TRACKING DAILY STEPS: AN INVESTIGATION ON A SMALL POST-SECONDARY CAMPUS

Brent D. Bradford,[1, A, B, C, D] Adam Howorko,[2, A, B, C, D] Erinn Jacula,[3, A, D] Jason Daniels,[1, D, E] Shaelyn Hunt,[1, D] Nicole Correia[1, D]

[1] Concordia University of Edmonton, Education
[2] Concordia University of Edmonton, Psychology
[3] Concordia University of Edmonton, Physical Education & Wellness
[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Description; [E] Funds Collection

Address for correspondence:
Brent D. Bradford
Concordia University of Edmonton
Office: AW 239
7128 Ada Boulevard, Edmonton, Alberta T5B 4E4
E-mail: brent.bradford@concordia.ab.ca

Abstract The production of mood-regulating chemicals (e.g. serotonin) may be impacted through prolonged or acute stress events. If a serotonin-deficit exists, depression-related illnesses may result, with such illnesses projected to become the second highest lifetime burden of disease. Critically, physical activity has been found to assist in increasing serotonin levels, positively impacting adult neurogenesis and mood. The purpose of this study was to track daily steps (physical activity) employing a step-counting technology across a small Canadian university. Guided by the research questions: *Can tracking daily steps encourage elevated levels of physical activity?* and *What differences, if any, exist between physical activity levels amongst students and faculty/staff?*, such an understanding may add to the current body of knowledge concerning physical activity levels in educational institutions. Over a 9-week period, students (n = 32) took significantly more steps than faculty/staff (n = 16), and significantly more in Week 9 than in Week 2.

Key words physical activity, post-secondary faculty/staff, post-secondary students, physical activity technology, daily steps

Introduction

Neuroendocrine functions in the human brain are impacted by stressful events which, in turn, influence moods (Lupien, McEwan, Gunnar, Heim, 2009). The production of mood-regulating chemicals such as serotonin may be negatively impacted through prolonged or acute stress events. Hence, if a deficit of serotonin exists, depression-related illnesses may result, with such illnesses projected to become the second highest lifetime burden of disease, exceeded only by heart disease (Greenwood, Fleshner, 2011; World Health Organization [WHO], 2017). Critically, physical activity has been found to help increase serotonin levels (Valim et al., 2013), having a positive effect on adult neurogenesis and positively impacting mood (Ernst, Olson, Pinel, Lam, Christie, 2006). Likewise, higher physical activity levels are associated with a reduction in chronic conditions such as Type 2 diabetes, obesity, cardiovascular disease, and premature death (Go et al., 2014; Warburton, Nicol, Bredin, 2006).

To combat such chronic conditions and other health-related issues, post-secondary campuses are aiming to include wellness programs to improve and/or maintain student and faculty/staff wellness. For example, Concordia University of Edmonton in Alberta, Canada, has developed a range of initiatives through the School of Physical Education & Wellness (e.g. drop-in intramurals, fitness classes) and other campus wellness teams (e.g. Mental Health Action Team*)* to support students and faculty/staff wellness. Other such initiatives organized across Canadian post-secondary campuses include: peer support centres; international student services; health clinics; etc.

With such initiatives occurring across post-secondary campuses, it seems fitting to study an essential component of wellness (e.g. physical activity levels). Hence, this quantitative study examined physical activity levels (i.e. daily steps) employing step-counting technology (e.g. pedometers, Fitbits) worn by students and faculty/staff. Step-counting technology has been found to be effective in ascertaining accumulative physical activity levels and can be a valid predictor of daily activity (Craig, Tudor-Locke, Cragg, Cameron, 2010; Husted, Llewellyn, 2017), and due to the wide commercial availability, wearable step-counting technology has increased in popularity throughout the years (Market Realist, 2017; Rote, 2017; Science Daily, 2017). Hence, guided by the general research questions: *Can tracking daily steps encourage elevated levels of physical activity?* and *What differences, if any, exist between physical activity levels amongst students and faculty/staff?*, such an understanding may add to the current body of knowledge concerning physical activity levels on post-secondary campuses. Additionally, participants may become more aware of their physical activity levels, along with a better understanding of how physical activity impacts their daily lives (e.g. lowering stress).

Review of related literature

Physical activity has been linked to several health benefits, such as in physical, mental and emotional health (Go et al., 2014; Hales, Lauzon, 2015). According to A.L. Morgan, D.A. Tobar, and L. Snyder (2010), physical activity has been found to prevent, reduce and manage many chronic health conditions. Surfacing in the mid-1980s, physical activity recommendations aimed at promoting public health outcomes have continued to evolve, while new evidence and scientific methods for measuring physical activity have emerged (Physical Activity Guidelines Advisory Committee, 2008). For example, ParticipACTION (2019) specifies an amount of time (i.e. 150 minutes per week) that individuals from 18−64 years old should undertake in moderate to vigorous physical activity in order to experience potential health benefits.

In terms of physical activity, this study focused on daily walking steps as the operationalized variable. Hence, in order to track daily steps, pedometers and other wearable technology items (e.g. Fitbits) are well suited for the task (Freak-Poli, Wolfe, Backholer, de Courten, Peeters, 2011; Kovelis et al., 2012). Pedometers, for instance, have grown in popularity over the years (Market Realist, 2017; Kovelis et al., 2012; Tudor-Locke, Bassett, 2004) as inexpensive tools that can easily and accurately advise about and enumerate the number of daily steps, and have greatly advanced the objective measurement of physical activity patterns for individuals (Baskerville, Ricci-Cabello, Roberts, Farmer, 2017; Bassett et al., 1996; Husted, Llewellyn, 2017; Schneider, Crouter, Bassett, 2004).

Although 10,000 steps per day has been suggested as an effective target for physical activity for the general population (Choi, Pak, Choi, Choi, 2007; Morgan, Tobar, Snyder, 2010; Tudor-Locke, Bassett, 2004), B.C. Choi et al. (2007) contended that 10,000 steps daily is not usually achievable in normal daily routines. Moreover, that particular number of steps was originally arrived at with no empirical evidence, and has received much attention in recent years; reaching 10,000 steps may not equate to a sufficient amount of physical activity (Science Alert, 2016; White et al., 2013). According to Science Alert (2016), there is certainly nothing wrong with walking 10,000 steps daily as it is much better than the 3,000 to 4,000 average, but they also emphasize that we should not treat 10,000 steps per day as a scientifically proven goal.

> *Walking is the simplest form of exercise. Employing a pedometer is a good way to get yourself to do it* (Harvard Health Publications, 2017).

According to R.P. Pangrazi and A. Beighle (2013), counting steps is an effective way to measure physical activity levels, and although pedometers cannot measure swimming or cycling, they still represent one of the best ways to measure common physical activity, as most daily physical activity accumulated by individuals (about 90%) is *over land* (Pangrazi, Beighle, 2010). When individuals are asked to recall and self-report their previous day's physical activity level, most find it difficult to quantify the true answer; recall may have been done on an atypical day, thus resulting in an under or overestimation (Sallis, 1991; as cited in Pangrazi, Beighle, 2010).

Step-counting studies

The use of pedometers or other step-counting technology has been found to be associated with significant increases in physical activity, weight loss, improvements in blood pressure (Stanford Medicine, 2007), reductions in body mass index (BMI), and increased cardiovascular fitness (Bravato et al., 2007; Chan, Ryan, Tudor-Locke, 2004; Freak-Poli et al., 2011). Moreover, step-counting technology devices (e.g. pedometers) have become key research tools by measuring "steps", and providing immediate feedback, as motivational tools within intervention programs, to enhance physical activity levels and to elevate quality of life, across an array of clinical conditions such as: hypertension (Lee, Watson, Mulvaney, Tsai, Lo, 2010), diabetes (Diedrich, Munroe, Romano, 2010; Furber et al., 2008), inactivity in overweight and obese older people (Sugden et al., 2008; Pal, Cheng, Egger, Binns, Donovan, 2009), cardiovascular risk (Tully, Cupples, Chan, McGlade, Young, 2005), obesity (Tessier et al., 2010), and in healthy adults (Marshall et al., 2009; Tudor-Locke, Lutes, 2009), to name a few. As well, other studies have described a range of pedometer walking research protocols for adults with lower back pain (Krein et al., 2010; McDonough et al., 2010) to assess the effects on pain-related disability and functional interference.

As a motivational tool, several findings have indicated that step-counting technology can assist in motivation for physical activity. In 2007, Stanford researchers analyzed 26 studies and summarized the results in *The Journal of the American Medical Association:* pedometer users walk more than 2,000 additional steps per day than do those without, and their overall physical activity levels were higher by 27% (Harvard Health Publications, 2017).

Moreover, an array of pedometer-based interventions promoted achievement and sustainability in 10,000 steps per day (Araiza, Hewes, Gashetewa, Vella, Burge, 2006; Schneider, Bassett, Thompson, Pronk, Bielak, 2006; Swartz et al., 2003), while others have advocated for alternative activity goals which typically involve incremental increases over baseline throughout the intervention (Croteau, 2004; Moreau, Degarmo, Langlet, 2001; Tudor-Lockke et al., 2004). In a systematic review of 18 observational pedometer studies and 8 randomized controlled trials, D.M. Bravata et al. (2007) concluded that participants exhibited significant decreases in systolic blood pressure. Generally, other health outcomes have also shown positive improvements among pedometer users such as waist circumference, serum glucose concentrations and lipid profiles (Swartz et al., 2003; Moreau, Degarmo, Langlet, 2001; Chan, Spangler, Valcour, Tudor-Locke, 2003). According to the Physical Activity Guidelines Advisory Committee (2008), pedometer-associated health benefits have been established in a variety of adult populations, such as in overweight adults and at-risk individuals for diabetes.

Likewise, physical and psychological benefits were found following a 15-week walking program in which participants added 2,200 steps per day, up to approximately 8,000 (Morgan, Tobar, Snyder, 2010), supporting the idea that counting steps can be motivational, leading to increased physical activity levels, while also being a cost-effective intervention (Kang, Marshall, Barreira, Lee, 2009).

Step-counting studies in educational settings

Throughout the years, step-counting studies have been undertaken at all educational levels. Z. Butcher, S. Fairclough, G. Stratton, and D. Richardson (2007) examined pedometer use and its effects on physical activity levels in primary schools (n = 177, mean age = 9). It was found that immediate pedometer feedback was associated with significant physical activity increases when fused with additional strategies; pedometer feedback alone did not elicit significant increases in steps per day.

Likewise, at the secondary school level, L. Schofield, W.K. Mummery and G. Schofield (2005) investigated physical activity levels through pedometer employment as an intervention. Over a 12-week period, Schofield and colleagues compared pedometer use in combination with daily step count targets and the use of time-based goals for physical activity involvement (n = 85 females; mean age = 15). Pedometer use and daily step count targets were found to significantly improve physical activity levels over 6 weeks, and when compared with traditional time-based physical activity prescriptions, pedometer use helped enhance physical activity involvement over a 6-week period.

Similarly, at the post-secondary level, E.M. Jackson and A. Howton (2008) assessed the effectiveness of a pedometer intervention to improve physical activity levels on a college campus (n = 290 college students) through a 12-week period. During Week 1, which was used as a baseline, instructors briefly discussed recommended daily steps, goal setting, and strategies to elevate physical activity levels. A significant increase in steps was found throughout the intervention. Likewise, A.E. Rote (2017), who studied a sample of post-secondary students, found an increase in steps per day by employing step-counting technology. However, Rote's findings were lower than in other such studies (e.g. Jackson, Howton, 2008).

On the contrary, not every study has been quite so positive regarding step-counting technology. According to Harvard Health Publications (2017), a British review of interventions to promote walking published the same year as the Stanford review, noted that the effect of the pedometer on walking may decrease as time goes on – an issue found with many exercise programs. Likewise, in 2008, Norwegian investigators found no difference in results for pedometer users and participants who were instead counseled to increase the number of steps per day. Their argument was that it may not be the step-counting (i.e. pedometer use) that motivates people to "move" so much as regular counseling and setting and following goals. This is found to be consistent with the Stanford researchers' discoveries; the three pedometer studies that did not include set goals showed no significant physical activity improvement (Harvard Health Publications, 2017).

Although it is not widely known whether or not step-counters are motivators, Harvard Health Publications (2017) contended that the possibility lies in the idea that step-counting technology quantifies the physical activity efforts (i.e. number of steps) and most people respond to numbers, especially when related to exercise. For example, runners count miles, swimmers count laps, and perhaps, walkers count steps, which may serve as a motivational tool.

Although some experts invoke the self-efficacy theory as an explanation to step-counting technology as a motivator – developing a level of confidence that a task can be performed – what is being asked while “counting steps” (e.g. pedometer use) is to take more steps. Taking the commonly suggested 10,000 steps a day may seem like an unachievable goal for some, but it is within reach given that most people consistently step between 6,000 and 7,000 times daily (Harvard Health Publications, 2017). In other words, an additional 3,000 to 4,000 steps can add up to approximately 30 minutes (Harvard Health Publications, 2017). Hence, it is suggested that people can find the time to take these extra recommended daily steps, even during busy days. And, to support this notion further, walking, for instance, can take place in bouts of 10 minutes, which has been found to lead to an array of health benefits (Evans, 2011; Harvard Health Publications, 2017).

Procedures

After obtaining approval from the University Research Ethics Board, a convenience sample was employed at Concordia University of Edmonton. All students and faculty/staff were invited to participate via posters displayed throughout campus. 52 participants agreed to volunteer, and 48 participants completed the study (four chose to withdraw during the 9-week period).

Participants were provided with a pedometer or were permitted to use their own step-counting tool (e.g. pedometer, Fitbit, iPhone) to track their daily steps. Daily steps were self-reported by each participant at the end of each week on Sunday evening by emailing the totals to the principal investigator (PI) (i.e. Monday to Sunday totals) for nine consecutive weeks during the mid- to late-part of the Winter Semester (i.e. February−April). Along with the daily step recording, participants were asked to email their weight measurement recorded each Sunday evening throughout the 9-week period (i.e. one weight measurement per week – Sunday evenings).

Although the participants emailed their weekly totals for nine consecutive weeks, there was no return communication by the research team. There were no motivational messages, offerings of encouragement, notes of what the research stated regarding physical activity, etc. by the research team. Non-verbal intervention was intended to test if using a self-monitoring tool (i.e. step-counting technology) motivates people to modify their number of daily steps. Moreover, the only time participants were contacted by the PI was throughout the study’s first week when it was discovered that a few participants were changing their research tool (e.g. pedometer to Fitbit). Via email, the PI asked the participants to ensure they employ the same research tool for the duration of the study.

Data analysis

Prior to data analysis, missing data points were handled in the following ways as agreed upon by the research team: when there was no data for a particular day, the average for the specific week was calculated and inputted; when a weight measurement was missing, the overall average of the participant’s weight was calculated and inputted; when anomalies occurred (i.e. data that could not be used due to non-numerical data [e.g. 166+]), the average for the participant’s particular week was calculated and inputted. With an already small sample, the inputting of averages in these few areas permitted a participant who missed submitting a data point, or unknowingly inputted unusable data, to remain a participant whose data could be included in the analysis process.

Initial trends

Initially, descriptive statistics illustrated some trends worthy of discussion. According to Figure 1, all participants as a group of 48 showed an increase in average daily steps from Week 1 (7,169) to Week 9 (8,358). As illustrated in Figure 2, the group of students increased their daily steps while the faculty/staff remained relatively static. Figure 2 also depicts that the student group consistently took more steps than faculty/staff through the duration of the study (e.g. in Week 9, the student group averaged 9,666, while faculty/staff participants averaged 5,828). According to Figure 3, there was not much difference of daily steps taken between the days of the week by the whole group of participants. The lowest mean was 7,097 on Sundays, while the highest mean was 8,039 on Saturdays. All other days had a mean in the range 7,360−7,794. When divided into the two groups of Students and Faculty/Staff, the same trends occurred (see Figure 4); the student group means were, again, consistently higher than faculty/staff. For example, on Fridays, student means equaled 8,774, while faculty/staff averaged 5,865.

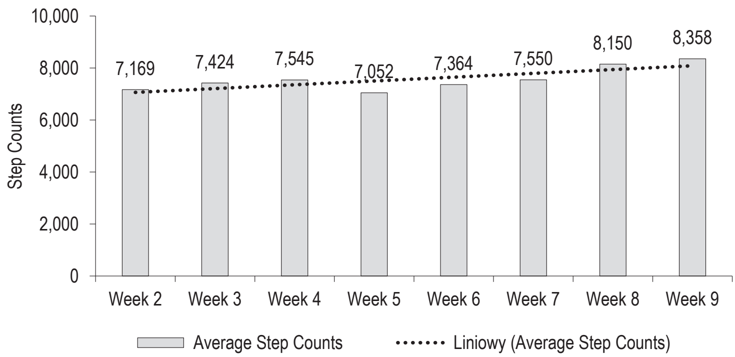

Figure 1. Average Step Counts: All Participants (n = 48)

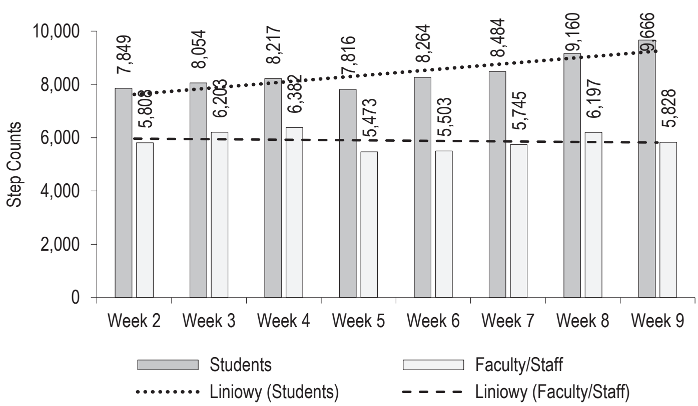

Figure 2. Average Step Counts: Students (n = 32) & Faculty/Staff (n = 16)

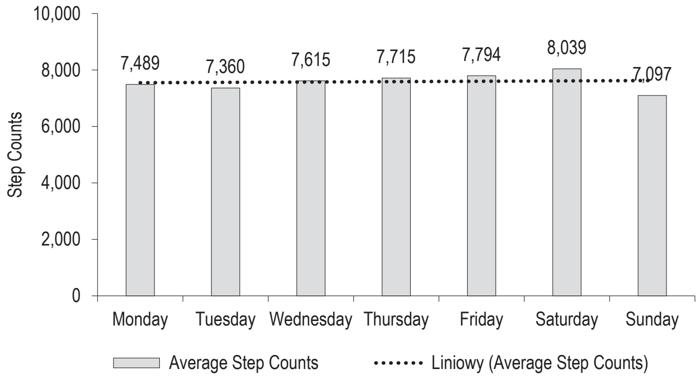

Figure 3. Average Step Counts: All Participants (7-Day Week)

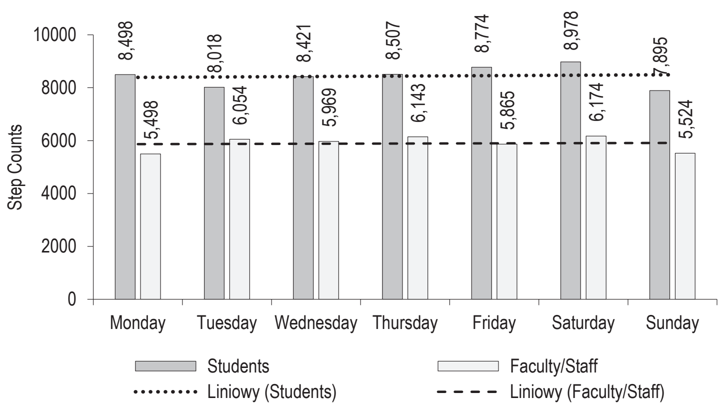

Figure 4. Average Step Counts: Students & Faculty/Staff (7-Day Week)

Inferential statistics

Independent sample t-tests were employed to search for differences between student and faculty/staff groups, and dependent sample t-tests were used to look at differences within the groups. Overall, there was a significant increase in the number of steps taken over the course of the study. A comparison of Week 2 and Week 9 indicated significantly more steps were taken in Week 9 than Week 2, ($t(42) = -2.3$, $p = 0.011$). When examined by participant type (i.e. student versus faculty/staff), students took significantly more steps than faculty/staff ($t(41) = 3.23$, $p = 0.001$), and students' step counts increased over the course of the study (i.e. students took significantly more steps in Week 9, than in Week 2), ($t(28) = -2.5$, $p = 0.009$). However, there was no significant difference in number of steps taken by faculty/staff over the course of the study.

There was a significant overall negative correlation between average steps and overall weight ($r = -0.43$, $p = 0.004$). For faculty/staff, there were significant negative correlations between steps and weight in Week 2 ($r = -0.617$, $p = 0.019$) and Week 8 ($r = -0.547$, $p = 0.043$). While levels of significance are mentioned here, it is important to note that results reporting statistically significant do not necessarily imply practical significance. The significance is likely due to the small sample size as several weeks showed similar correlation coefficients, but were not large enough to be considered significant.

Limitations

This research study did not go without limitations. Although step-counting technologies (e.g. pedometers, Fitbits, iPhones) measure the value of physical activity in steps and time, they do not measure the intensity of physical activity (e.g. walking vs. running) nor differentiate the many physical activities (e.g. on land [biking, weight lifting], off land [swimming]) (Lystrup, West, Olsen, Ward, Stephens, 2016; Pangrazi, Beighle, 2010). A second limitation was that the research tools were handled by each participant, and it was their choice to use either a pedometer, Fitbit or iPhone throughout the study. One such research tool may have recorded daily steps more accurately than others.

Third, although some results reported statistically significant, this does not necessarily imply practical significance. The low sample size may be associated with the low ability to detect significant differences. Also, the low sample size may make it challenging to generalize the findings beyond the participants.

Discussion

Throughout the 9-week study, the research team made a variety of discoveries. While investigating what differences, if any, existed between physical activity levels amongst students and faculty/staff, other interesting findings included the fact that students took a significantly higher number of steps on a daily basis than did faculty/staff.

This section will discuss each significant finding and elaborate on some noteworthy non-significant results.

1. Students took significantly more steps than faculty/staff ($\bar{x}$ student = 8,442 $\bar{x}$ faculty/staff = 5,890). This finding helps raise the question of differences between student and faculty/staff activities while on campus. Most commonly, students need to travel from class to class, which may be in different buildings and/or on different floors, whereas faculty/staff may not be required to travel as much during the day. For example, a professor may teach a variety of classes in the same room or within the same vicinity. This finding could help faculty/staff to recognize more deeply that their daily travel needs are minimal; perhaps faculty/staff could build within their daily schedule a walk around an athletics field, or up and down some stairs prior to and/or after class.

2. Students took significantly more steps in Week 9 than Week 2 ($\bar{x}$ week2 = 7,849, $\bar{x}$ week9 = 9,666). Interestingly, students took a significantly higher number of steps per day in Week 9 than Week 2. According to Figure 2, students seemed to demonstrate more willingness to engage in physical activity (i.e. steps) as the study progressed. This could be the result of several reasons such as, the step-counting technology helped motivate them to take more steps (e.g. motivated by technology's immediate feedback), the daily schedule required more steps as the semester progressed, the weather could have played a factor as the months from February to late-April can bring on some very cold to much warmer weather in northern Alberta, Canada. For example, as the weather warmed up, perhaps the students decided to become more physically active. Further, it seemed as if the participants were keenly motivated in the beginning, then slowed down, as reflected in the lower step counts in the middle, and were possibly more motivated towards the end of the study. This may be a qualitative question in the making: *What were participants experiencing through the study's different time periods?* Overall, the students appeared to have higher motivation to increase their step productivity. Faculty/staff data reflected a steady output; it could be that their routines were fixed. Whereas, the students have a more or less flexible schedule and, with the added step-count study, could consciously make an effort to increase their output. That said, an interesting question raised by a student was: *How many participants were students from a particular program (e.g. Education)?* In this individual's words: *I know my steps increased throughout the study due to my professional practicum experience.*

3. There was a significant overall negative correlation found between average steps and overall weight ($r = -0.43$). Although there might be a connection between steps and weight (i.e. as weight goes up, number of steps tend to stay the same or decrease), the direction of the relationship remains unclear. Moreover, another statistically significant finding included *significant negative correlations in Week 2 ($r = -0.617$) and in Week 8 ($r = -0.547$) between steps and weight for faculty/staff*, but not for the other weeks, which is likely due to the small sample size as several weeks showed similar correlation coefficients but were not large enough to be considered significant. While it is important to not rule out other factors when interpreting these findings, the information may help lead to further research questions in terms of physical activity and weight.

4. There was no significant difference found in steps taken by faculty/staff between Weeks 2 and 9. Unsurprisingly, no significant difference was found here if it is thought that faculty/staff responsibilities during the day remain quite close to a classroom, office, etc. With this, it is noteworthy that faculty/staff took the most steps on Saturdays ($n = 6,174$), while Sundays could be noted as a true 'day of rest' as the number of steps decreased to 5,524. This information again helps raise the question of whether faculty/staff could use some additional physical activity during the day such as a walk around the athletics field prior to and/or after class. However, this non-significant finding helps explain that throughout the 9-week study, faculty/staff maintained a level of consistency in daily steps; as the study progressed, there was no sign of the effect of faculty/staff becoming motivated by the immediate daily step-counting technology feedback.

5. There was no significant correlation found for students between steps and weight. Although weight measurements were not a focal point of the study, the research team thought the weekly recordings may add another level of understanding. Although it was found that the students recorded significant increases in daily steps throughout the study, exercise intensity was not recorded. Although more steps were taken in Week 9 than Week 2, this does not reveal the level of exercise intensity. Hence, although more steps were taken by students as the 9-week study progressed, their level of exercise intensity could have remained low, without any weight change.

Implications for future research

These findings can add to literature results by furthering understanding about physical activity levels on an academic campus. Although the findings cannot be generalized beyond the participants, what has become most helpful is the plethora of questions that arose for future research, such as:

- did the time of the academic year (i.e. Winter Semester) impact the data?
- can tracking daily steps (i.e. step-counting technology) provide extrinsic motivation for increased physical activity levels?

Future research should explore such queries, and whether or not other post-secondary institutions discover similar findings. Also, further research could focus upon exploring potential barriers impacting physical activity levels on all sizes of post-secondary campuses.

Conclusion and recommendations

Physical activity is an essential wellness component, and with post-secondary campuses focusing more and more on campus wellness, it is clear that physical activity levels must remain a considered variable. This study took aim at discovering if any physical activity level differences (i.e. steps per day) exist between students and faculty/staff on a small Canadian post-secondary campus.

Stemming from the findings, the differences between student and faculty/staff daily responsibilities may impact their physical activity levels. That said, it is worth noting that faculty/staff should strive to include more steps per day (i.e. increasing their physical activity levels) by setting aside a few moments at different times for a quick walk or exercise break.

Clearly, this study provides a basis for further investigative work in the area of physical activity levels measured through step-counting technology, along with continuing to inform students and faculty/staff across post-secondary campuses about the importance of daily physical activity and its direct relation to wellness. The findings add to literature related to tracking daily steps (i.e. step-counting technology) and physical activity levels. Therefore, the prescription of a walking program as an example of a first step toward a healthy level of wellness is recommended. This is particularly important as walking limits few, is easily accessible for most individuals, and requires no expensive equipment, and time rather than steps can be used as a target goal (Morgan, Tobar, Snyder, 2010).

References

Araiza, P., Hewes, H., Gashetewa, C., Vella, C.A., Burge, M.R. (2006). Efficacy of a pedometer-based physical activity program on parameters of diabetes control in type 2 diabetes mellitus. *Metabolism*, *55* (10), 1382–1387.

Baskerville, R., Ricci-Cabello, Roberts, N., Farmer, A. (2017). Impact of accelerometer and pedometer use on physical activity and glycaemic control in people with Type 2 diabetes: A systematic review and meta-analysis. *Diabetic Medicine*, *34* (5), 612−620. DOI: 10.1111/dme.13331.

Bassett, D.R., Ainsworth, B.E., Leggett, S.R., Mathien, C.A., Main, J.A., Hunter, D.C., Duncan, G.E. (1996). Accuracy of five electronic pedometers for measuring distance walked. *Med Sci Sports Exerc.*, *28* (8), 1071–1077.

Bravata, D.M., Smith-Spangler, C., Sundaram, V., Gienger, A.L., Lin, N., Lewis, R., Stave, C.D., Olkin, I., Sirard, J.R. (2007). Using pedometers to increase physical activity and improve health: A systematic review. *JAMA*, *298* (19), 2296−2304.

Butcher, Z., Fairclough, S., Stratton, G., Richardson, D. (2007). The effect of feedback and information on children’s pedometer step counts at school. *Pediatric Exercise Science*, *19* (1), 29−38.

Chan, C.B., Ryan, D.A.J., Tudor-Locke, C. (2004). Health benefits of a pedometer-based physical activity intervention in sedentary workers. *Prev Med*, *39* (6), 1215−1222.

Chan, C.B., Spangler, E., Valcour, J., Tudor-Locke, C. (2003). Cross-sectional relationship of pedometer-determined ambulatory activity to indicators of health. *Obes Res*, *11* (12), 1563−1570.

Choi, B.C., Pak, A.W., Choi, J.C., Choi, E.C. (2007). Daily step goal of 10,000 steps: A literature review. *Clin Invest Med*, *30* (3), E146−151.

Craig, C.L., Tudor-Locke, C., Cragg S., Cameron C. (2010). Process and treatment of pedometer data collection for youth: The Canadian physical activity levels among youth study. *Med Sci Sports Exerc,*, *42* (3), 430–5.

Croteau, K. (2004). A preliminary study of the impact of a pedometer-based intervention on daily steps. *Am J Health Promot,*, *18* (3), 217–220.

Diedrich, A., Munroe, D.J., Romano, M. (2010). Promoting physical activity for persons with diabetes. Diabetes *Educ*, *36* (1), 132–140.

Ernst, C., Olson, A.K., Pinel, J.P.J., Lam, R.W., Christie, B.R. (2006). Antidepressant effects of exercise: Evidence for an adult-neurogenesis hypothesis? *Journal of Psychiatry & Neuroscience*, *31* (2), 84–92.

Evans, M. [DocMikeEvans] (2011, 12). 23 and ½ hours: What is the single best thing we can do for our health? Retrieved from: ttps://www.youtube.com/watch?v=aUaInS6HIGo.

Freak-Poli, R., Wolfe, R, Backholer, K., de Courten, M., Peeters, A. (2011). Impact of a pedometer-based workplace health program on cardiovascular and diabetes risk profile. *Prev Med*, *53* (3), 162–171.

Furber, S., Monger, C., Franco, L., Mayne, D., Jones, L., Laws, R., Waters, L. (2008). The effectiveness of a brief intervention using a pedometer and step-recording diary in promoting physical activity in people diagnosed with type 2 diabetes or impaired glucose tolerance. *Health Promot J Austr*, *19* (3), 189–195.

Go, A.S., Mozaffarian, D., Roger, V.L. et al. (2014). Heart disease and stroke statistics − 2014 update: A report from the American Heart Association. *Circulation 2014*, *129* (3), e28−e292.

Greenwood, B.N., Fleshner, M. (2011). Exercise, stress resistance, and central serotonergic systems. *Exercise and Sport Sciences Reviews*, *39* (3), 140−149.

Hales, D., Lauzon, L. (2015). *Invitation to Health* (4th Ed). Toronto, ON: Nelson Education Ltd.

Harvard Health Publications (2017). Counting every step you take. Retrieved from: .

Hospes, G., Bossenbroek, L., Ten Hacken, N.H., van Hengel, P., de Greef, M.H. (2009). Enhancement of daily physical activity increases physical fitness of outclinic COPD patients: Results of an exercise counseling program. *Patient Educ Couns.*, *75* (2), 274−278.

Husted, H.M., Llewellyn, T. (2017). The accuracy of pedometers in measuring walking steps on a treadmill in college students. *Int J Exerc Sci*, *10* (1), 146−153.

Jackson, E.M., Howton, A. (2008). Increasing walking in college students using a pedometer intervention: Differences according to body mass index. *J Am Coll Health*, *57* (2), 159−164. DOI: 10.3200/JACH.57.2.159-164.

Kang, M., Marshall, S.J., Barreira, T.V., Lee, J.O. (2009). Effect of pedometer-based physical activity interventions: a meta-analysis. *Res Q Exerc Sport*, *80* (3), 648−655. DOI: 10.1080/02701367.2009.10599604.

Kovelis, D., Zabatiero, J., Furlanetto, K.C., Mantoani, L.C., Proenca, M., Pitta, F. (2012). Short-term effects of using pedometers to increase daily physical activity in smokers: A randomized trial. *Respir Care*, *57* (7), 1089−1097. DOI: 10.4187/respcare.01458.

Krein, S.L., Metreger, T., Kadri, R., Hughes, M., Kerr, E.A., Piette, J.D., Kim, H.M., Richardson, C.R. (2010). Veterans walk to beat back pain: Study rationale, design and protocol of a randomized trial of a pedometer-based Internet mediated intervention for patients with chronic low back pain. *BMC Musculoskelet Disord*, *11*, 205.

Lee, L.L., Watson, M.C., Mulvaney, C.A., Tsai, C.C., Lo, S.F. (2010). The effect of walking intervention on blood pressure control: A systematic review. *Int J Nurs Stud*, *47* (12), 1545–1561.

Lupien, S.J., McEwen, B.S., Gunnar, M.R., Heim, C. (2009). Effects of stress throughout the lifespan on the brain, behaviour and cognition. *Nature Reviews Neuroscience*, *10*, 434−445. DOI: 10.1038/nrn2639.

Lystrup, R.M., West, G.F., Olsen, C., Ward, M., Stephens, M.B. (2016). Pedometry to prevent cardiorespiratory fitness decline – Is it effective? *Military Medicine*, *181*, 1235−1239.

Market Realist (2017). *Will Fitbit's Revenue Rise in 2016 and Beyond?* Retrieved from: http://marketrealist.com/2017/02/will-fitbits-revenue-rise-in-2016-and-beyond.

Marshall, S.J., Levy, S.S., Tudor-Locke, C.E., Kolkhorst, F.W., Wooten, K.M., Ji, M., Macera, C.A. Ainsworth, B.E. (2009). Translating physical activity recommendations into a pedometer-based step goal. 3000 steps in 30 minutes. *Am J Prev Med*, *36* (5), 410–415.

McDonough, S.M., Tully, M.A., O'Connor, S.R., Boyd, A., Kerr, D.P., O'Neill, S.M., Delitto, A., Bradbury, I., Tudor-Locke, C., Baxter, D.G., Hurley, D.A. (2010). The Back 2 Activity Trial: education and advice versus education and advice plus a structured walking programme for chronic low back pain. *BMC Musculoskelet Disord*, *11*, 163.

Moreau, K., Degarmo, R., Langlet, J. (2001). Increasing daily walking lowers blood pressure in postmenopausal women. *Med Sci Sports Exerc*, *33* (11), 1825–1831.

Morgan, A.L., Tobar, D.A., Snyder, L. (2010). Walking toward a new me: The impact of prescribed walking 10,000 steps/day on physical and psychological well-being. *Journal of Physical Activity and Health*, *7*, 299−307.

Pal, S., Cheng, C., Egger, G., Binns, C., Donovan, R. (2009). Using pedometers to increase physical activity in overweight and obese women: A pilot study. *BMC Public Health*, *9*, R309.

Pangrazi, R.P., Beighle, A. (2013). *Dynamic Physical Education for Elementary School Children* (17th Ed.). New York, NY: Pearson.

Pangrazi, R.P., Beighle, A. (2010). *Dynamic Physical Education for Elementary School Children* (16th Ed.). San Francisco, CA: Benjamin Cummings.

ParticipACTION (2019). Canadian physical activity guidelines: For adults 18-64 years. Retrieved from .

Physical Activity Guidelines Advisory Committee (2008). *Physical Activity Guidelines Advisory Committee Report*. Washington, DC: U.S. Department of Health and Human Services.

Roddy, E., Zhang, W., Doherty, M. (2005). Aerobic walking or strengthening exercise for osteoarthritis of the knee? A systematic review. *Ann Rheum Dis*, *64* (4), 544–548.

Rote, A.E. (2017). Physical activity intervention using Fitbits in an introductory college health course. *Health Education Journal*, *76* (3), 337−348.

Schneider, P.L., Bassett, D.R., Thompson, D.L., Pronk, N.P., Bielak, K.M. (2006). Effects of a 10,000 steps per day goal in overweight adults. *Am J Health Promot*, *21* (2), 85–89.

Schneider, P., Crouter, S., Bassett, D. (2004). Pedometer measures of free-living physical activity: comparison of 13 models. *Med Sci Sports Exerc.*, *36* (4), 331–335.

Schofield, L. Mummery, W.K., Schofield, G. (2005). Effects of a controlled pedometer-intervention trial for low-active adolescent girls. *Med Sci Sports Exerc.*, *37* (8), 1414−1420.

Science Alert (2016). *Do you really need to take 10,000 steps per day?* Retrieved from: http://www.sciencealert.com/do-you-really-need-to-take-10-000-steps-per-day.

Science Daily (2017). Smartphone data used in global study of physical activity: Large-scale study reveals targets for obesity prevention, wisdom of walkable communities. Retrieved from: https://www.sciencedaily.com/releases/2017/07/170710113613.htm.

Stanford Medicine (2007). Pedometers help people stay active, Stanford study finds. Retrieved from: lp-people-stay-active-stanford-study-finds.html.

Sugden, J.A., Sniehotta, F.F., Donnan, P.T., Boyle, P., Johnston, D.W., McMurdo, M.E. (2008). The feasibility of using pedometers and brief advice to increase activity in sedentary older women–a pilot study. *BMC Health Serv Res*, *8*, 169.

Swartz, A.M., Strath, S.J., Bassett, D.R., Moore, J.B., Redwine, B.A., Groer, M., Thompson, D.L. (2003). Increasing daily walking improves glucose tolerance in overweight women. *Prev Med*, *37* (4), 356.

Tessier, S., Riesco, E., Lacaille, M., Perusse, F., Weisnagel, J., Dore, J., Mauriege, P. (2010). Impact of walking on adipose tissue lipoprotein lipase activity and expression in pre- and postmenopausal women. *Obes Facts*, *3* (3), 191–199.

Tudor-Locke, C., Bassett, D. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Med.*, *34* (1), 1−8.

Tudor-Locke, C., Bell, R.C., Myers, A.M., Harris, S.B., Ecclestone, N.A., Lauzon, N., Rodger, N.W. (2004). Controlled outcome evaluation of the First Step Program: A daily physical activity intervention for individuals with type II diabetes. *Int J Obes Relat Metab Disord*, *28* (1), 113–119.

Tudor-Locke, C., Lutes, L. (2009). Why do pedometers work? A reflection upon the factors related to successfully increasing physical activity. *Sports Med*, *39* (12), 981−993.

Tully, M.A., Cupples, M.E., Chan, W.S., McGlade, K., Young, I.S. (2005). Brisk walking, fitness, and cardiovascular risk: a randomized controlled trial in primary care. *Prev Med*, *41* (2), 622–628.

Valim, V., Natour, J., Xiao, Y., Pereira, A.F., Lopes, B.B., Pollack, D.F., Zandonade, E., Russell, I.J. (2013). Effects of physical exercise on serum levels of serotonin and its metabolite in fibromyalgia: A randomized pilot study. *Rev Bras Reumatol*, *53* (6), 538−541. DOI: 10.1016/j.rbr.2013.02.001.

Warburton, D.E.R., Nicol, C.W., Bredin, S.S.D. (2006). Health benefits of physical activity: the evidence. *Can Med Assoc J*, *174* (6), 801–809.

White, D.K., Tudor-Locke, C., Felson, D.T., Gross, K.D., Niu, M., Lewis, C.E., Torner, J., Neogi, T. (2013). Walking to meet physical activity guidelines in knee osteoarthritis: Is 10,000 steps enough? *Arch Phys Med Rehabil,*, *94* (4), 711−717. DOI: 10.1016/j.apmr.2012.11.038.

World Health Organization (WHO) (2017). *Cardiovascular diseases (CVDs)*. Retrieved from http://www.who.int/mediacentre/factsheets/fs317/en.

Cite this article as: Bradford, B.D., Howorko, A., Jacula, E., Daniels, J., Hunt, S., Correia, N. (2020). Tracking Daily Steps: An Investigation on a Small Post-Secondary Campus. *Central European Journal of Sport Sciences and Medicine*, *3* (31), 75–86. DOI: 10.18276/cej.2020.3-06.