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Technology-Based Physical Activity Self-Monitoring Among College Students

ZACK PAPALIA†1, OLIVER WILSON†1, MELISSA BOPP‡1, and MICHELE DUFFEY‡1

[1]Department of Kinesiology, Pennsylvania State University, University Park, PA, USA

†Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 11(7): 1096-1104, 2018. Understanding the relationship between college students' physical activity (PA) self-monitoring and PA levels has the potential to inform initiatives to promote PA. This study's purpose was to examine the prevalence of technology-based self-monitoring among college students the potential relationship between device usage, goal setting behaviors, PA enjoyment, and PA levels. An online survey assessed students' demographics, current PA level, technology-based PA self-monitoring, and psychosocial outcomes. Independent t-tests examined differences in PA level and psychosocial outcomes by device use. 55.5% of the final sample (N=1,154) reported technology-based self-monitoring. Mobile phone app-based PA tracking was the most commonly reported (29.9%), followed by heart rate monitors (23.1%). Device use was significantly related to vigorous PA and psychosocial outcomes. Findings have the potential to inform development of technology-based interventions that promote student PA.

KEY WORDS: university, exercise, wearable, smartphone, app, social media

INTRODUCTION

Physical activity (PA) plays a major role in the prevention and treatment of numerous non-communicable diseases, including type II diabetes, heart disease, hyperlipidemia, stroke, anxiety, depression, certain cancers, among others (27). Despite the documented benefits, most Americans fail to meet established PA recommendations (17, 34). One of the largest decreases in PA occurs during the transition from adolescence and young adulthood (12), with nearly half of college students insufficiently physically active (21). In fact, college student physical inactivity was identified as one of the primary health behaviors to address by Healthy Campus 2020,(1) in part due to the potential to prevent these deterioration in physical activity levels from developing and persisting into later adulthood (4).

Unlike PA, technology use among college students, including the use of PA monitoring devices and smartphones is increasing, with college-aged individuals spending in excess of eight hours per day on smartphones (23). The use mobile phones to influence PA remains an emerging field of research (5). As of 2013, there were over 100,000 health-related mobile apps available for smartphones, and it was predicted that by the end of 2015 over 500 million smartphone owners globally will use health-related apps (20). Along with smartphone-based health tracking, the market for wearable computing devices ("wearables") and other PA monitoring devices (ie. heart rate monitors) has grown substantially in recent years, and is expected to continue to grow at an increasingly rapid rate (11). Despite these trends, technology-based PA tracking device use in health behavior interventions has only recently been explored, with recent studies concluding that mobile devices may be an effective means for influencing PA behavior in children, adolescents, and adults (6, 16, 23, 30, 32).

Pairing this technology with theoretically-grounded behavior change interventions represents a promising combination for increasing PA (6). Many devices can generate user-specific activity prompts that incorporate cues to action, and constructs associated with Social Cognitive Theory (3). such as increased self-efficacy, self-regulation, and goal setting which are positively associated with PA (28, 33). However, prior to developing interventions, current usage rates and behavior trends relating to technology-based PA self monitoring usage and PA levels, warrant exploration. Therefore, this study's purpose was to examine the current prevalence of technology-based PA self-monitoring among college students the potential relationship between device usage, goal setting behaviors, PA enjoyment, and PA levels.

METHODS

Participants
This cross-sectional study was conducted at a large, northeastern United States university between August, 2014 and May, 2015. Undergraduate students, from all colleges across the university, enrolled in PA for-credit classes were recruited to complete an online survey (Qualtrics, Provo, UT) via direct email during the first three weeks of the semester. Participation was entirely voluntary and did not impact students' grades, though instructors were asked to encourage student participation. An informed consent statement was presented when students they opened the survey link. The University' Institutional Review Board approved this study. Cookies were used to prevent multiple submissions. Figure 1 displays the CHERRIES breakdown of survey performance.

Protocol
Demographic and Health Measures - Participants reported their age, sex, race, and year in school. Weight and height were reported and body mass index (BMI) was calculated.

Device Use - Participants reported (Yes/No) whether they had used 13 popular self-monitoring PA tracking devices or smartphone applications within the last 30 days. To simplify, the groups were divided into the most common: FitBit™, Nike Fuelband™, Jawbone™, Heart Rate Monitor, Pedometer, Activity Tracking App, Weight Loss App, and "Other." Individuals were classified as device users or non-device users based on whether they had used any of the aforementioned devices to monitor their PA. The average number of devices used per person was calculated.

Goal Setting - PA goal setting behavior was assessed using the 6-item Exercise Goal-Setting Scale with a 5-point Likert Scale ranging from 1 ("does not describe") to 5 ("describes completely") (14). The 6 items were summed to an overall score (range: 6-30). The scale showed good reliability in the current study (α = 0.89).

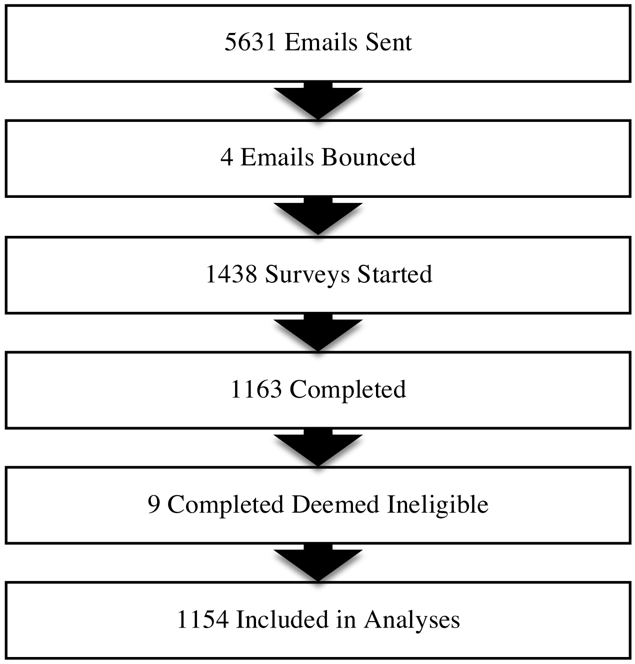

Figure 1. Survey recruitment and participation via CHERRIES (15).

Physical Activity Enjoyment - The Physical Activity Enjoyment Scale (PACES) was used to provide descriptive information on students' feelings toward PA via a 7-item index measuring attitudes toward PA on a scale ranging from 0 (low PA enjoyment) to 10 (high PA enjoyment) (8). The 7 items were summed to get one total Enjoyment Score on a scale of 0-70, which showed excellent reliability in the current study (α = 0.94).

Physical Activity Self-Monitoring - Participants provided information on frequency of recording exercise behaviors on a 4-item, 5-point Likert scale (1 = never; 5 = all of the time) (24). This scale showed excellent reliability in the current study (α = 0.95).

Physical Activity Level - The Global Physical Activity Questionnaire (GPAQ), a reliable and valid self-report method of assessing PA (7, 19) was used to assess minutes per week of vigorous and moderate leisure time PA (2).

Statistical Analysis

All analyses were completed using SPSS Version 22.0 (IBM, Armonk, NY). Independent samples t-tests were conducted to examine differences between device users and non-users relative to moderate physical activity (MPA), vigorous physical activity (VPA), PA enjoyment, and PA goal setting. The significance levels for all the tests were set at $p < .05$. Cronbach's alphas were calculated to assess the reliability of PA enjoyment, goal setting, and self-monitoring scales.

RESULTS

Participant characteristics and PA device use prevalence are displayed in Table 1. The majority of participants were women (54%) and Non-Hispanic White (80.9%), with an average age of 21 ± 1.44 years, and a BMI of 22.5 ± 4.9 kg/m². Over half (55.5%) reported using at least one device in the last 30 days. Of those who used a device to regularly track PA, nearly 48% reported using multiple devices. Smartphone-based applications were the most popular, with 29.9% of participants using activity-tracking apps, and 16.7% using nutrition-tracking apps. Over 23% reported using heart rate monitors regularly, with 10.8% using FitBit™, Jawbone™, or Nike Fuelband™ wearable devices. The "Other Wearables" category included Garmin Vivofit™, Misfit™, Samsung Gear™, Nordic Track iFit Active™, Withings Pulse™, and "Other".

Table 1. Participant characteristics and device use (n=1,154).

Variable		n (%)	Mean (SD)
Demographics	Age		21.07 (1.44)
	Sex		
	Men	494 (46%)	
	Women	581 (54%)	
	Ethnicity		
	Non-Hispanic White	862 (80.9%)	
	Other racial/ethic groups	203 (19.1)	
	Class standing		
	Underclassmen	100 (9.3)	
	Upperclassmen	980 (90.7)	
	BMI		22.5 (4.9)
Device Use	Use Device? (No)	513 (44.5%)	
	Use Device? (Yes)	641 (55.5%)	
	Use 1 Device	334 (28.9%)	
	Use 2 Devices	214 (18.5%)	
	Use 3 Devices	67 (5.8%)	
	Use 4 Devices	20 (1.7%)	
	Use 5 Devices	5 (0.4%)	
	Use Activity App	323 (29.9%)	
	Use Nutrition App	181 (16.7%)	
	Use Fitbit™ , Fuelband™ , or Jawbone™	117 (10.8%)	
	Use Heart Rate Monitor	250 (23.1%)	
	Use Pedometer	122 (11.3%)	
	Use Other Wearable	88 (8.1%)	
	Devices per Person		1.67 (0.84)

While MPA did not differ based on device users for all participants, male, but not female, device users reported significantly higher MPA. By contrast, though analyses of all participants revealed that device users reported higher VPA, this difference was mostly attributable to women in whom a similar difference was found, whereas VPA did not differ based on device use among men. Similarly, PA Enjoyment was found to be higher among all participants and women who used devices, but not men. Finally, device users, regardless of sex, reported greater PA Goal Setting (Table 2).

Table 2. Relationships Between PA and Device Use (n = 1,154).

	Device Users, Mean (SD)	Non-Users Mean (SD)	*p*	*t*
All				
Moderate PA (min/week)	174.8 (169.8)	160.6 (167.6)	0.156	-1.42
Vigorous PA (min/week)	180.6 (164.5)	151.8 (192.0)	0.006	-2.74
PA Enjoyment	54.1 (13.2)	50 (18.4)	< 0.001	-3.96
PA Goal Setting	14.3 (6.5)	9.9 (6.8)	0.047	-10.90
Men				
Moderate PA (min/week)	202.7 (214.3)	165.5 (182.6)	0.039	-2.074
Vigorous PA (min/week)	225.8 (200.4)	196.21 (223.6)	0.122	-1.548
PA Enjoyment	56.04 (12.5)	56.7 (12.8)	0.576	0.599
PA Goal Setting	15.1 (6.2)	11.6 (6.3)	< 0.001	-6.318
Women				
Moderate PA (min/week)	157.7 (132.0)	152.4 (138.6)	0.645	-0.462
Vigorous PA (min/week)	153.5 (129.9)	105.9 (142.1)	< 0.001	-4.096
PA Enjoyment	53.1 (13.5)	50.3 (14.8)	0.020	-2.328
PA Goal Setting	14.1 (6.6)	10.3 (6.3)	< 0.001	-6.779

PA: physical activity, SD: standard deviation

DISCUSSION

With less than half of all college students meeting PA guidelines, the relationship between VPA and technology-based self-monitoring should be noted when crafting future PA promotion interventions. The finding that the majority of students were regularly using PA monitoring devices and wearables is consistent with trends in national data that indicate a rapid increase in the use of such technology (11). Moreover, despite recent findings to the contrary (22), the high rate of device utilization, and their association with PA suggest that, with the proper programs, device use may in fact improve benefit students' PA.

FitBit™, Fuelband™, and Jawbone™ comprised over 97% of the PA wearable market (excluding smartphone-based apps) during 2013 (29). Though less extreme, this study's findings show similar preference for Fitbit™, Jawbone™, and Fuelband™ as seen in broader market research. The larger share of "Other Wearables" may indicate that students are trending towards emerging wearables rather than established brands (18). Future studies may examine the motivation behind specific device choice and differences between student preferences relative to the general population.

Adoption of smartphone based mobile apps has been closely linked with increased health consciousness (9). In this study, mobile apps were the most commonly utilized, indicating that students may be receptive to health outcome focused PA interventions. Tailored PA interventions using feedback from smartphone app-based activity monitors have been shown to be feasible and effective, though many popular applications currently fail to significantly employ theoretically underpinned behavior change techniques (10, 35)

Differences in PA based on device use varied between sexes. With respect to MPA the absence of a difference in MPA based on device use among women is likely due to participants engaging in high amounts of MPA through active transport independent of device use, and potentially indicates that some students consider active transport as MPA. By contrast, device use may have encouraged men to increase their active transport through the tracking of steps and/or distance travelled. Future studies may examine the active transportation behaviors of college students relative to self-monitoring and PA levels. Considering how active transportation contributes towards MPA may reveal more accurate relationships between device use and transport and non-transport related MPA. Device users reporter significantly higher VPA, but not MPA, compared to non-users. Though upon further analyse sex differences in PA intensities based on device use were revealed. The absence of a difference in VPA among men may be attributable to men already participating in high levels of VPA, while the opposite may explain the difference observed in women. Relevant to VPA, many wearables and apps can alert or "reward" users for engaging in high intensity activity, potentially motivating users to focus more on VPA rather than MPA..

Regardless of sex, device users reported significantly greater PA Goal Setting. The ability to quantify activity through PA devices may make goal setting and adherence easier. However, similar to PA, sex differences were found with respect to the relationship between device use and PA Enjoyment, with female, but not male, device users reporting significantly higher PA enjoyment. Greater PA Enjoyment among device users may be explained by increased self-efficacy and/or or the use of devices making PA more enjoyable. Similar to promoting VPA over MPA, many devices also encourage users to beat previous records, such as daily active minutes, distance ran, time spent in training heart rate zones, etc. The impact and ability of these devices to provide real-time feedback has only been examined relatively recently, with findings indicating that situation and context specific feedback can be an effective motivational tool (25, 31).

Future research could examine how the introduction of PA monitoring devices may influence or change an individual's goal setting behaviors within an established theoretical framework. Other studies could examine the magnitude of behavior change associated with different devices (ie, FitBit™ vs. mobile app) in an effort to identify the intervention delivery method with the highest success potential in the current population. Findings ultimately could be incorporated into campus-wide health and fitness promotion programs.

Notable limitations include, the reliance on self-report data, and the sampling of participants enrolled in college PA for-credit classes that may skew PA. Future research should examine a broader sample of students enrolled in a range of classes including those that do not involve PA, utilize objective PA measurements in a sub-group samples to verify self-report PA data accuracy, and consider the length of time that individuals have been using wearables for.

In conclusion, the relationship between technology-based self-monitoring and PA level suggests that mobile devices (ie, smartphones, wearables) should be considered in future college student PA interventions. The technological capability, both in terms of utilization and sensor accuracy, is still in its infancy, and thus the potential for significant health impact with these devices is substantial (13). With so many hours per day devoted to mobile device use, interventions utilizing PA tracking devices - particularly those able to integrate with a smartphone - may prove to be an extremely powerful tool in future health promotion for students as well as, potentially, the population as a whole. Lifetime health habits and behaviors are heavily influenced by routines developed during college (26). Therefore, utilizing a platform where students are already heavily invested - smartphone-based technology - as a means to promote lifelong health and wellness has the potential to generate a significant, lasting impact.

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