AMERICAN JOURNAL OF HEALTH EDUCATION
2019, VOL. 50, NO. 2, 67–79
https://doi.org/10.1080/19325037.2019.1571960

Motivational Readiness to Change Exercise Behaviors: An Analysis of the Differences in Exercise, Wearable Exercise Tracking Technology, and Exercise Frequency, Intensity, and Time (FIT) Values and BMI Scores in University Students

Carrie McFadden and Qing Li

Towson University

ABSTRACT

Background: Research indicates that increased exercise behaviors collectively called FIT (frequency, intensity, and time) values, equate with positive health outcomes. Young college adults often gain weight due to decreased exercise. **Purpose**: This study seeks to understand whether wearable exercise technology is associated with increased exercise among university students. **Methods**: A questionnaire identified motivational stages for exercise and wearable use. **Results**: Of the 115 students meeting all three FIT recommendations, 70 regularly exercised within the last 6 months. Of these, nearly half (*n* = 31) also regularly wore a wearable technology. Overall, 90 students were identified as regularly using wearable technology, 31 met all three FIT recommendations, and 53 met two FIT recommendations (frequency and time). Of total regular exercisers meeting two of three recommendations (*n* = 112), nearly half (*n* = 53) were wearable technology users. **Discussion**: Findings suggest that wearables may be associated with increased exercise and FIT values among university students. **Translation to Health Education Practice**: Wearable exercise technology has potential to enhance theory-based physical activity promotion to help students increase exercise and decrease risks of obesity and chronic disease. Future studies could examine how active student exercisers and active users of wearable technology use that technology to motivate them to exercise more.

A AJHE Self-Study quiz is online for this article via the SHAPE America Online Institute (SAOI) http://portal.shapeamerica.org/trn-Webinars

ARTICLE HISTORY
Received 1 August 2018
Accepted 17 October 2018

Background

Parallel to the declining exercise levels in both university students and the adult population,[1,2] there has been a recent and swift advent of wearable exercise tracking technologies, such as the later-generation smartphones, fitness applications (apps), and body-worn dedicated tracking devices; for example, Fitbit.[3] An assumption of such tracking device use is that users will likely exercise more frequently, more intensely, or longer while using the devices. Yet, there is little evidence to suggest the effectiveness of wearable technology at promoting exercise.[4] Even less is known about device use among university students and the impact that this technology may have on student exercise frequency, intensity, or time (FIT) behaviors. A study performed by the National College Health Assessment found that less than half of college students reported exercising at the recommended FIT levels set forth by the American College of Sports Medicine (ACSM).[2]

In 2017, nearly 17% of teens were obese and 40% of adults were obese.[1] Obesity rates often increase when young adults leave home and enter university settings.[5] During the past 2 decades, a significant increase in obesity and obesity-related chronic diseases—for example, type 2 diabetes, hypertension, and dyslipidemia—has occurred among teens and young adults.[6] Reasons for student weight gain include changes in diet and eating patterns and decreased physical activity.[5] Consistently, Health Educators understand that regular physical exercise, as students move through the aging process, is one of the most effective ways to offset obesity, lower body mass index (BMI), and decrease risk of chronic disease.[7] Recommendations for regular exercise are stated in terms of exercise frequency, intensity, and time (FIT values).

The ACSM, the Centers for Disease Control and Prevention, and the American Heart Association recommend FIT in 2 categories: one for moderate intensity and one for vigorous intensity. Moderate exercise is defined as activities that are not exhausting, such as fast walking, baseball, tennis, easy biking or swimming, and badminton. Vigorous exercise is defined as activities where the

CONTACT Carrie McFadden cmcfadden@towson.edu Department of Health Sciences, Towson University, 8000 York Road, Towson, MD 21252.

heart beat becomes rapid, such as running, jogging, hockey, football, soccer, vigorous biking or swimming, or cross-country skiing. Current recommendations for each FIT value are a frequency of 5 days per week at the intensity of moderate aerobic activity for a time of at least 30 minutes per session. The second recommendation is frequency of 3 days per week at the intensity of vigorous activity for a time of at least 20 minutes per session in order to achieve optimal health and weight management.[1,7,8]

It is evident that university students are not getting enough exercise.[2] Wearable technology, with its increasing popularity and accessibility, may provide a useful tool to promote and encourage exercise behavior in the university setting.[9,10] Previous studies have indicated that university students have an interest in tracking their physical activity throughout the day.[11-13] Research has also suggested that students expressed interest in specific features of the technology that they find desirable for use.[11-13] Popular features included running and workout tracking apps that allowed for self-monitoring,[12,13] activity goal setting, and apps or technology that were easy to use with minimal instructions.[11-13] Recent studies indicate that university students use self-monitoring and goal setting as important features afforded by wearable technology to increase physical activity overall.[14-16] Additionally, studies revealed that wearable technology devices today are accurate in their measurements of physical activity and have the potential to positively and accurately assess exercise activity.[4,17,18] For example, movement analysis studies have demonstrated average to excellent levels of smartphone accuracy during walking, jogging, running, and step climbing.[4] Finally, there have been studies pertaining to the educational affordances of wearable technology, suggesting that the use of the technology in an educational setting offers immediate, relevant, contextual, and personal information that may lead to more proactive behaviors.[9,13,19,20]

In health and exercise science education, there has been a long-standing gap between theory and practice.[21-23] The use of wearable exercise tracking technologies in Health Education offers university students individualized, contextually relevant knowledge, delivered through the most advanced technology.[9] Use of the technology may help to bridge the gap between classroom-taught exercise theory and day-to-day practical performance of exercise behaviors. Analyses of theory-driven physical activity interventions have shown that the component most strongly associated with successful behavior change, and a popular feature among university students, is self-monitoring.[12,13,18] Health Educators can have students monitor their actual physical activity throughout the semester. Class discussions can center on how physical activity can influence students' future chronic disease risk and how exercise recommendations are issued to promote the long-term health benefit from regular exercise. Ensuring that students become aware of the frequency of their exercise or physical activity, the intensity with which they perform the activities, and the length of time they move can have an impact on long-term health and well-being.

Existing literature has shown that there is student interest in wearable technology and that heart rate monitors and accelerometers embedded in wearable technology can provide objective and accurate measures of FIT values. More recent studies have shown that there are increases in daily physical activity levels when technology is used as a way to increase activity awareness.[14-16] To date, however, few studies have examined whether students are using wearable exercise tracking technology during exercise and whether or not its use is associated with increased adherence to the current exercise recommendations for FIT.

The Transtheoretical Model (TTM) of behavior change serves as the theoretical framework for the current study.[24] The TTM explains the various stages that an individual goes through when acquiring a certain health behavior. Originally applied to smoking cessation, the TTM described the motivational readiness to change through the stages of change in individuals with health problems, such as tobacco addiction.[24] The TTM has since been widely applied to health promotion programs and has been used to help explain the processes of exercise adoption and exercise adherence.

A core construct of the TTM is the stages of change (SOC). The SOC represent ordered categories along a continuum of motivational readiness to change a problem behavior or readiness to acquire a new behavior, such as the readiness for the adoption of regular exercise or physical activity.[24] The SOC represent the temporal dimension of behavior change and are defined as precontemplation (never performing a particular behavior), contemplation (thinking about the behavior to begin within the next 6 months), preparation (activity to begin the behavior within the next 30 days), action (performing the behavior within the past 6 months) and, maintenance (regularly performing a particular behavior for 6 months or longer). In this study, the TTM's SOC are used to examine where along this motivational continuum (from *never* to *regularly*) university students fall in performing exercise and in their readiness to use wearable exercise tracking technology use. See Table 1 for examples of questions pertaining to each stage.

However, the stages of change do not necessarily represent discrete categories. Survey participants can

Table 1. University of Rhode Island Change Assessment questions.[a]

Precontemplation questions	I don't have the time or energy to exercise regularly right now
	I don't have the time or energy to track my exercise regularly with a wearable device right now
Contemplation	I really think I should work on getting started with a regular exercise program in the next 6 months
	I really think I should work on getting started with regular tracking of exercise with a wearable device in the next 6 months
Preparation	I am preparing to start a regular exercise in the next few weeks
	I am preparing to start regularly tracking my exercise within the next few weeks. (I have looked into buying a device; I've talked with friends who use a tracker)
Action	I have started to exercise regularly, and I plan to continue
	I have started to track my exercise regularly with a wearable device, and I plan to continue
Maintenance	I have completed 6 months of regular exercise
	I have completed 6 months of regular tracking exercise with a wearable device

[a]Sample questions from the University of Rhode Island Change Assessment for each stage along a motivational continuum to perform exercise and to use a wearable exercise tracking technology device.

obtain a high score (meaning that they answered strongly agreed and agreed with each stage question within one stage) for one or more of the 5 SOC subscales. A multistage designation for survey participants was not uncommon and indicated that participants may somewhat overlap between the different stages of change along the continuum.[25-28]

Because of this possibility of scoring high in more than one stage, there existed the potential for survey participants to be placed in more than one stage. To answer the research questions, first for frequency designations (percentages of participants in each stage) and then for data comparison purposes, one overall score, a readiness to change (RTC) score, was needed for each participant that accounted for the sum of an individual's SOC scores. This overall RTC score was then compared to cutoff scores, indicating a numeric level from low to high likelihood to perform exercise and/or to use a wearable device. Readiness to perform a behavior was indicated by the score from low (not ready to perform a behavior) to high (ready to perform a behavior).

Understanding where students fall in their readiness to use wearable exercise tracking technology and what potential wearable technology may have for increasing FIT values and lowering BMI scores can enhance Health Education practices. Understanding the potential influence that wearable technology may have on increasing theory-based physical activity indicates their use as a potential effective intervention in Health Education to help promote physical activity and decrease the risk of chronic disease in university students.[10]

Purpose

The purpose of this study was to better understand whether the regular use of wearable exercise tracking technology during exercise might be associated with increased exercise behaviors, as measured through exercise FIT values among university students. Data were analyzed to answer the following research questions: (1) Where did university students fall along an RTC motivational continuum (from *never* to *regularly*) to exercise? (2) Where did university students fall along an RTC motivational continuum (from *never* to *regularly*) to use a wearable exercise tracking technology (ie, smartphone trackers, fitness phone apps, and Fitbits or body-worn devices) during exercise? (3) What were the differences among the RTC motivational level to exercise, the RTC motivational level to use a wearable technology, and FIT values? (4) What were the differences among the RTC motivational level to exercise, the RTC motivational level to use a wearable technology, and BMI scores?

Methods

Research design

This study was a quantitative design using an administrated self-report questionnaire to determine university students' level of exercise and use of wearable exercise tracking technology during exercise. This convenience sample study utilized both a descriptive and difference of groups means (means testing) research design. The data collection occurred during the fall 2016 semester at a large 4-year university in the Mid-Atlantic region of the United States.

Participants

Students were enrolled in 19 sections of a basic health course, which is a required university core course offered to all students, regardless of degree, major, or class status. Questionnaires took approximately 15 minutes to complete and were administered by the first author once during each class section. Data were collected through CampusLabs (an online data collecting method), which was used to distribute the questionnaire in each class section. The survey was administered on the university's mobile cart of 35 computer tablets (iPads) in the regular classroom for 13 face-to-face sections. Six fully online course sections had the survey delivered through a link in Blackboard, the university's learning management system. An announcement about the survey and the informed consent were made to each course section of students—one for face-to-face sections and one for online sections.

Procedures

The study was granted institutional review board approval, and the Wearable Exercise Tracking Technology (WETT) Questionnaire was developed to collect data. Each course section received an announcement about the research, stating that students had the option to not participate in the survey and that there was neither a direct risk nor benefit for participation. Students could stop taking the questionnaire at any time. Course instructors stepped out of the room during questionnaire administration. Students then completed the questionnaire (N = 417).

Measures

A self-report questionnaire was used as the means of data collection. The WETT Questionnaire was adapted from the University of Rhode Island Change Assessment (URICA), a widely used instrument in staging people along the motivational continuum to change or perform a health behavior.[25] The stages that the URICA identifies follow the foundational constructs of the TTM's SOC.[24] The stages are precontemplation (PC), contemplation (C), preparation (P), action (A), and maintenance (M).[24] See Table 1 for examples of the questions for each stage. The URICA has been measured widely in the literature for its internal consistency's strong coefficient alpha.[26] The URICA was adapted with permission for use in the WETT Questionnaire to include wearable exercise tracking technology use during exercise behavior. The adapted questions asking about wearable technology use used the same format structure of the original URICA questions and remained consistent with the original tool. The adapted measure was discussed through personal communication with expert scholars and colleagues in the field of behavior change theory who stated that the adaptation following the original tool was satisfactory to accurately measure SOC for wearable technology use for this study and that the adapted questions kept the integrity of the original URICA. The WETT study question scale was found reliable (48 items; α = .86).

The WETT was divided into 3 parts. In part 1, participants completed 48 questions (24 for exercise and 24 for wearable use) that employed a 5-point Likert scale response format with responses including 1 = *strongly disagree*, 2 = *disagree*, 3 = *undecided*, 4 = *agree*, and 5 = *strongly agree*. Participants were requested to indicate how closely they agreed or disagreed with each question.

Part 2 of the questionnaire asked 3 independent questions used to obtain information on participants' exercise frequency, intensity, and time (duration of exercise sessions) to determine FIT values. Questions included (1) How often per week do you exercise? (2) How intense is a typical exercise session for you? and (3) How long is an average exercise session? Each question asked participants to choose an answer that best described their behavior for each FIT value. For frequency the choices ranged from 1 to 5 or more days per week. Intensity queried one of the following as defined by American College of Sports Medicine[7]:

- Light intensity: You are moving but not exerting, and you are not breathing hard or sweating.
- Moderate intensity: Your breathing quickens, light sweat after 10 minutes, you can converse but not sing in activities such as brisk walking, easy swimming, non-circuit weight lifting.
- Vigorous intensity: your breathing is deep and rapid, sweating after a few minutes, you can't say more than a few words in activities such as running, brisk jogging, circuit weight training.

Exercise time choices ranged from 1 to 60 minutes or more per each exercise session.

The questions were written in accordance with health and human performance research guidelines[29] and pretested with a representable sample for content during a pilot study in September 2016. Of the 417 participants who answered part 1 of the survey, 350 went on the answer part 2 of the survey.

Part 3 of the questionnaire requested participants to respond to basic demographic information, including gender, age, ethnicity, class status, height, and weight. Height and weight were used to calculate BMI scores for each participant. All of the 417 participants answered this section of the survey.

Analysis

To analyze research questions 1 and 2, descriptive statistics were used to identify the percentage of students at each level of the motivational continuum from *never* to *regularly* for both exercise behavior and wearable exercise tracking technology use during exercise. This motivational continuum followed the TTM URICA questionnaire in order to identify students as one the 4 stages of change, from precontemplation (*never*) to maintenance (*regularly*) based on the overall RTC score, as shown by the questions in Table 1.

Twenty-four questions employed a 5-point Likert-scale survey to indicate where university students fell along a motivational continuum to exercise. This continuum is indicated by the 5 categories found in the transtheoretical model of behavior change, ranging from precontemplation to maintenance (PC to M). Students answered 1 to 5 (*strongly disagree* to *strongly agree*) for questions from each of the 5 categories. Student level of agreement for each question identified them into a SOC, which allowed for RTC designations for each participant (N = 417). From the RTC scores, percentages (frequency of occurrence) were calculated for each stage along the motivational continuum to exercise and to use a wearable technology.

To analyze research questions 3 and 4, the 5 stage designations based on participants' overall RTC scores, from *never* to *regularly*, were trichotomized in order to turn the continuous RTC scale into 3 discrete groups. Based on the literature and discussions with experts, data were divided into 3 categories to aid in data comparisons.[30,31] The PC stage was categorized into one group, because this category represented no action and no intention of action to exercise or to wear a tracking device in the foreseeable future.[31] Contemplation and preparation were categorized as one group, because this grouping categorized pre-action or an inevitable intention to action.[31] Action and maintenance were grouped as a third category, representing action and applied intention to exercise and or to wear an exercise tracking device.[31]

Grouping the RTC designations into 3 categories was an appropriate grouping for this study, because adjacent stages correlated more highly with each other than with any other stage.[31] Studies have indicated that the similarities between adjacent stages are more strictly linked than nonadjacent stages.[30,31] Studies have indicated that although individuals in change often progress from one stage to the next, they often have attitudes and behaviors that characterize more than one stage at a time.[31] Preparation, for example, was found to be nondiscriminate from contemplation, its adjacent stage.[31] Preparation was similar in response rates to action, its other adjacent stage. Yet, studies suggested that due to preparation's pre-action characteristics, it more commonly agrees with contemplation's characteristics.[30,31]

Further, studies suggested that the stages are best represented by 3 RTC categories, now thought of as (1) least likely for change, (2) middle likely for change, and (3) most likely for change, based on behavior and behavior intention.[32]

These 3 groups (PC) *least likely*, (C, P) *middle likely*, and (A, M) *most likely* were the 3 categories used for all subsequent group means testing. Analyses of variance (ANOVAs) for both exercise and wearable exercise technology behaviors were conducted to answer research question 3. Group comparisons were analyzed using a univariate ANOVA to determine whether differences existed between the 3 levels of RTC. ANOVA results yielded descriptive statistics for the data, including the means and standard deviations for each group (least likely, middle likely, and most likely).

Results also showed the F value and the associated probability of significance of F. The differences among the means were declared significant at the .05 level. Two separate ANOVAs for exercise motivation and 2 separate ANOVAs for wearable technology to measure differences between each group's frequency and time were conducted.

Tukey's honestly significant difference (HSD) post hoc tests were performed to identify where a significance might be measured if overall significance was found in any of the ANOVA analyses.

Because intensity of exercise was a categorical variable indicating whether students were performing light activity, moderate activity, or vigorous activity, 2 chi-square analyses were used to compare the frequencies of responses between each group. The first chi-square analysis tested the difference in intensity between the 3 RTC groups (least, middle, most likely) for exercise behavior. The second chi-square analysis tested the difference in exercise intensity between the 3 RTC groups for wearable exercise technology use. See Tables 2 and 3.

A third chi-square analysis looked only at students who met all 3 of the FIT recommendations and was used to cross-analyze the RTC for exercise with the RTC for wearable use to determine how many students regularly meeting all 3 FIT values were also regularly using a wearable exercise tracking technology during exercise as shown in Table 4.

To analyze whether differences existed among the 3 groups for BMI, 2 additional ANOVAs allowed a comparison between a BMI score and exercise beha-

Table 2. Results of the chi-square exercise RTC and intensity of exercise (N = 350).[a]

	Moderate intensity, n (%)	Vigorous intensity, n (%)	Total, n (%)
Precontemplation	57 (65.5)	25 (28.7)	87 (100.0)
Contemplation–preparation	58 (70.7)	20 (24.4)	82 (100.0)
Action/maintenance	112 (61.5)	70 (38.5)	182 (100.0)

[a]RTC indicates readiness to change. χ^2 < 0.05. Table indicates that the 70 students who fell into the action/maintenance stage of change and exercised vigorously met all 3 of the frequency, intensity, and time exercise recommendations.

Table 3. Results of the chi-square wearable RTC and intensity of exercise (N = 350).[a]

	Moderate intensity, n (%)	Vigorous intensity, n (%)	Total, n (%)
Precontemplation	130 (65.3)	64 (32.2)	199 (100.0)
Contemplation–preparation	44 (71.0)	16 (25.8)	62 (100.0)
Action/maintenance	53 (58.9)	31 (38.9)	90 (100.0)

[a]RTC indicates readiness to change. χ^2 < 0.05. Table indicates that 90 students were regularly using a wearable technology device. Of the 90, 31 met all 3 of the frequency, intensity, and time exercise recommendations. Of the 90, 53 met 2 of the 3 exercise recommendations, and 6 met either one or none of the recommendations.

vior and a comparison between BMI score and wearable exercise technology use for each participant.

Results

Participants were 417 university students ranging in age from 17 to 22, with a mean age of 19.3. Over half (54%) of the students were College of Health Professions majors. Fifty-seven percent of the participants were white/Caucasian and disproportionately female (70%). All students were undergraduates.

Research question 1 sought to determine where students were in terms of motivation to regularly exercise and was answered by part 1 of the WETT Questionnaire, utilizing the URICA questions and the derived RTC designations, from precontemplation to maintenance, for each participant (N = 417). The results showed that nearly 40% (n = 167) fell into the action/maintenance stages for exercise behavior and roughly 60% (n = 250) of students fell among the precontemplation (39%), contemplation (9%), and preparation (11%) stages, as shown in Table 5.

Research question 2 sought to determine where students were in terms of motivation to use a wearable technology device during regular exercise. Research question 2 was also answered by part 1 of the WETT Questionnaire, utilizing the adapted URICA questions for wearable motivation. Wearable device use was scored identically to the URICA used in research question 1, using the same measure for placement into an SOC for wearable device use during exercise based on an overall RTC score for each participant (N = 417). The results showed that roughly a quarter of participants (n = 90) were in the action/maintenance stages, meaning that they regularly used wearable technology during exercise. Of note, over 60% of students were identified in the precontemplation stage of wearable technology device use, meaning that they had no foreseeable intent to use technology. See Table 5.

Table 5. Motivational stage of change continuum to perform exercise and to use a wearable technology (N = 417).[a]

	% Exercise, % use wearable technology
Precontemplation	39.1, 62.7
Contemplation	8.5, 7.8
Preparation	10.8, 7.8
Action	9.6, 4.1
Maintenance	32.0, 17.6

[a]Percentages indicate where students fell along the transtheoretical model of behavior change motivational scale to perform exercise and to use a wearable tracking technology device.

Research question 3 was answered by part 2 of the questionnaire, which asked specifically about each participant's exercise FIT behaviors to see whether there were differences among the 3 groups for both exercise and wearable technology use. The statistical processes of ANOVA, Tukey's HSD post hoc test, and chi-square tests were used. These tests aided in the understanding of whether or not students who identified themselves as regularly exercising were actually exercising to the recommended levels and whether students who identified as regularly using wearable technology during exercise had increased exercise FIT behaviors and improved BMI scores, indicating a healthy range. Fewer participants (N = 350) answered part 2 of the survey.

Specifically, for research question 3, 2 ANOVAs looked at exercise motivation and the FIT variables of exercise frequency and exercise time. One ANOVA analyzed whether or not differences occurred among the exercise RTC groups (least likely, middle likely, and most likely to exercise) and the variable of exercise frequency, and one ANOVA analyzed whether or not differences occurred among the RTC groups and the variable of exercise time per session.

Table 4. Intensity of exercise and exercise RTC compared to intensity of exercise wearable technology RTC.[a]

Wearables cutoff score (3 levels)	Exercise cutoff score	Light intensity, n (%)	Moderate intensity, n (%)	Vigorous intensity, n (%)	Row total
Precontemplation	Precontemplation	3 (4.29)	48 (68.57)	19 (27.14)	70
	Contemplation/preparation	1 (1.89)	35 (66.04)	17 (32.08)	53
	Action/maintenance	0 (0.00)	47 (62.67)	28 (37.33)	75
Contemplation/preparation	Precontemplation	1 (11.11)	4 (44.44)	4 (44.44)	9
	Contemplation/preparation	1 (5.00)	18 (90.00)	1 (5.00)	20
	Action/maintenance	0 (0.00)	22 (66.67)	11 (33.33)	33
Action/maintenance	Precontemplation	0 (0.00)	5 (71.43)	2 (28.57)	7
	Contemplation/preparation	2 (22.22)	5 (55.56)	2 (22.22)	9
	Action/maintenance	0 (0.00)	43 (58.11)	31 (41.89)	74

[a]RTC indicates readiness to change. Chi-square analysis indicates of the 70 students in the action/maintenance stage of exercise 31 students were in the action/maintenance stage of wearable technology use and met all 3 of the exercise recommendations for frequency, intensity and time. Forty-three students were in the action/maintenance stage of wearable use and in the action/maintenance stage for exercise and met 2 of the 3 exercise recommendations.

The ANOVA for exercise and frequency indicated that there were no significant differences between the RTC groups for frequency of exercise. That is, all groups were exercising between 3 and 4 times per week.

However, a significance was found between the RTC groups for exercise session time. That is, the most likely to exercise group (M = 4.04, SD = 1.01) exercised significantly longer during an exercise session than did the least likely to exercise group (M = 3.56, SD = 1.25) but not significantly longer then the middle likely to exercise group (M = 3.90, SD = 1.02). Tukey's HSD post hoc test showed that the only significant difference was between those students least likely to exercise and those most likely to exercise. The least likely group exercised on average roughly 31 minutes per bout of exercise and the most likely to exercise exercised for roughly 41 to 45 minutes per bout. There is no significant difference between the middle likely group (38 minutes) and the other groups in terms of time spent exercising.

Two ANOVAs were then performed to analyze whether or not associations existed between wearable exercise technology device use and FIT. One ANOVA analyzed wearable device use motivation and the variable of exercise frequency, and one ANOVA analyzed wearable device use motivation and the variable of exercise time. Results indicated that there were no significant differences among the RTC of the 3 groups representing the least likely (M = 4.02, SD = 1.34), middle likely (M = 4.13, SD = 1.48), and most likely (M = 4.10, SD = 1.45) to use a wearable technology device during exercise and frequency of exercise. That is, all groups were exercising roughly 3 times per week.

Similarly, the ANOVA did not show any differences between the 3 groups and the variable of exercise time. That is, the average self-reported length of time spent exercising, roughly 35 minutes, was the same for each RTC wearable technology group (least likely: M = 3.90, SD = 1.13; middle likely: M = 3.83, SD = 1.03; and most likely: M = 3.90, SD = 1.10).

Three chi-square analyses were also used to analyze research question 3 for the exercise variable of exercise intensity. The first 2 chi-square analyses looked at the relationship between (1) the RTC motivational level to exercise and exercise intensity and (2) the RTC motivational level to use a wearable technology device and exercise intensity. The chi-square analysis was used to compare intensity responses (indicating light activity, moderate activity, and vigorous activity) among the 3 groups.

In terms of exercise RTC and the exercise variable of intensity, the chi-square test of goodness-of-fit results indicated that intensity levels for the 3 groups were not equal among the groups. The chi-square for exercise RTC and intensity showed a significant result, χ^2 (6, N = 350), 16.40, P < .05. That is, the most likely to exercise group was exercising at significantly more vigorous intensity levels than the least likely to exercise group. There were no significant differences among the groups for moderate levels of exercise, as shown in Table 2.

In terms of wearable technology device use RTC and the exercise variable of intensity, the chi-square test of goodness-of-fit results indicated that intensity levels (moderate to vigorous) for the 3 groups for technology use motivation did not differ significantly. That is, the chi-square for wearable technology RTC and intensity showed a nonsignificant result, χ^2 =3.90, df = 6; P < .05. See Table 3.

The third chi-square analysis looked only at students who met all 3 of the FIT recommendations: Typical time duration recommendations for moderate-intensity activities are at least 30 minutes per session 5 days per week. For vigorous-intensity activities, the recommended time duration is at least 20 minutes per session 3 or more days per week. The number of students meeting the recommendations (n = 115) was used to cross-analyze the RTC for exercise with the RTC for wearable use. The chi-square test identified a strong association between the most likely (action/maintenance) stage for regular exercise behavior and most likely (action/maintenance) stage for wearable use, showing that students who regularly used the wearable technology were significantly more likely to be regularly exercising than either the least likely or middle likely to use a wearable technology, χ^2 (2, N = 350) = 48.08, P < .01. That is, of the 35 students in the action/maintenance stage of regular wearable use who met all 3 FIT recommendations, 31 were in the action/maintenance stage of regular exercise, as shown in Table 4.

Finally, research question 4 investigated whether or not there was an association among the RTC groups (least, middle, most likely to exercise) and BMI scores. Research question 4 also addressed whether or not there was an association among the RTC groups to use a wearable exercise technology and BMI scores. The 2 ANOVAs indicated no significant differences among all 3 groups and the BMI scores of each group. BMIs were surprisingly similar between the exercise readiness groups (least RTC: M = 24.61, SD = 5.50; middle RTC: M = 23.36, SD = 3.90; and most RTC: M = 24.50, SD = 4.10). Similar to exercise readiness, wearable technology readiness groups displayed very similar BMIs (least RTC: M = 24.30, SD = 4.70; middle RTC: M = 23.90, SD = 4.20; and most RTC: M = 24.62, SD = 4.72). It seems clear from this investigation that neither exercise stage nor wearable technology use was related to participants' BMI.

Discussion

Decreased physical activity among university students has long been an area of study. The Healthy Campus

2020 initiatives have identified physical inactivity of university student as a primary area of concern.[14] Parallel to declining activity levels in many college students, there has been a swift advent and adoption of wearable exercise tracking technology. Yet, technology-based exercise tracking devices have only recently begun to be explored as a health behavior intervention in the university population.[14]

The current study is among the first to investigate the exercise behaviors of university students taking into account the use of a wearable technology during exercise, compared to the measurable outcomes of exercise FIT values, based on the current ACSM exercise guidelines. Study results provide Health Educators with an encouraging quantitative background to employ wearable exercise tracking technology for the promotion of exercise behaviors to reduce obesity and risks of chronic disease in university settings.

Similarly to national norms, finding that less than half of university students reported exercising at the recommended levels, this current study found that nearly 60% (N = 417) reported not regularly exercising. Moreover, results showed that of the roughly 40% of students who reported that they did regularly exercise, only 115 students actually met all 3 FIT recommendations. Of the 115 meeting the recommendations, 70 were found to be in the most likely to exercise group (action/maintenance). The rest of the students meeting all 3 of the guidelines (n = 45) identified themselves in the precontemplation to preparation stages of exercise as per the ACSM definition of recommended exercise in part 1 of the survey. However, results show that they were performing activity that allowed them to meet the recommendations. It is understandable that a student might think of sport participation, even if casual and infrequent, or walking across campus or to and from school as exercise. However, this student's activity might change if his or her routine or location changes the following semester. Students might also over- or underestimate the time it takes to walk to class or perhaps takes a shuttle or rides with a friend on rainy or cold days. In other words, this type of activity is not necessarily considered exercise if the behavior is not consistent. Whatever the activity, it was on an intermittent or irregular basis and not performed regularly as it was for students who identified in the action/maintenance stages.

Next, results showed that roughly a quarter of students (n = 90) were regularly using wearable exercise tracking technology. A cross-analysis (Table 2) showed that nearly half of the 70 regular exercisers (action/maintenance) were also in the most likely group to be regular wearable technology users (n = 31). The group of students who were regularly meeting the exercise recommendations and also regularly using wearable technology represents the largest percentage of students who met all 3 of the FIT recommendations, as seen in Table 4. That is, of the 90 students identified as being regular users of wearable technology, 31 were also regular exercisers who met all 3 FIT recommendations. Of the 90 wearable device users, 53 met 2 out of 3 FIT recommendations (for frequency and time), and the remaining 6 met one or no recommendations.

Of the total regular exercisers (action/maintenance) meeting 2 of the 3 recommendations (n = 112), slightly less than half (n = 43) were regular wearable technology users, as shown in Table 2. Therefore, of the 90 students who regularly use wearable technology, 74 met 2 or 3 of the FIT recommendations. Though this number represents under a quarter of the study population, it is an encouraging finding for Health Educators looking for quantitative support to encourage the use of wearable technology for students.

Of the 70 students in the action/maintenance stage of regular exercise who met all 3 of the FIT recommendations, 28 students were identified in the least likely group (precontemplation) to use wearable technology. That is, 28 students met all 3 recommended exercise guidelines but were not using wearable technology and had no intention of using wearable technology in the foreseeable future. There was no significant difference in any of the FIT values between the 2 groups of non-technology users (n = 28) and technology users (n = 31) who were in the most likely to exercise group. This means that regardless of technology use, these 2 groups of students were exercising within similar exercise FIT values.

In fact, the current study identifies that roughly 75% of students are not tracking exercise with wearable technology. This finding yields important considerations for Health Educators, because wearable technology may be ideally targeted for students in the contemplation and preparation stages of wearable use. Guided education on wearable technology use and the value of the data generated may help tip the decisional balance in favor of tracking exercise. This instruction could focus on the technology's ability to provide substantial assistance in helping students to understand the value and importance of tracking activity over time. By the time students enter the preparation stage, the pros in favor of attempting to change a sedentary behavior outweigh the cons.[24] Students may be talking with friends, reading about features of wearables or technology devices, or investigating how their phone might track activity. They may have even tracked a few days of activities over the past month. Health Educators can begin to use technology as an exercise promotion intervention, encouraging students to experiment with the technology for individualized tracking and exercise data.

Of greater concern, this research identified that the largest percentage of students surveyed (63%, n = 260) were in the precontemplation motivational stage, with no intention of beginning to use a wearable tracking technology within the next 6 months. This is a fairly understandable number of students falling within this stage, given the relative novelty of the technology. Students may not have yet thought about using trackers or identified tracking as useful for their exercise sessions or been taught about the value of the data that wearables provide. Health Educators have an opportunity to introduce this technology as a way to enhance or provide self-monitoring ability, increase goal setting, and ultimately motivate students to exercise. This is the stage where Health Educators can instruct students that technology alone will not initiate or sustain an exercise program, but it can help students identify their current level of physical activity, bringing awareness to the areas in which students could begin to make improvements.

Finally, the current study indicated that the exercise variable of intensity was where many students fell short of meeting all 3 exercise recommendations (n = 227). Most students were exercising 3 to 4 days per week, yet the majority of students surveyed were only exercising moderately during this time, falling short of the 5 days per week recommendation of moderate intensity. Students who exercised vigorously (n = 115) met the recommendations given the frequency of exercise, yet only 70 students surveyed were regularly exercising for a 6-month period or longer. Of greatest concern was students not meeting the intensity value, because intensity of exercise appears to be critical regarding future cardiovascular disease risk reduction.[33] This is an important consideration for the use of wearable technology in Health Education today. On the one hand, Health Educators can promote the use of technology to track exercise intensity, because many wearable technologies display heart rate during exercise, and can indicate where students need to make modifications in the moment. On the other hand, Health Educators need to help students in understanding, interpreting, and internalizing the exercise data they track, because they must become aware that exercise needs to be performed at a certain intensity depending on its frequency for health benefits and decreased risks for chronic disease.

There is a pressing need in Health Education to stress the importance of adherence to all 3 of the FIT recommendations as shown by the results of this study. The use of wearable technology as an instructional tool allows educators to teach students how to self-monitor workouts, to understand how their exercise activity compares with current recommendations, and to discover where behavior changes must be incorporated. Wearable technology offers immediate feedback on the FIT values so that students can understand their activity in the moment. Health Educators should encourage students to use a wearable technology device to track, analyze, and store their data over a period of weeks and months to confirm the effectiveness of their exercise sessions. Ultimately, the effectiveness of their day-to-day exercise sessions is an indicator of their risk level for development of chronic disease, both now and in the future.

The present study offers a preliminary understanding of where students fell along the motivational continuum for both exercise and using a wearable exercise tracking technology during exercise. The findings support an association between wearable technology device use and increased level of exercise FIT values in those who regularly use the technology. Results show promise for these technologies as potential behavior change exercise interventions in the university setting. Future research should be done to further the limited understanding of how wearable technology influences exercise behaviors in university students. For example, studies could examine how students who are regular exercisers and regular users of wearable technology devices use the technology to drive their behavior to exercise more.

Limitations and future directions

Though the current research yields interesting results, it is not without its limitations. Studies have suggested that self-report data, as used in the current study, are subject to limitations, such as inaccurate recall and the response bias of social desirability in misreporting height, weight, and level of exercise performed per week.[34]

Another limitation to this study was the comprehensive data collection instrument. This study used the TTM, the URICA, and the adapted URICA to determine level of motivation for exercise and wearable technology device use behaviors. The URICA is a valid and reliable field-tested instrument based on a widely regarded behavior change theory, which justified its use. Though use of the TTM and URICA might be an excellent way to stage students in a classroom setting to help design appropriate educational strategies aimed at increasing physical activity based on stage of readiness, recent studies have shown that using simpler methods (ie, The Global Physical Activity Questionnaire) can accurately assess physical activity and exercise in larger populations of study. Future studies could more easily assess university students' exercise levels and use of wearable exercise technology, consistent with methods used in recent studies.[14]

There are also inherent limitations to using BMI as a categorical tool for obesity designations that are well documented in the literature.[35] Diet's influence on BMI scores was not factored into this study. Regardless of exercise level, diet may be a stronger factor in the similarity of BMI scores found among university study participants. Some experts believe that overall physical activity is important for weight loss, yet food consumption and diet have the greatest impact on BMI scores.[36] Diet is a key factor in university student weight gain, with all-you-can-eat meal plans, lack of parental supervision, changes in eating behaviors, and added calories from alcoholic drinks.[5,37-39]

In addition to not controlling for diet, this research did not control for any other key covariates in the main analysis, which therefore this limits this study's scope of generalizability. Differences in wearable technology use and exercise FIT behaviors between gender designations, declared college majors, defined class status, and race or ethnicity could offer key insight into exercise behaviors and merit future investigation.

Finally, the TTM processes for exercise behavior change have not been investigated within the context of the TTM behavior change theory.[40] Concurrent with the stages of change, the TTM defines processes, or activities, that accompany each stage along the motivational continuum, from precontemplation through maintenance. These processes provide important guidelines for intervention strategies to help people move from stage to stage.[24] Processes include activities such as self-monitoring and daily tracking, feedback, and incentives. These processes should be investigated for future use in Health Education when designing curriculum to deepen understanding of the possibilities afforded by wearable technology.

One important area for further investigation, and an important implication for Health Education, is to define and highlight the processes that students in the action/maintenance stage of change use to drive their increased exercise behavior. Activity tracking has been equated with successful behavior change in previous studies.[10,41,42] Wearable exercise tracking technologies offer students a way to use the strategy of tracking to understand whether or not they are exercising to levels that promote health and fitness. To pursue how students use this technology to help keep them exercising regularly and to meet the FIT levels that promote health and decrease chronic disease risk would be a fruitful area of future study. Current studies are beginning to show a relationship between activity tracking, goal setting, and increased exercise behaviors.[14] The motivational factors associated with goal setting and other motivational factors of wearable technology merits further investigation.

Translation to Health Education Practice

The rapidly expanding use of wearable exercise tracking technologies raises important questions about their potential benefits in Health Education. Researchers caution that these technological devices should act as facilitators, and not drivers, of health behavior change.[18] Therefore, wearable technology may offer promise to change or increase exercise behaviors but less due to their technology and more because of the behavioral change strategies that can be designed around them.[15] Wearable use alone is not proven to change behavior, perhaps due to the fact that few wearable technologies are found to include theoretical foundations recommended for behavior change in their design.[40]

The TTM,[24] a model of intentional behavior change, is the theoretical underpinning for this study and helped to identify where university students fell along the RTC motivational continuum from precontemplation to maintenance in (1) exercise behavior and (2) wearable exercise tracking technology use during exercise. The motivational continuum is an important consideration for Health Education practice. The first 3 stages of the RTC continuum, precontemplation, contemplation, and preparation, collectively equate to no action and pre-action to perform a behavior, such as exercise or wearable use, but little actual participation in the behavior itself. The current study found that roughly 60% to 70% of students surveyed fell within this range of the continuum and are either not exercising at all or not exercising regularly as per the definition provided in the questionnaire, nor were they using a wearable technology device.

The highest percentage of students for both exercise (39%) and wearable use (63%) were identified in the precontemplation stage as having no intention of performing the behavior. This finding is both concerning as well as informative for Health Educators. Students in this stage must not be dismissed as resistant or unmotivated to change; instead, they may be uninformed or underinformed about the consequences of their sedentary behavior. Health Educators can offer information, guidelines, and encouragement to these students, with the understanding that traditional behavior change programs, often requiring immediate action, may not match the motivational needs of this group of students.

To address the challenges of students in the precontemplation stage, Health Educators need to emphasize the importance of education over exercise promotion. Health

Educators understand that it is important to evaluate a student's readiness to change. For example, if an intervention, such as the use of a wearable exercise tracking technology, is offered as an exercise promotion strategy, students in this stage may not be ready to use it. Interventions that are not matched to the readiness of a student will be less likely to succeed.[24] Therefore, a more stage-specific intervention for a student in the precontemplation stage would be to educate him or her about the consequences associated with a sedentary lifestyle and to provide basic education on how to begin an exercise program. Health Educators have an opportunity to introduce wearable technology as a way to enhance or provide self-awareness, self-monitoring ability, and goal setting to students beginning an exercise program. This is the stage where educators can instruct students that technology alone will not initiate or sustain an exercise program, but it can help students identify their current level of physical activity and where they may seek to make improvements.

Findings from the current research also show that there are students (n = 28) who maintain regular and effective exercise without using technology. This has important implications for Health Education. Wearable technology can offer unprecedented access to novel inspiration to maintain or excel in one's fitness program for people in the action/maintenance stage. For example, personalized coaching apps can now track pace, distance, and speed and provide spoken feedback (eg, in-the-moment encouragement) during an exercise session. There are also apps that check biomechanical postures, such as vertical oscillation or stride efficiency. These apps can use voices of personal trainers and professional athletes to provide dynamic, responsive audio feedback for momentary ecological guidance and motivation. Wearable technologies can provide the needed push for a regular exerciser to continue with his or her program or exercise routine or return back to regular exercise after a gap in exercise behavior.

University students are increasingly more technology-centric, and the use of technology is firmly entrenched in their lives.[43,44] Students have more access to wearable technologies than in any other time in history.[3,7] This current study provides Health Education with an encouraging quantitative background to employ nontraditional devices (ie, Fitbit, smartphone, etc) for the promotion of exercise behaviors. Findings of the present study indicate that wearable technology holds promise as a potential positive behavior change exercise intervention in the university setting. Ultimately, it is the goal of the Health Educator to teach students how to be accountable and to understand and to meet exercise recommendations over time. Yet, behavior and behavior change can be circular and cyclical, and students can move in and out of periods of regular exercise. Concepts of Health Education must emphasize human nature, human potential, and human emotions and not simply cognitive processes and overt behavior.[45] A humanistic orientation to learning provides for the function of motivation and involves individual choice and responsibility.[45] Wearable technology is a vital instructional tool offering a humanistic approach to teaching and learning. It offers contextual, situational, immediate, relevant information that is personal to the student in order to help him or her make decisions so that exercise and well-being become a lifelong pursuit.

This study provides evidence that wearable exercise tracking technology has a positive association with increased FIT values and provides a basis for Health Educators to build technology use into theory-based course curriculum. Identifying students' motivational readiness for health behaviors is important. Health Educators understand that if a student has not sufficiently prepared for behavior change or committed to a chosen plan of action, no action to exercise or a relapse back to sedentary behavior is likely.[24] Health Educators also understand the role that motivation plays in keeping students actively engaged in their regular exercise program. Wearable exercise tracking technology is an innovative way to help students understand how their current physical activity compares to what is recommended for long-term health benefit and reduced risk of chronic disease throughout the life span. One way that Health Educators can be innovative in measuring students' daily physical activity to help them understand whether they are truly exercising at the recommended levels is through the use of wearable exercise tracking technology.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

1. Centers for Disease Control and Prevention. Heart Disease. https://www.cdc.gov/heartdisease/conditions.htm. Published October 30, 2017. Accessed June 15, 2017.
2. National College Health Assessment. http://www.acha-ncha.org/overview.html. Published Fall, 2017. Accessed June 15, 2018.
3. National Report on College Students. Pearson student mobile device survey. http://www.pearsoned.com/wp-content/uploads/Pearson-Student-Mobile-Device-Survey-2015-National-Report-on-College-Students-public-release.pdf. Published June, 2015. Accessed June 15, 2018.

4. Bort-Roig J, Gilson ND, Puig-Ribera A, Contreras RS, Trost SG. Measuring and influencing physical activity with smartphone technology: a systematic review. *Am J Sports Med*. 2014;44:671–686. doi:10.1007/s40279-014-0142-5.
5. Gropper SS, Simmons KP, Connell LJ, Ulrich PA. Changes in body weight, composition, and shape: a four-year study of college students. *J Appl Physiol Nutr Metab*. 2012;37:1118–1123. doi:10.1139/h2012-139.
6. United States Department of Health and Human Services. The surgeon general's call to action to prevent and decrease overweight and obesity. https://www.surgeongeneral.gov/priorities/prevention/about/healthy-aging-in-action-final.pdf. Published November, 2016. Accessed June 15, 2018.
7. American College of Sports Medicine. Annual survey: 2017 fitness trends. https://www.acsm.org/about-acsm/media-room/news-releases/2015/10/26/annual-survey-reveals-new-1-fitness-trend-in-2016-2017. Published November 2016. Accessed October 2017.
8. American Heart Association. Healthy living. https://www.heart.org. Published February 2, 2014. Accessed June 15, 2018.
9. Bower M, Sturman D. What are the educational affordances of wearable technologies? *Comput Educ*. 2015;88:343–353. doi:10.1016/j.compedu.2015.07.013.
10. Cadmus-Bertram L, Marcus BH, Patterson RE, Parker BA, Morey BL. Randomized trial of a fitbit-based physical activity intervention for women. *Am J Prev Med*. 2015;49(3):414–418. doi:10.1016/j.amepre.2015.01.020.
11. Middelweerd A, van der Laan D, van Stralen M, et al. What features do Dutch university students prefer in a smartphone application for promotion of physical activity? A qualitative approach. *Int J Behav Nutr Phys Act*. 2015;12(31):1–11. doi:10.1186/s12966-015-0189-1.
12. Stvilia B, Choi W. Mobile wellness application-seeking behavior by college students: an exploratory study. *Lib Inf Sci Res*. 2015;37:201–208. doi:10.1016/j.lisr.2015.04.007.
13. Gowin M, Cheney M, Gwin S, Wann TF. Health and fitness app use in college students: a qualitative study. *Am J Health Educ*. 2015;46(4):223–234. doi:10.1080/19325037.2015.1044140.
14. Papalia Z, Wilson O, Bopp M, Duffey M. Technology-based physical activity self-monitoring among college students. *Int J Exer Sci*. 2018;11:1096–1104.
15. Dunn EE, Robertson-Wilson J. Behavior change techniques and physical activity using the fitbit flex. *Int J Exer Sci*. 2018;11:561–574.
16. Fritz T, Huang EM, Murphy GC, Zimmermann T. Persuasive technology in the real world: a study of long-term use of activity sensing devices for fitness. Paper presented at: CHI '14 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems; April 26, 2014; Toronto, Ontario, Canada.
17. Ferguson T, Rowlands AV, Olds T, Maher C. The validity of consumer-level activity monitors in health adults worn in free-living conditions: a cross-sectional study. *Int J Behav Nutr Phys Act*. 2015;12(42):1–9. doi:10.1186/s12966-015-0201-9.
18. Patel MS, Asch DA, Volpp KG. Wearable devices as facilitators, not drivers, of health behavior change. *J Am Med Assoc*. 2015;39(13):459–460. doi:10.1001/jama.2014.14781.
19. Keeley K, Potteiger K, Brown CD. Athletic training education: there's an app for that. *Athl Train Educ J*. 2015;10(2):190–199. doi:10.4085/1002190.
20. Nahm E. Mobile technologies for health education: what do we need to consider? *Online J Nurs Inform*. 2015;17:18–20.
21. Barnett BE, Merriman WJ. Knowledge of physical fitness in prospective physical education teachers. *Phys Educ*. 1994;5:74–78.
22. Bulger SM, Mohr DJ, Carson LM, Robert DL, Wiegand RL. Preparing prospective physical educators in exercise physiology. *Quest*. 2000;52:166–185. doi:10.1080/00336297.2000.10491708.
23. Van Donselaar L, Leslie DK. Current and recommended preparation of physical education teachers in exercise physiology. *Phys Educ*. 1990;47:209–217.
24. Prochaska JO, DiClemente CC. Stages and processes of self-change of smoking: toward an integrative model of change. *J Clin Psychol*. 1983;51:390–395.
25. Cancer Prevention Research Center. Exercise: Stages of change—continuous measure. http://www.uri.edu/research/cprc/Measures/Exercise. Published 2007. Accessed October, 2017.
26. Samuelson M. Changing unhealthy lifestyle: who's ready…who's not: an argument in support of the stages of change component of the transtheoretical model. *Am J Health Promot*. 1990;12(1):13–14. doi:10.4278/0890-1171-12.1.13.
27. Carney MM, Kivlahan DR. Motivational subtypes among veterans seeking substance abuse treatment: profiles based on stages of change. *Psychol Addict Behav*. 1995;9:1135–1142. doi:10.1037/0893-164X.9.2.135.
28. DiClemente CC, Hughes SO. Stages of change: profiles in alcoholism treatment. *J Subst Abus Alcohol*. 1990;2:217–235. doi:10.1016/S0899-3289(05)80057-4.
29. Baumgartner A, Hensley LD. *Conducting and Reading Research in Health and Human Performance*. 4th. New York, NY: McGraw-Hill; 2007.
30. Ceccarini M, Borrello M, Manzoni GM, Castelnuovo G. Assessing motivation and readiness to change for weight management and control: an in-depth evaluation of three sets of instruments. *Front Psychol*. 2015;6(51):511–521. doi:10.3389/fpsyg.2015.00511.
31. McConnaughy EA, Prochaska JO, Velicer WF. Stages of change in psychotherapy: measurement and sample profiles. *Psychother*. 1983;20(8):368–375. doi:10.1037/h0090198.
32. University of Maryland Baltimore County. The habits lab at UMBC. Published 2016. http://habitslab.umbc.edu/. Accessed September 5, 2018.
33. Bond B, Hind S, Williams C, Barker A. The acute effect of exercise intensity on vascular function in adolescents. *Med Sci Sports Exer*. 2015;47(12):2628–2635. doi:10.1249/MSS.0000000000000715.
34. Gorber SC, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obes Rev*. 2007;8(4):307–326. doi:10.1111/j.1467-789X.2007.00347.x.

35. Ross R, Janiszewski PM. Is weight loss the optimal target for obesity-related cardiovascular disease risk reduction? *Can J Cardiol*. 2008;24(Suppl D). doi:10.1016/S0828-282X(08)71046-8. PMID:18787733.
36. Wortly D, An JY, Nigg CR. Wearable technologies, health and well-being: a case review. *Digit Med*. 2017;3:11–17. doi:10.4103/digm.digm_13_17.
37. Butler SM, Black DR, Blue CL, Gretebeck RJ. Change in diet, physical activity and body weight in female college freshman. *Am J Health Behav*. 2004;28:24–32.
38. Delinsky SS, Wilson GT. Weight gain, dietary restraint and disordered eating in the freshman year of college. *Eat Behav*. 2008;9(1):82–90. doi:10.1016/j.eatbeh.2007.06.001.
39. Nelson MC, Kocos R, Lytle LA, Perry CL. Understanding the perceived determinants of weight-related behaviors in late adolescence: a qualitative analysis among college youth. *J Nutr Educ Behav*. 2006;41 (4):287–292. doi:10.1016/j.jneb.2008.05.005.
40. Cowan LT, Van Wagenen SA, Brown BA, et al. Apps of steel: are exercise apps providing consumers with realistic expectations? A content analysis of exercise apps for presence of behavior change theory. *Health Educ*. 2012;40(2):133–139.
41. Azar K, Lesser LI, Laing BY, et al. Mobile applications for weight management: theory-based content analysis. *Am J Prev Med*. 2013;45(5):583–589. doi:10.1016/j.amepre.2013.07.005.
42. Mercer K, Li M, Giangregoria L, Burns C, Grindrod K. Behavior change techniques present in wearable activity trackers: a critical analysis. *JMIR Mhealth Uhealth*. 2016;4(2):40. doi:10.2196/mhealth.4461.
43. Dhawan E Gen-Y workforce and workplace are out of sync. Forbeswoman. www.forbes.com. Published September 8, 2014. Accessed August, 2015.
44. National Center for Academic Transformation. http://www.thencat.org. Published 2014. Accessed August, 2015.
45. Merriam SB, Caffarella RS, Baumgartner LM. *Learning in Adulthood: A Comprehensive Guide*. San Francisco, CA: John Wiley & Sons, Inc; 2007.