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Cover Page Footnote
The researchers would like to express gratitude to the participants, and Drs. Deirdre Hill, Steve Prewitt, and Dean Culpepper for their support throughout the research study. He would also like to thank the TRIO McNair Scholar Program for funding the purchase of the Fitbit watches.

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Using Fitbit Competitions to Increase Physical Activity in College Students

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Abstract

Background: Physical inactivity is a leading risk factor for global mortality (World Health Organization, 2018). Only one in four college students meet the current federal Physical Activity Guidelines of engaging in ≥150 minutes/week of exercise (Raynor and Jankowiak, 2010). The advancement of technology, especially in the acquisition of physical activity data, combined with the desire for virtual social interaction, has not been studied in college students. It is unknown if physical activity trackers and accompanying mobile apps, such as Fitbit, could motivate college students to be more physically active. It was hypothesized that wearing a Fitbit watch and participating in weekly competitions via the app would increase weekly step counts in college students as compared with a simple pedometer.

Methods: Seventeen students were randomly assigned to either Fitbit (6F/3M, 22±1yr) or pedometer groups (4F/4M, 21±2yr). All participants wore pedometers in Week 1 for baseline comparisons. The pedometer group continued wearing the pedometer for three more weeks. The Fitbit group wore Fitbit watches for the next four weeks and were invited to weekly competitions via the mobile app. Pre- and post-data on weekly step counts were compared using repeated measures ANOVA.
Results: There was no significant difference in weekly step counts between groups during Week 1 (Fitbit: 37,014±19,676 vs Pedometer: 43,631±14,499, p>0.05). Analysis revealed a significant interaction (group*time, p=0.005) with an increased step count by the Fitbit group (161±76%), while the pedometer group showed a decrease (76±33%).

Conclusions: Fitbit participants were more motivated to be physically active, indicated by the continued increase in weekly step count throughout the weeks, whereas the pedometer group reduced their step count. The results confirm that merely tracking step count is not enough to maintain physical activity. Adding the social and competitive aspect of a mobile app can be a powerful motivator for college students.

**Keywords:** Fitbits, Pedometers, Competition, Motivation

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**Introduction**

Physical inactivity is a major risk factor for mortality worldwide (WHO, 2018). The current public health recommendation for physical activity is to engage in at least 150 minutes of moderate-intensity aerobic exercise per week (Haskell et al., 2007). In the United States, it is estimated that approximately 25% of the adult population is sedentary, while only about half engage in aerobic physical activity (Lewis et al., 2016; Giddens et al., 2017). This trend is quite similar in college students: only 52.8% of college students were found to meet the recommendation in 2017 (CDC, 2018). And only one in four met the aerobic and muscle strengthening recommendations (Raynor & Jankowiak, 2010).

Advances in technology, specifically on the wearable device market such as Fitbits, is touted as a means for people to lead a healthier and better life (Lupton, 2015). However, one
study showed that 50% of the individuals stopped using Fitbits within the second week they purchased it (Asimakopoulos et al., 2017). Moreover, 62% of the individuals who downloaded an application to track their activity level stopped using it on the second week.

Several avenues to promote physical activity have been investigated previously with modest success, including prompts to increase stair use, monetary incentives, internet-based education programs, and access to places and opportunities for physical activity (Franko et al., 2008; Kahn et al., 2002; Pope & Harvey, 2014). Competition could be a way to encourage individuals to increase their physical activity throughout the day. In the days before wearable devices, people had to meet up or enter their daily activity on a tracking spreadsheet/online form in order to compare and compete against others. Wearable devices track and store activity automatically. An associated mobile application can be set up to compete against family and friends without any extra input from the individual. Giddens et al. observed an increase in step count, psychological well-being, physical health, and reductions in insurance premium in a company that provided employees with Fitbits and arranged competitions within teams (2017).

Despite many efforts to increase physical activity in college students, the percentage of people meeting the national recommendations has not increased substantially in recent years (CDC). The purpose of this study is to investigate whether wearing a Fitbit watch and using the competition function of the Fitbit mobile application can motivate college students to be more physically active. The research question is: Can Fitbit competitions increase physical activity in college students as compared to simple pedometers?
Methods

Study Design

The study was a concealed experimental pre- and post-intervention with a control group. Participants were told the study was only testing for the step count measurements without the knowledge of the measuring methods (i.e., with Fitbit or pedometer). Following the end of the study, all participants were debriefed about the true purpose and could choose to have their data excluded from the analysis (none did). The study was approved by the institutional review board (#1836).

Participants

20 healthy college students were recruited via flyers and word-of-mouth. Inclusion criteria were ages between 18-25 years and exercising for at least 30 minutes per week but no more than 210 minutes per week. Participants were also to have never worn a wearable fitness watch. Student-athletes and pregnant women were excluded from the study.

Fitbits and Pedometer

There were two types of measurement devices: Fitbit watches and simple pedometers. The Fitbit watch was worn on either wrist while the pedometer was worn on the waistband of the participant’s pants. The participant wearing the pedometers had to place the device in the midline of the quadriceps. If they were exercising, they were asked to move it to the midline of their hamstring for safety purposes. All participants were selected randomly in order to determine which device they would be receiving. Each group met up separately at a different time.

International Physical Activity Questionnaire (IPAQ)

Participants completed this seven day recall questionnaire on their physical activity at the beginning and end of the experimental period.
Procedures

All participants were given pedometers to wear during the first week in order to compare the baseline step count of both groups. At the beginning of the second week, Fitbits were given to the experimental group only. Participants were asked to download the Fitbit application on their phone. They received weekly invites to join the “weekly hustle”, which is a competition within the Fitbit application. After accepting the invitation, the participants could see the step counts of the other participants. The control group wore the pedometers for four weeks while the experimental group wore pedometers for one week and then the Fitbit for an additional four weeks. Weekly step counts were recorded for each individual.

Data Analysis

The primary variable of interest was the weekly step count. Baseline (pre) step counts were compared between groups from the first week when all participants wore pedometers. Weekly step counts were compared between groups using repeated measures ANOVA. A p-value of < 0.05 was considered significant.

Results

Table 1 shows baseline data. There were no differences between groups in age, weekly and daily step counts during the first week with pedometers, nor subjective physical activity levels.
Table 1

Baseline Data

<table>
<thead>
<tr>
<th></th>
<th>Fitbit</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>6F/3M</td>
<td>4F/4M</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>22 ± 1</td>
<td>21 ± 2</td>
</tr>
<tr>
<td>Weekly Step Count</td>
<td>37,014 ± 19,676</td>
<td>43,631 ± 14,499</td>
</tr>
<tr>
<td>Daily Step Count</td>
<td>5,288 ± 2,811</td>
<td>6,233 ± 2,071</td>
</tr>
<tr>
<td>IPAQ (MET-min/week)</td>
<td>5,248 ± 4,012</td>
<td>4,451 ± 2,845</td>
</tr>
</tbody>
</table>

Weekly step counts increased in the Fitbit group and decreased in the control group throughout the weeks (Figure 1). A significant interaction (group*time) was found in weekly step count (p=0.005). Figure 2 shows the average daily step counts per week. The participants in the Fitbit group overall increased by 2,575 ± 2,753 steps, while those in the control group decreased by 1,605 ± 2,503 steps. No significant differences were found in IPAQ scores (Figure 3).
Figure 1

*Pre- and Post-Intervention Weekly Step Count*

![Graph showing weekly step count comparison between Fitbit and Control groups.](image)

Figure 2

*Average Daily Step Counts Per Week*

![Graph showing average daily step counts over weeks for Fitbit and Control groups.](image)
Figure 3

*Pre- and Post-Intervention IPAQ Scores*

![IPAQ Scores Graph]

Discussion

The results of the present study showed that using physical activity trackers with a social competitive component can help increase step counts in college students. The college years are filled with opportunities and challenges for students who make a number of choices that can impact health behaviors, such as academic course load and study time, leisure activities, and social media use. In many cases, maintaining a physical activity schedule is low on a college student’s list of priorities.

Recommendations and Benefits of Physical Activity

Physical activity improves the cardiorespiratory and musculoskeletal systems and thereby helps reduce diseases (Huang et al., 2016). According to the 2018 Physical Activity Guidelines for Americans, 2nd edition, regular physical activity also provides many other benefits, such as improved cognitive function, reduced anxiety and depression risk, and improved sleep and quality of life (2018). Additionally, Merrill analyzed survey data of 20,114 employees and reported that physical health is significantly associated with job performance and absenteeism.
(2013). The same could be expected in college students who need to maintain high academic performance in the classroom and during study time.

The 2018 Physical Activity Guidelines for Americans, 2nd edition (8) recommend that adults should do at least 150 minutes a week of moderate-intensity aerobic physical activity and at least 2 days of muscle-strengthening activities (2018). Walking is one of the most popular and easiest way to accumulate the aerobic activity minutes. While most global physical activity guidelines are expressed in terms of frequency, intensity, and time, counting steps is an easy way for all people to measure and monitor. Step counts are sometimes used in physical activity guidelines, but there is a wide discrepancy in the ranges being recommended (Tudor-Locke & Bassett, 2004). In their systematic review, Tudor-Locke and Bassett summarized that 7,000-8,000 steps/day is associated with meeting the physical activity guidelines of 150 min/week in healthy adults (2004). The results of the present study showed that college students on average did not meet these step count at the beginning of the study. However, the participants in the Fitbit group increased their step counts such that in Week 4, they averaged just under 8,000 steps/days.

**Accuracy of Fitbits**

Fitbits are considered one of the most accurate physical fitness wearable devices currently on the market (Storm et al., 2015; Huang et al., 2016; Takacs et al., 2014). Storm, Heller and Mazza conducted a study where they took seven different wearable devices and placed them on a participant to determine for the mean absolute percentage error (MPE) (2015). They found that the Fitbit One had a MPE of less than 2.6%. This one was the second best after the Move monitor with a MPE of less than 2.0% (Storm et al., 2015). A different study found that when the subjects were walking in a level surface, the Fitbit One’s steps was also one with the least
amount of percentage error (Huang et al., 2016). It had a step count error of 2.3 +/- 4.7%. A similar investigation had test subjects walk at five different speeds on a treadmill (Takacs et al., 2014). The percent relative error found was less than 1.3%. They concluded that Fitbit One’s reliability in step counts is excellent at any speed (2014).

**Motivation to Keep Exercising**

There are three components that encourage motivation: autonomy, competence, and psychological relatedness (Asimakopoulous et al, 2017). Self-efficacy and socially natured connections promote action choices to improve learning, behavioral and motivational outcomes between users. With the three components, one still needs feedback in order to see if one is improving or not. Fitbit watches have the ability to vibrate when one has reached a goal or if one has very few steps left to reach the goal. If one is doing competitions against others who own a Fitbit, it will vibrate to tell the individual that someone has passed them or vice versa (Asimakopoulous et al., 2017). Several physical fitness wearable devices now have the ability for several individuals to compete against each other, but competitors would need to be using the same type and platform. Presenting other features that the fitness devices are capable of motivates participants to be more active and healthier (Giddens et al., 2017). Even if the individual did not reach the pre-programmed 10,000 step goal or any other goal, they are aware of how many steps they took by looking at the device.

Many companies now offer physical activity wearable devices to help motivate and improve the workers’ health as part of their wellness plan (Giddens et al., 2017). Giddens et al. measured step counts of employees who had been given Fitbits through their wellness program (2017). Employees were put in teams and competed through the Fitbit application. They found that the employees increased their step counts, showed improvements in psychological well-
being and physical health, and the company experienced a reduction in insurance premiums (Giddens et al., 2017). When asked if the wearable devices motivated them to be more active, most participants said that it did (Asimakopoulos et al., 2017). In the present study, we asked participants about their perception of the wearable device and if it encouraged them to be more active. Eight of the nine participants wearing a Fitbit declared that the device did motivate them to exercise. Some mentioned the device pushed them to get up and perform intense workouts and others were motivated to walk a little more. The participants in the control group, on the other hand, were not as motivated with the pedometer. Six out of the eight participants stated that the pedometer did not truly motivate them to be more active since they would forget they had the device on their waistband of their pants. The social and interactive features of the Fitbit seemed to remind participants to get up and move.

**Study Limitations**

The participants in this study were strangers to each other. We may expect to see a larger increase in step count activity if competing against friends or family. All participants were randomly divided into the Fitbit and control groups without taking into account personal attributes. Thus, there could have been some unintended effects, for example sex differences may influence competition, motivation, and social aspect of the study. We did not have enough participants to analyze any potential sex differences. There is some evidence that women perform more light-intensity activity, while men do more moderate and vigorous-intensity (Wolin et al., 2008); how this may impact step counts is unclear. Moreover, men typically show greater competitiveness than women (Deaner et al., 2016), which may change the response to the Fitbit competitions. Furthermore, it is possible that competitions with co-ed or single-sex groups could have shown different results.
Acknowledgements

The researchers would like to express gratitude to the participants, and Drs. Deirdre Hill, Steve Prewitt, and Dean Culpepper for their support throughout the research study. They would also like to thank the TRIO McNair Scholar Program for funding the purchase of the Fitbit watches.
Works Cited


