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Running Head: Accelerometer-Measured Physical Activity

**Accelerometer-Measured Versus Self-reported Physical Activity in College Students:
Implications for Research and Practice**

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Abstract. Objective: To determine the level of moderate-vigorous physical activity (MVPA) assessed via self-report and accelerometer in the college population, and to examine intrapersonal and contextual variables associated with PA. **Participants:** Participants were 77 college students at a university in the northwest sampled between January 2011 and December 2011. **Methods:** Participants completed a validated self-report measure of PA and measures of athletic identity and benefits and barriers to exercise. Participants' PA levels were assessed for two weeks via accelerometry. **Results:** Participants' estimations of their time spent engaged in MVPA was significantly higher when measured via self-report vs. accelerometry. Stronger athletic identity, perceived social benefits and barriers, and time-effort barriers were related to PA levels. **Conclusions:** Estimation of college level PA may require interpretation of data from different measurement methods, as self-report and accelerometry generate different estimations of PA in college students who may be even less active than previously believed.

Keywords: accelerometer, athletic identity, barriers, physical activity, self-report

An estimated 41% of the nation's 17-24 year old population is currently enrolled in college, and the undergraduate enrollment in postsecondary educational institutions is projected to rise through 2021.¹ The overall health of the college student population is a public health concern as the transition from late adolescence to adulthood is accompanied by a time of increased personal choice, and behaviors adopted during emerging adulthood may have life-long effects.²

Specifically, physical activity (PA) behavior within this population is of importance given the myriad health benefits associated with a physically-active lifestyle and the reported low estimates of PA levels in the college student population.^{3,4} Recent data from a national sample of college students surveyed in The American College Health Association-National College Health Assessment underscores this point, indicating that the majority of college students do not meet current PA guidelines. Only 19.5% of the population sampled was engaging in moderate-intensity physical activity (MPA) for at least 30 minutes on 5-7 days in the past week, and only 29.3% was engaging in vigorous-intensity physical activity (VPA) for at least 20 minutes on 3-7 days in the past week.⁵

Low PA levels in the college population are concerning for several reasons. First, sedentary college students miss the beneficial effects of PA on overall physical and mental health.^{3,6-8} Second, the typical college years are considered a critical period during which individuals strive to form a clear sense of identity, which helps direct their present and future behavior,^{9,10} and sedentary college students may miss the opportunity to formulate a personal identity that includes PA. This is important because PA levels typically decline as students transition from high school to college,^{11,12} decline further throughout college,^{13,14} and continue to decline from age twenty-four throughout adulthood,¹⁵ making the college years a key time to

attenuate or reverse this trend in order to improve health. Third, the vast majority of research on PA conducted thus far has relied on self-report, and psychologists have long known that individuals are prone to systematic self-report bias¹⁶ that leads them to overestimate and over-report the extent to which they possess desirable traits or engage in desirable behavior. Because the majority of college students report that they would like to increase their PA behavior,¹⁷ it is possible that many students may systematically overestimate the amount of time they spend engaging in such behavior, potentially leading to erroneous conclusions about the population's actual level of PA.

Technological advances have improved researchers' ability to measure PA. Pedometers have been used to assess PA in some studies with college students,¹⁸⁻²⁰ but this technology is limited to measuring only the accumulative number of steps taken by an individual. More recently, accelerometers, which are comprised of a motion sensor to record time spent at various intensities of PA, have been utilized by researchers in order to provide a more accurate assessment of PA.^{21,22} Accelerometers are currently considered the gold standard for measuring PA as they have demonstrated excellent reliability and validity and are believed to provide a direct and accurate measure of PA making them suitable as a criterion measure to evaluate the validity of PA surveys.²²⁻²⁴ However, despite the availability of these new measurement devices, PA is still routinely assessed via self-report by researchers, health care professionals, as well as by those college students themselves who actually attempt to quantify their PA behavior. Because of this, it is critically important to evaluate the extent to which these measurements agree.

The International Physical Activity Questionnaire (IPAQ)²⁵ is a widely used self-report measure of PA that has demonstrated variable but generally acceptable test-retest reliability (coefficients ranging from 0.32-0.88), as well as fair to moderate criterion-related validity when compared to accelerometer measured PA (average correlation coefficient of 0.30) in several studies of adults in various countries.²³ Correlations between self-reported and accelerometer-measured VPA tend to be stronger than those between self-reported and accelerometer-measured MPA.^{24,26} Whereas a number of studies have compared measurement of PA via the IPAQ and accelerometers in adults and children,^{23,24,26} very few have focused specifically on the college population. Dinger and Behrens measured the validity and reliability of the short form IPAQ, using accelerometers as the criterion measure, in 123 college students.²² Looking at PA accumulated in bouts of 10min or greater, participants reported an average of 233.1 min of moderate-vigorous intensity PA (MVPA) each week compared to 73.5 min/wk of MVPA measured via accelerometer. The main correlation coefficients between IPAQ and accelerometer measured PA were between (0.19-0.47), which is similar to the larger studies conducted with adults.^{23,24,26} Also consistent with studies of adults, college students' IPAQ and accelerometer measured VPA levels (0.47) were more closely aligned than were IPAQ and accelerometer measured MPA (0.23). Overall, the Dinger and Behrens study demonstrated that college students tend to more accurately report VPA, but that they report higher levels of both MPA and VPA when measured via self-report (IPAQ) vs. accelerometry, raising the possibility that college students may be even less physically active than has been documented in self-report studies.^{11,12}

These apparent differences in accelerometer-measured PA and self-report are a problem not only for researchers and professionals attempting to quantify PA patterns in college students,

but also for the students themselves. If an individual overestimates the extent to which they engage in a desirable behavior, such as PA, they may be less likely to strive to change their behavior,²⁷ thus preventing them from reaping the physical and mental health benefits that accrue to those who are sufficiently physically active. Because of this, accurate measurement of PA behavior in college students is an important issue that warrants attention from researchers and other professionals.

The first purpose of the present study was to examine PA levels in the college population as measured by two different methods; self-report and accelerometry. Consistent with the Dinger and Behrens study,²² we hypothesized that students' self-reported MVPA levels would be significant higher than their accelerometer-measured MVPA levels. The second purpose of this study was to examine intrapersonal and contextual factors that may influence PA in college students. Regarding intrapersonal factors, we predicted that the extent to which students identified as an athlete would be related to PA levels, with stronger athletic identity being associated with higher levels of PA. Because significantly fewer students participate on organized sport teams in college as compared to high school,¹² we also predicted that students' athletic identity would be lower in college when compared to high school.

Regarding contextual variables, we examined perceived benefits and barriers to exercise in order to help identify factors that potentially could be addressed to increase PA levels among college students. Importantly, research suggests that intrinsic motivating factors such as interest, enjoyment, and personal challenge or satisfaction may be more closely related to consistent PA, whereas extrinsic motivating factors such as weight control and improving physical appearance may be more closely linked with inconsistent PA patterns.^{28,29} Because individuals often find

engaging in social or competitive physical activities intrinsically motivating,²⁹ we hypothesized that higher levels of PA would be associated with perceived social benefits of exercise.

Regarding barriers to exercise, we predicted that, consistent with previous research^{30,31} lower levels of PA would be linked with perceived physical discomfort and time-effort barriers.

METHODS

Participants and Setting

Data collection occurred between January 2011 and December 2011. The sample consisted of first-year students who were recruited through the Freshman Resource Center at a private university in the Pacific Northwest. Interested students were pre-screened via email and excluded from the study if they reported having any significant health problems (e.g., asthma, heart disease, diabetes). The final sample included 77 undergraduate volunteers who averaged 18.61 (sd=0.80) years of age, 48.6% were female, and 79.2% were white. Racial backgrounds of other participants included Asian American/ Pacific Islander (12.9%), Bi- or Multi-racial (3.9%), Latino/a/ Hispanic (2.6%), and Native American (1.3%). All students lived on a pedestrian-oriented campus that provides access to a student recreation center that is open seven days per week, free fitness classes, year-round intramural sports, an outdoor pursuits program, a bike shop with no cost gear, and a swimming pool.

Procedures

Participants were assessed individually at four different sessions over the course of two weeks as part of a larger study of college student physical and mental health. Upon arriving at the lab for the first session, participants completed several paper and pencil self-report measures asking about their physical activity and mental and physical health. Described below, these

questionnaires included: 1) the International Physical Activity Questionnaire, Short Form, self-administered 7-day recall to measure self-reported physical activity during the past 7 days (IPAQ)²⁵; 2) the Athletic Identity Scale (AIS)³² which measured the extent to which participants self identified as an athlete in high school and college; and 3) the Benefits and Barriers to Exercise self-report (BBE)³³, which asked participants about their perceived benefits and barriers related to physical activity. Participants also completed several additional self-report surveys regarding their physical and mental health, which were not part of the present study.

Following completion of the self-report measures, participants scheduled a physical fitness test that took place on a subsequent day. The fitness test included measurement of the following physical variables: 1) estimated maximal $\dot{V}O_2$ through the YMCA submaximal cycle ergometer test; 2) percent body fat through 7-site skinfold thickness measurements measured using Harpenden calipers; and 3) additional anthropomorphic variables (weight, height, and waist circumference) used to calculate body mass index (mg/kg^2) and waist to hip ratio.

Immediately after completing the physical fitness testing, participants were fitted with an Actigraph GT3X+ accelerometer (Pensacola, FL) that they wore for the next 14 days. The GT3X+ is a tri-axial, solid state accelerometer designed to measure body acceleration in three planes. Participants were instructed to wear the accelerometers over their right iliac crest under their clothes for 24 hours including during sleep and to remove it only for showers and water-based activities such as swimming.

All participants returned to the lab at the end of the first 7 days of physical activity monitoring with the accelerometers, at which time they again completed the IPAQ to assess their self-reported MPA and VPA levels during the previous week. Participants were then instructed

to continue wearing the accelerometers for an additional 7 days, for a total of 14 days of monitoring. At the end of the second 7-day monitoring period (14 days after the fitness tests) participants again completed the IPAQ and turned in their accelerometers, and the accelerometer data were analyzed using Actilife 6.0 software. All procedures and materials used in this study were approved by the authors' Institutional Review Board, and all participants provided written consent after being informed about the study.

Measures

International Physical Activity Questionnaire – Short Form, Self-Administered 7-day recall (IPAQ). The IPAQ²⁵ is a 7-item self-report measure of physical activity over the prior seven days. Respondents are asked to indicate the number of days in the past week they engaged in VPA for at least 10 minutes at a time. Respondents are then asked “How much time did you usually spend doing vigorous physical activities on one of those days?” Parallel questions follow that ask respondents about the number of days and amount of time on those days they engaged in: a) MPA and b) walking. Finally, respondents indicate the amount of time they usually spent sitting on a weekday over the course of the past week. The IPAQ has been reported to demonstrate acceptable reliability and validity in various populations including college students,²²⁻²⁶ and the authors of the IPAQ assert that the measure is suitable for estimating participation in physical activity in both research and applied settings.²⁵

Benefits and Barriers to Exercise (BBE). The BBE³³ is a 48-item self-report questionnaire that asks the respondent to rate the personal importance of 24 perceived benefits and 24 perceived barriers to exercise on a five-point scale (1 = Not Important to 5 = Extremely Important). The construct validity of the BEE was supported in a factor analytic study conducted

with undergraduate students which found that both the benefits and barriers scales were comprised of 4 factors (benefits = social, psychological, body image, and health; barriers = time-effort, social, physical effects, and specific obstacles). Test-retest correlations for BBE scores on those eight factors ranged from .60 to .86.³³ In the present sample, Cronbach's alpha ranged from .67 (health) to .86 (psychological) for the 4 benefit factors and from .38 (social) to .82 (time-effort) for the 4 barrier factors. Responses within each factor are summed and divided by the number of items comprising the factor to generate an average score for each type of benefit and barrier.

Athlete Identity Scale (AIS). The AIS is a slightly modified version of the Exercise Identity Scale (EIS)³² with the only modification being that the word *exerciser* from each of the EIS questions was changed to *athlete*. The AIS consists of nine questions such as "I consider myself an athlete" rated on a seven-point scale (1 = Strongly disagree to 7 = Strongly agree) that are summed to create an overall athletic identity score. Participants were asked to rate their athletic identity in high school and in college separately. The nine EIS questions comprise a single factor with loadings between .50 and .91.³⁴ The EIS has demonstrated adequate internal consistency (Cronbach's alpha between .73 and .94) and test-retest (.93) reliability,³² and EIS scores are strongly related to actual exercise behavior with the latter accounting for 35% to 52% of the variance in the former.^{32,35} In the present sample Cronbach's alpha was .96 for high school athletic identity and .94 for college athletic identity on the AIS.

Actigraph GT3X+ accelerometer. The accelerometers were initialized and downloaded using the ActiLife software provided by the manufacturer. The data were collected in 10-s epochs. To analyze the data, the 10-s epochs were collapsed into 60-s epochs which has been

shown to be a validated epoch for young adults.³⁶ Nonwear time was counted as 60 consecutive minutes with zero counts, with the allowance for 1 min with counts greater than zero. Nonwear time was excluded from further analysis. Data were included if the subject had accumulated a minimum of 10 h of valid activity recordings per day for at least 4 d, which is in accordance with similar studies³⁷ and suggestions from other physical activity researchers.³⁶ Time spent at different intensities of physical activity were determined using the NHANES cut-points: sedentary (<100counts/minute); light (100-2,019 counts/minute); moderate (2,200-5,998 counts/minute); and vigorous (>5,999 counts/minute).³⁸ Current recommendations are that physical activity bouts are of at least 10min or greater³⁹ so the number of MVPA bouts (>2,200 cpm) bouts that were 10 min or greater and total time spent in those bouts was determined.

Data Analyses

Using participants' self-reports on the IPAQ during the two weeks they wore the accelerometer we calculated the total number of minutes each participant reported engaging in MPA and VPA and divided the result by 14 in order to generate a self-reported average number of minutes of MVPA per day for each participant. Similarly, using the NHANES accelerometer cut points we calculated the total number of minutes each participants engaged in MVPA as measured by the accelerometer and divided the result by the number of valid days recorded to generate an accelerometer-derived average number of minutes of MVPA per day for each participant. The resulting averages were then compared using paired-samples *t*-tests. The self-reported and accelerometer-derived averages were also compared to the CDC recommended standards of MVPA for adults³⁹ and we calculated the percentage of students meeting the standards according to each measurement method. Those self-reported and accelerometer-

derived percentages were then compared via chi-square analyses. In addition, Pearson product moment correlations were calculated in order to examine agreement between PA levels assessed via self-report and accelerometry, and to determine whether accelerometer-derived PA levels were associated with participant scores on the physical fitness and/or contextual variables assessed in this study. Finally, we used a paired-samples *t*-test to determine whether athletic identity scores changed from high school to college. An alpha level of .01 was used to determine statistical significance for all analyses.

RESULTS

Measures of Physical Activity and Fitness

Scores for female and male participants on the physical activity and fitness variables assessed in this study are displayed in Table 1. Female participants had significantly higher % body fat compared to male participants, $t(61) = 8.89, p < .001$, and male participants had significantly higher estimated VO_2 max scores than females, $t(60) = 3.28, p < .01$. Based on their IPAQ scores from the follow-up visits at 7 and 14 days, participants reported engaging in an average of 66.14 minutes of MVPA per day during the study. Accelerometer data indicated that participants engaged in an average of 19.90 minutes of MVPA per day during the study. Self-reported and accelerometer-derived MVPA indices were not significantly correlated with each other, $r(77) = .21, p = .08$. A paired-samples *t*-test revealed that participants' self-reported MVPA levels were significantly higher than their accelerometer-derived MVPA levels, $t(68) = -6.69, p < .001$. Females' self-reported MVPA levels were 37.27 minutes higher per day than their accelerometer-derived MVPA levels, and males' self-reported MVPA levels were 58.63 minutes higher per day than their accelerometer-derived MVPA levels. Examination of individual

participant IPAQ and accelerometer scores indicated that 85.5% of the students (81.2% of females and 90.9% of males) had higher self-reported MVPA than accelerometer-derived MVPA, whereas only 14.5% of the students (18.8% of females and 9.1% of males) had higher accelerometer-derived MVPA than self-reported MVPA.

Table 2 shows the percentage of female and male participants who would be classified as sufficiently physically active based on self-report and accelerometer-derived measurement, respectively, when compared to the current recommended standards of MVPA for adults (i.e., minimum of 150 minutes per week accumulated in bouts of 10min or greater).³⁹ Overall, we found that 66.7% of participants would be classified as sufficiently physically active based on their self-report. When we compared participants' accelerometer data to the CDC recommended standards we found that only 33.8% of participants would be classified as sufficiently physically active. Chi-square analyses indicated that a significantly higher proportion of respondents would be classified as sufficiently active if their self-reported physical activity rather than their accelerometer-measured physical activity was used as the basis for comparison with the recommended standards, $\chi^2(1, N = 77) = 37.59, p < .001$, and that a significantly higher proportion of male students than female students met the CDC recommended standards based on accelerometer-derived data, $\chi^2(1, N = 72) = 9.29, p < .01$.

Physical Activity and Physical Fitness

Pearson product moment correlations were conducted in order to determine whether higher levels of accelerometer-measured MVPA were associated with better physical fitness. Our results indicated that number of minutes of MVPA per day assessed by accelerometry was not

significantly related to participants' VO₂ max, Body Mass Index, Percent Body Fat, or Waist to Hip Ratio.

Intrapersonal and Contextual Variables Associated with Physical Activity

Scores for female and male participants on the intrapersonal and contextual variables assessed in this study are displayed in Table 3. Pearson product moment correlations were conducted to determine the extent to which accelerometer-measured MVPA levels were associated with athletic identity and perceived benefits and barriers to exercise. Our results revealed that time spent engaged in MVPA, as measured via accelerometer, was significantly correlated with the extent to which participants currently considered themselves an athlete, $r(77) = .27, p < .01$. Relatedly, a follow-up paired samples *t*-test indicated that participants identified more strongly as athletes in high school than in college $t(76) = 4.72, p < .001$.

Regarding perceived benefits of exercise, accelerometer-measured MVPA levels were significantly directly correlated with perceived social benefits $r(76) = .33, p < .01$, but not with perceived psychological, body image, or health benefits. Finally, accelerometer-measured MVPA levels were significantly inversely correlated with perceived time-effort barriers $r(74) = -.24, p < .05$ and social barriers $r(73) = -.27, p < .05$, but not with perceived physical or specific barriers.

COMMENT

The primary purpose of this study was to examine PA levels in the college population as measured by two different methods; self-report and accelerometry. Psychologists have long known that individuals tend to overestimate and over-report the extent to which they engage in desirable behavior¹⁶ and it appears the students in our study may have overestimated their PA

levels. Indeed, over 85% of the students in our study self-reported levels of MVPA that were, on average, a robust 46.24 minutes per day (i.e., over 5 hours and 23 minutes per week) higher than their levels of accelerometer-measured MVPA. If accelerometer-derived PA levels are as accurate as believed,²²⁻²⁴ these results suggest that researchers, health professionals, and other individuals who use self-report to assess PA, may significantly overestimate many college students' PA levels.

These results are potentially concerning because the instrument used in the study was the IPAQ, which is considered one of the most reliable and valid self-report measures of PA.^{22,23,25} The authors of the IPAQ assert that it is suitable for assessing participation in PA, and researchers who conducted a psychometric analysis of the IPAQ with college students concluded that "health education and promotion professionals can confidently use this questionnaire to assess college students' participation in physical activity."²² The results of our study cast doubt on those claims. Perhaps one could argue that the students in our study were particularly poor at recalling their PA, or that our results were a byproduct of variability associated with measurement error. However, recent studies conducted using accelerometers with adults^{24,26,40} have also found significantly higher self-reported PA levels suggesting that our results are not an aberration. Further, closer examination of data from a validation study of the IPAQ in college students²² reveals that IPAQ scores were correlated with PA measured via accelerometer at magnitudes of only .19 to .47, and students also self-reported significantly higher levels of MVPA compared to accelerometer data.

Importantly, considering this apparent self-report bias, there is reason to believe that the already concerning low levels of PA among college students reported in the research literature to

date may be even worse than believed. Indeed, the 66.7% of first-year students in our study who reported meeting the minimum recommended standards for MVPA was largely consistent with previous research conducted with college students in the U.S. and Canada.^{11,12} However, accelerometer data suggested that only 33.8% of students met the recommended standards. This was true even though previous studies have revealed that reactivity often leads to temporary increases in PA among individuals wearing an accelerometer.⁴¹ Thus, it is possible that previous studies using self-report may have artificially inflated the percentage of college students (as well as others in the population) who are believed to be sufficiently active and that the vast majority of college students may not be sufficiently active. Consistent with that interpretation, another recent study using accelerometers estimated that fewer than 25% of college students meet the CDC guidelines for MVPA.²¹

Considering these data, researchers and college health professionals should consider moving toward making objective measurement of physical activity routine whenever possible and using self-reported estimates of PA somewhat cautiously. In addition, this discrepancy in reports of PA amongst college students is important to address considering the need to identify college health priorities and establish measurable objectives and goals as recommended by Healthy Campus 2020.⁴² Without accurate measurement and surveillance of PA levels on individual campuses it is difficult to benchmark individual campus data against national data and targets. Using accelerometers or other devices to assess PA may not only provide more accurate data for researchers, health professionals, and students themselves, but may also provide a more realistic picture of the extent of the problem of physical inactivity in this population.

Another purpose of the present study was to examine intrapersonal and contextual variables that are linked with PA among college students. Consistent with hypothesis, we found that athletic identity was directly and significantly related to higher levels of PA. Also as expected, our results indicated that although students reported that the mental and physical health and appearance benefits of exercise are important to them, those perceived health and appearance benefits were not associated with PA, but social benefits were. Regarding barriers to PA, we found that both time-effort and social barriers were associated with lower levels of PA, but that physical discomfort was not.

These results have implications for professionals who are interested in the health of college students and who are developing and implementing strategies for increasing activity levels in this population. Because time-effort barriers were linked with physical inactivity in this and previous studies,^{30,31} even if college students think that they should engage in PA and are provided with access to a recreation facility and a number of elective courses or intramural sports to choose from, many will believe that they do not have enough time or energy to do so. Requiring students to engage in PA courses or intramural sports would be a simple way to overcome this perceived time-effort barrier. Interestingly, compulsory PA was the norm at American colleges for years as physical health was considered a critical component of student development and success, but the percentage of four-year colleges with a PA requirement has dropped from a high of 97% in the 1920s and 1930s to the current all-time low of 39.55%.⁴³ Requiring students to participate in PA courses or intramural sports would almost certainly result in higher activity levels than those observed in students in this and other studies,^{11,12,21,22} and may help substantially more students meet the current recommended standards for PA.³⁹

Another reason that colleges should consider compulsory PA is that the vast majority of students who played organized sports in high school do not do so at the college level because traditional collegiate athletic programs are only accessible to a very small proportion of the college population.¹² This shift in sports participation may help explain our finding that the extent to which students view themselves as an athlete decreased significantly from high school to college. Our results and previous research suggest that the traditional college years may be a critical time for identity development^{9,10} and that athletic identity may be even more closely related to PA in college students and older adults than is actually participating in team athletics.^{12,35} Requiring college students to participate in PA courses or intramural sports may help some maintain or strengthen their athletic identity beyond high school, thus potentially increasing their engagement in PA in the present, as well as in the future. Indeed, studies have found that PA levels as a college senior are highly predictive of PA levels six years after graduation,⁴⁴ and that alumni from colleges with PA requirements are more active than their peers who attended colleges without such requirements.⁴³

Finally, social benefits and barriers were both significantly related to PA in this study. Participation in compulsory PA courses or intramural sports would most likely occur primarily in group settings, thus providing students with access to a peer group of physically active students and removing the social barriers centered around not knowing others who exercise and not wanting to exercise alone that appear to be linked with physical inactivity. In addition, PA courses or intramural sports that challenge students to improve their skills or that provide opportunities for enjoyable social interaction or competition may also serve to increase students'

intrinsic motivation to engage in PA, which researchers believe to be a key variable influencing engagement in PA in the long-term.^{28,29}

Limitations

This study included a relatively small convenience sample of first-year, on-campus students from a single private university that was somewhat disproportionately young, male, and white when compared to the population of the entire university, thus limiting the ability to generalize the results with confidence.

Conclusions

The results of the present study suggest that researchers, health professionals, and college students themselves may have been systematically overestimating the extent to which college students engage in PA, and that the problem of inactivity in college students may be even worse than currently believed. Considering the seriousness of the health consequences known to be associated with physical inactivity, it is time for colleges to take steps to help students become more active. Requiring participation in PA courses or intramural sports that allow students the option to engage in activities they find intrinsically rewarding may hold the most promise of helping students to develop and maintain habits of PA in the college years and beyond that can help them avoid the myriad physical and mental health problems that are known to be associated with physical inactivity. At a minimum, requiring undergraduates to participate in PA courses or intramural sports would most likely significantly contribute positively to the current health of the college population.

Of course, colleges that consider adding a PA requirement as part of their curriculum would have many practical issues to address in order to do so. For example, would such courses

be taught by tenure-track or other full-time faculty within a traditional departmental structure, or by adjunct instructors, community volunteers, or students themselves? How would colleges fund any additional labor, facilities, and/or supplies that may be needed to offer PA courses? Would students receive credit hours for the courses and would the courses be graded? To what extent may the costs associated with implementing compulsory PA be offset by reduced costs linked with treating mental and physical health problems in physically inactive students?

In addition to those and other practical matters it will also be important for researchers to continue to evaluate PA patterns amongst college students at schools that require PA and those that do not. Ideally, prospective longitudinal studies will be conducted in the future to evaluate the extent to which participation in compulsory PA influences students' behavior, athletic identity, physical and mental health, and perceived benefits and barriers to exercise across the college years and into adulthood.

Though some may argue that compulsory PA is not feasible or appropriate at the college level, the overwhelming majority of colleges required physical activity in the past and a substantial (though much lower) percentage of colleges still do.⁴³ The research suggests that more colleges should consider doing so if they truly are concerned about the physical and mental health of their students. It is somewhat vexing that over the past century as we have become increasingly aware of the health consequences known to be associated with physical inactivity, colleges have simultaneously removed PA courses from their curricular requirements. This is an unfortunate trend, and the time has come for colleges to consider either reinstating compulsory PA or else taking other concrete steps that address the problem of physical inactivity in the student population in a meaningful way.

NOTE

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Table 1. Physical Activity and Fitness Scores by Sex

| Variable | Female <i>n</i> = 35 | | | Male <i>n</i> = 37 | | |
|-------------------------------------|-------------------------|--------|-------------|-----------------------|--------|-------------|
| | Mean (SD) | Median | Range | Mean (SD) | Median | Range |
| IPAQ MVPA | | | | | | |
| minutes/day | 53.09 (48.9) | 29.46 | 0.00-175.71 | 82.85 (63.83) | 74.98 | 0.00-250.36 |
| Accelerometer MVPA | | | | | | |
| minutes/day | 15.82 (14.4) | 9.29 | 0.00-54.53 | 24.22 (20.71) | 18.14 | 1.43-101.71 |
| Estimated VO² Max | | | | | | |
| (ml/kg/min) | 36.61 (8.1) | 36.00 | 22.05-59.11 | 43.32 (7.95) | 40.95 | 31.25-59.21 |
| Body mass index | 22.70 (2.5) | 22.29 | 18.22-27.41 | 22.83 (2.39) | 23.11 | 18.67-27.46 |
| Percent body fat | 22.39 (6.5) | 23.00 | 5.70-35.53 | 10.32 (4.11) | 9.46 | 4.26-20.21 |
| Waist-hip ratio | 0.73 (0.0) | 0.72 | 0.67-0.82 | 0.79 (0.27) | 0.79 | 0.72-0.84 |

Note. IPAQ = International Physical Activity Questionnaire – Short Form, Self-Administered 7-day recall; MVPA = Moderate-Vigorous Physical Activity

Table 2. Percentage of Participants Meeting CDC Physical Activity Guidelines Based on Measurement Method by Sex

| Reporting Method | Female <i>n</i> = 35 | Male <i>n</i> = 37 |
|------------------|-------------------------|-----------------------|
| IPAQ | 53.1% | 78.8% |
| Accelerometer | 22.9% | 45.9% |

Note. IPAQ = International Physical Activity Questionnaire – Short Form, Self-Administered 7-day recall

Table 3. Athletic Identity and Benefits/Barriers to Exercise Scores by Sex

| Variable | Female <i>n</i> = 35 | | | Male <i>n</i> = 37 | | |
|-------------------|-------------------------|--------|------------|-----------------------|--------|------------|
| | Mean (SD) | Median | Range | Mean (SD) | Median | Range |
| Athletic identity | | | | | | |
| High school | 41.60 (16.44) | 46.00 | 9.00-63.00 | 44.11 (16.12) | 50.00 | 9.00-63.00 |
| College | 34.71 (15.52) | 36.00 | 9.00-63.00 | 40.03 (14.01) | 42.00 | 9.00-63.00 |
| Benefits | | | | | | |
| Social | 2.61 (0.88) | 2.50 | 1.00-5.00 | 3.14 (1.03) | 3.00 | 1.00-5.00 |
| Psychological | 4.20 (0.67) | 4.33 | 2.78-5.00 | 4.04 (0.70) | 4.17 | 2.22-5.00 |
| Body image | 4.34 (0.83) | 4.67 | 1.67-5.00 | 4.26 (0.57) | 4.33 | 2.83-5.00 |
| Health | 4.26 (0.61) | 4.40 | 2.40-5.00 | 4.13 (0.55) | 4.00 | 2.80-5.00 |
| Barriers | | | | | | |
| Time-effort | 2.66 (0.94) | 2.75 | 1.00-4.88 | 2.49 (0.92) | 2.31 | 1.00-4.00 |
| Physical | 1.60 (0.56) | 1.50 | 1.00-3.17 | 1.47 (0.47) | 1.33 | 1.00-2.83 |
| Social | 1.38 (0.58) | 1.00 | 1.00-3.33 | 1.40 (0.54) | 1.33 | 1.00-3.33 |
| Specific | 2.04 (0.63) | 2.00 | 1.00-3.29 | 1.88 (0.70) | 1.71 | 1.00-3.43 |