

DISCUSSION

The current pilot study examined the effects of the use of a popular, commercially-available, wearable activity monitors on physical activity behaviour relative to a control group which did not utilize activity monitoring. There were no statistically significant differences between groups or across time. However, presently the control group reported a reduction of maximum and adjusted activity scores of 22.3% and 21.7%, respectively. Conversely, the Fitbit One group exhibited only small reductions of 2.4% and 0.5% in maximum and adjusted activity scores, respectively. The differences in these reductions in activity scores between the Fitbit One and control groups yielded effect sizes of d = 0.78 for the maximum activity score and d = 0.67 for the adjusted activity score. This would be considered moderate effect sizes with the Cohen's d for the maximum activity scores nearly achieving the threshold for a large effect size (i.e., large Cohen's $d \geq 0.8$) (Cohen, 1988). In other words, while statistical significance was not achieved, due likely to a small sample size, the effects reported herein may still have clinical relevance.

Prior studies on wearable activity monitors have provided evidence that the use of such devices may promote greater physical activity in the wearer (Araiza et al., 2006; Lyons et al., 2014; Nowicki, Murlikiewicz, & Jagodizinska, 2010). While the current results were not in agreement with these findings, the Fitbit Group better maintained physical activity behaviour throughout the study relative to those in the control group. A possible explanation for these decreases in physical activity may be attributed to the anticipation of volunteering for a physical activity study. Both groups may have increased physical activity at baseline and this may be due to an expectancy effect of volunteering for this physical activity monitoring study (Kirsch, 1985). However, the novelty of the intervention may have waned over the course of the six-week trial (Kluger & DeNisi, 1996). This may explain why the control group reduced their activity. The novelty of participating in the study may also have waned for the Fitbit One group however, because they were receiving feedback from their wearable activity monitor they better maintained their activity. It is possible that wearable activity monitors may aid in maintaining motivation to be physically active in individuals after the novelty of initiating an activity program has waned.

While the Fitbit One group may have better maintained their physical activity than the controls, both groups exhibited decreases in physical activity. While this is contrary to some studies which have shown an increase in physical activity with the use of wearable activity monitors, the current findings do somewhat support those from Jakicic et al (2016) which found no benefit to wearing activity monitors as part of a weight loss intervention. Jakicic's group utilized a large sample (N = 471) and compared weight loss in participants who utilized an activity monitor in addition to a diet and exercise intervention versus participants following the same intervention without access to wearable activity monitors. Those without an activity monitor actually lost significantly more weight (5.9 kg) than those with monitors (3.5 kg) over the 24-month intervention. Taken together, the results of this prior study indicating no benefit, our current results where activity was largely unchanged in the Fitbit One group and those studies which have indicated wearable activity monitors may increase physical activity, it would appear that the combined evidence for such devices as a tools to increase physical activity behaviour is equivocal.

While this pilot study provides evidence that a wearable activity monitor may aid individuals in better maintaining physical activity behaviour over a six-week study in which this behaviour is assessed, there are limitations. Primarily, the sample size was small composed of only women. As we have stated previously, power analyses revealed that there were moderate effect sizes for the primary outcomes yet these were not statistically significant. Therefore, given these moderate effect sizes, it appears that capturing differences in physical activity behaviour in groups of women with and without physical activity monitors can be achieved with a sample size (n = 20 per group) that, while larger than the one utilized in the present pilot study (n = 9 – 10 per group), is still fairly small. Finally, physical activity behaviour was assessed via self-report. While the Human Activity Profile is a validated survey for assessing physical activity behaviour it is still subjective in nature and may be affected by bias (Bastone et al., 2014; Bilek et al., 2005; Teixeira-Salmela et al., 2007). The decision to use self-report measures was because we hypothesized that wearing this device would affect physical activity. Future studies that wish to assess the impact of wearable activity monitors on physical activity behaviour should consider larger sample sizes and utilize another, previously-validated wearable activity monitor that does not provide feedback to the user, as an objective measure of physical activity.

CONCLUSION

In recent years there has been a proliferation in the availability and popularity of wearable physical activity monitors marketed directly to consumers (Piwek et al., 2016). The present pilot study assessed the effect of a popular, commercially-available wearable activity monitor (e.g. Fitbit One) upon physical activity in women with and without such a device. Participants without a wearable activity device (i.e., control group) exhibited decreases in physical activity of >20% which may be greater (effect sizes, d = 0.67 - 0.78) than the Fitbit One group (decrease of ≤ 2.4%). These findings add to the increasingly equivocal evidence regarding the efficacy of activity monitors to promote physical activity behaviour. Because of the popularity of these devices and the equivocal findings regarding their efficacy, more research on this topic is warranted.

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