Physical Activity Engagement outside of College Physical Education: Application of the Transtheoretical Model

Heontae Kim, PhD
Taejeong Song, PhD
Soyoun Lim, PhD
Harold W. Kohl III, PhD
Ho Han, PhD

Objective: In this study, we examined physical activity (PA) engagement outside of college physical education (PE) classes using the Transtheoretical Model (TTM). **Methods:** Overall, 414 university students enrolled in PE classes voluntarily participated in this study. Participants were asked to complete a survey packet to measure 4 core constructs of TTM and their PA level performed outside of PE classes. Among the participants, 150 randomly selected students were asked to wear a triaxial accelerometer for 7 consecutive days to identify their PA level. Descriptive statistics and multivariate analyses of variance were used to determine the association between stages of motivational readiness and other strategic core constructions. **Results:** We categorized 77% of respondents into either the "action" stage or the "maintenance" stage for engaging in additional PA outside of the classes. Behavioral processes of change showed a graded and significant association with the stages. Both self-efficacy and decisional balance were significantly higher in students at higher stages. **Conclusion:** Our findings showed that most students enrolled in college PE classes had additional PA outside of the class participation. In addition, behavioral processes may be effective strategies for this specific target group to promote PA.

Key words: behavioral intention; physical education; physical activity; transtheoretical model; college students; stages of change

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Insufficient physical activity (PA) is one of the most important public health problems in the 21st century, with increased evidence of deleterious associations with obesity, hypertension, cancer, and cardiovascular diseases.[1] PA participation declines with age with the greatest decline occurring in late adolescence and early adulthood.[2] The American College Health Association announced that PA is one of the priority health-risk behaviors in the college population in the United States (US).[3] In 2019, it was reported that PA levels were insufficient in more than half (50.2% men and 56.0% women) of the college students to achieve health benefits.[4] Despite the urgent need for PA promotion for college students, a striking lack of attention has been paid to the population regarding PA.

Despite the extensive evidence of physical education's (PE) efficacy to promote PA in various school settings, insufficient research is available to confirm the effectiveness of PE to promote college students'

Heontae Kim, Data Analyst, Institute of Child Nutrition, The University of Mississippi, University, MS, United States. Taejeong Song, Post-doctoral Research Fellow, Department of Internal Medicine, University of Cincinnati College of Medicine, Cincinnati, OH, United States. Soyoun Lim, Assistant Professor, Department of Kinesiology, Mississippi State University, MS, United States. Harold W. Kohl III, Professor, Division of Epidemiology, Human Genetics and Environmental Sciences, School of Public Health Austin Regional Campus, University of Texas Health Science Center at Houston, Austin, TX, United States. Ho Han, Assistant Professor, School of Community Health Sciences, Counseling and Counseling Psychology, Oklahoma State University, Stillwater, OK, United States.
Correspondence Dr Han; hohan@okstate.edu

PA.[5] Also, college PE as a means of PA promotion was excluded from the list of recommended intervention strategies by the Guide to Community Preventive Services Task Force, and still requires additional research to prove college PE as a legitimate strategy in PA intervention programs.[5] In addition, as the number of 4-year colleges and universities requiring mandatory PE for graduation remarkably decreased by 39%,[6] only preferred activity courses such as running and weight training are taken in an elective manner by students.[7] Given the fact that participating in one-credit hour college PE is typically insufficient to achieve the recommended amount of PA to achieve health benefits,[1] it is important to examine the patterns of PA performed outside of PE classes for a better understanding about overall PA levels of college students; therefore a better PA guidance balancing activity type, duration, frequency, and intensity could be provided for a maximum health outcomes.

Conceptual framework such as the Transtheoretical Model (TTM) can provide both physical and psychological insights of a behavior change, herein PA. For example, the results of TTM application for PA can identify the current status of intentional readiness to engage in PA and determine appropriate strategies to help individuals improve their initial readiness of change. TTM consists of 4 core constructs including stages of change, processes of change, self-efficacy, and decisional balance. The construct of stages of change is a central component of TTM and represents a temporal dimension of behavior change indicating an individual's intentional readiness to change a behavior. The stages of change are comprised of 5 elements – including precontemplation (stage 1), contemplation (stage 2), preparation (stage 3), action (stage 4), and maintenance (stage 5). As an individual's behavior change occurs, especially habitual behavior, when they are ready to do so,[8] identifying an individual's readiness of behavior change can be a useful predictor of a future behavior change.

Whereas the stages of change indicate the status of 'when' regarding an individual's intentional readiness of behavior change, other core constructs provide 'how' information that can be used to progress through the stages. The processes of change are comprised of 5 cognitive processes and 5 behavioral processes. In general, the cognitive processes are more favored by individuals in early stages, whereas people in later stages rely more on the behavioral processes rather than the cognitive processes. Self-efficacy refers to task-specific confidence in individual's ability to perform a certain behavior in high-risk situation.[9] Self-efficacy is an important strategy to avoid relapsing back to original behavior, and higher level of self-efficacy is typically found in people in later stages compared to those in early stages. Decisional balance indicates individual's relative weighting of pros and cons of behavior change. Individuals perceive more pros than cons as they progress through the stages.[10]

The traditional action-oriented measures of PA such as a self-reported questionnaire and activity monitor solely rely on the amount of PA and easily overlook an individual's intentional readiness to perform PA in physically inactive people. Identifying PA performed outside of PE classes using the TTM can provide better understanding of not only the status of PA participation, but also students' intentional readiness with relevant strategies to engage in physical activity. Thus, the purpose of the present study was to examine PA engagement outside of college PE classes using the TTM.

METHODS

Participants and Protocol

Overall, 414 college students, who voluntarily enrolled in PE classes offered in a large urban university in the southern US participated in the current study. All participants were undergraduates (18 to 29 years) registered in various academic disciplines such as education, natural sciences, engineering, communication, and other programs. The PE classes herein included 4 separate courses such as aerobic walking, weight training, circuit aerobics, and body works. Each course consisted of a variety of activities to achieve course objectives mostly aiming to improve students' body composition, aerobic capacity, and muscular endurance. With the instructor's permission, research staff members visited the PE classes and introduced the current study to recruit the study participants. Participation was anonymous and voluntary.

Following informed consent, participants were asked to complete a survey packet to measure 4 core constructs of TTM and their PA level performed outside of PE classes. Among the participants, 150 randomly selected students were asked

to wear a triaxial accelerometer (Actigraph GT3X+; ActiGraph, Pensacola, FL) to validate the self-reported PA assessment before completing the survey packet. The participants, who were selected to wear an activity monitor, visited to the laboratory twice before and after the 7-day PA assessment. At the first visit, participants were given a triaxial accelerometer (Actigraph GT3X+; ActiGraph, Pensacola, FL) with a written and in-person instructions and asked to wear the activity monitor on their right hip for 7 consecutive days. After the 7-day data collection period, participants returned the device and completed the survey packet.

Measures

All measures associated with PA herein, such as intention to perform PA, strategies to perform PA, and times spent in PA, referred to the PA performed outside of PE classes. In other words, any PA that occurred in PE classes was not counted for the study outcomes. Table 1 reports the descriptions of TTM constructs.

Demographic characteristics. We asked participants about their age, sex, race/ethnicity, height, weight, and current year in college.

Intentional readiness to engage in physical activity. Current intention to engage in PA outside of PE classes was assessed using the Physical Activity Stages of Motivational Readiness Questionnaire. Four dichotomous scale (yes/no) questions were provided with examples of PA types (eg, walking briskly, jogging, bicycling, and swimming) and a definition of regular PA (≥ 5 days/week for ≥ 30 minutes). Participants were classified into one of the 5 stages by the scoring algorithm.[11]

Strategic constructs of the TTM. Processes of change, decisional balance, and self-efficacy to engage in PA outside of PE classes were measured using previously validated questionnaires.[10,12] The questionnaire of processes of change included 40 questions consisting of 4 items for each 10 processes. Each item asked the participants to rate the frequency of behavior occurrence during the past month on a 5-point Likert scale from 1 (never) to 5 (repeatedly).[11] An average of 4 items in each process was calculated to score the processes of change. For self-efficacy, a 5-point Likert scale from 1 (not at all confident) to 5 (extremely confident) was used to rate how confident participants would be

Table 1

Descriptions of Core Constructs of the Transtheoretical Model

Constructs		Description
Stages of Change		
Precontemplation (Stage 1)		Inactive and no intention to become more active
Contemplation (Stage 2)		Inactive and intention to become more active
Preparation (Stage 3)		Participating in insufficient physical activity
Action (Stage 4)		Participating in sufficient physical activity[a]
Maintenance (Stage 5)		Incorporate physical activity into lifestyle[a]
Processes of Change		
Cognitive Processes	Consciousness Raising	Obtaining information about physical activity to support the behavior change
	Emotional Arousal	Experiencing negative emotional consequence followed by being inactive
	Environmental Reevaluation	Recognizing how one's inactivity affects to others surrounding
	Self-Reevaluation	Understanding the personal benefits of being physically active
	Social Liberation	Increasing awareness of opportunities to be physically active
Behavioral Processes	Contingency Management	Praising or rewarding oneself for being physically active
	Counter Conditioning	Making a decision to participated in physical activity instead of sitting when feeling tired or stressed
	Helping Relationships	Seeking family members or friends who is able to provide support for being physically active
	Self-Liberation	Making promise, plans, and commitments to be active
	Stimulus Control	Setting up reminders to be active
Self-Efficacy		Physical activity-specific confidence that people can deal with high-risk situations without relapsing to be physically inactive
Decisional Balance		Individual's relative weighting of the pros and cons of being physically active

Note.
PA = physical activity
[a] Achieving government physical activity guidelines: at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity of aerobic physical activity a week.

Table 2
Demographic Variables and Physical Activity Levels across the Stages

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Total
N (%)	7 (1.7%)	34 (8.2%)	54 (13.0%)	68 (16.4%)	251 (60.6%)	414 (100%)
Age (year)	20.3±0.5	20.6±1.6	20.6±1.6	20.5±1.6	20.5±1.7	20.5±1.7
Sex						
Men	5 (1.8%)	24 (8.7%)	38 (13.7%)	44 (15.9%)	166 (59.9%)	277 (66.9%)
Women	2 (1.5%)	10 (7.3%)	16 (11.7%)	24 (17.5%)	85 (62.0%)	137 (33.1%)
Race						
White	2 (1.1%)	9 (5.2%)	25 (14.4%)	18 (10.3%)	120 (69.0%)	174 (42%)
Hispanic	0 (0%)	9 (8.7%)	13 (12.5%)	24 (23.1%)	58 (55.8%)	104 (25.1%)
Black	2 (6.5%)	2 (6.5%)	1 (3.2%)	4 (12.9%)	22 (71.0%)	31 (7.5%)
Asian	3 (2.9%)	14 (13.3%)	15 (14.3%)	22 (21.0%)	51 (48.6%)	105 (25.4%)
College Year						
1	0 (0%)	8 (9.2%)	10 (11.5%)	19 (21.8%)	50 (57.5%)	87 (21.0%)
2	3 (2.2%)	5 (3.6%)	17 (12.2%)	19 (13.7%)	95 (68.3%)	139 (33.6%)
3	4 (4.4%)	9 (9.9%)	17 (18.7%)	16 (17.5%)	45 (49.5%)	91 (22.0%)
4	0 (0%)	12 (12.4%)	10 (10.3%)	14 (14.4%)	61 (62.9%)	97 (23.4%)
Physical Activity Levels (hours/week)						
Self-reported (N=414)	1.60±0.97	5.53±7.05	7.05±4.17	10.48±7.72	13.00±8.36	10.88±8.15
Accelerometer (N=150)	0.2±0.18	1.24±0.74	1.57±0.86	3.44±2.12	4.34±2.90	2.52±1.86

Note.
Values are mean±standard deviation or frequency (%).

engaging in PA in 5 different situations. A higher score indicates greater self-efficacy. Lastly, for decisional balance, the questionnaire included 16 items (10 pros and 6 cons), and the difference in the averages between pros and cons was computed for scoring decisional balance. Participants were asked to rate how important each item is when making a decision to be physically active on a 5-point scale from 1 (not at all important) to 5 (extremely important). Decisional balance scores greater than 0 indicate that an individual feels the benefits of being physically active more than the barriers.

Physical activity engagement. A modified, self-administered version of 7-Day Physical Activity Recall (7DPAR) was used to measure weekly amount of moderate- and vigorous-intensity PA performed outside of PE classes in the past 7 days. The 7DPAR for college students has been validated.[13] In addition, times spent in moderate-to-vigorous physical activity (MVPA) were objectively measured using a research-grade activity monitor. After the device was returned, total wear-time was validated by the standard requiring a minimum of 10 hours of daily wearing time for at least 4 days a week.[14] A one-second epoch length was set for data collection. Freedson cut-points were used to determine moderate (1952 to 5724 counts/minute) and vigorous (≥ 5725 counts/minute) intensity PA while reflecting a minimum of 10-minute bout requirement.[15]

Data Analysis

Demographic characteristics and other appropriate variables including PA times and scores of TTM constructs were analyzed by descriptive statistics. The chi-square test was used to determine the differences in stage distributions by sex. Multivariate analyses of variance (MANOVAs) were conducted to compare the scores of strategic constructs across the stages with Bonferroni *post hoc* tests. A Kruskal-

Wallis non-parametric test was also conducted for the self-reported PA levels across the stages due to not meeting the assumptions of normality and homogeneity of variance required for ANOVA test. The IBM SPSS Statistics 22 for Windows (Armonk, NY) was used with an α of .05 for all statistical analyses.

RESULTS

Table 2 shows the demographic characteristics of participants. Of the 414 respondents, 66.9% (N=277) were men and the mean age of the participants was 20.5±1.7 years. Generally, the participants were evenly distributed by race and college year categories except for a low number of Blacks (7.5%). However, the low proportion of black students in this sample reflects its proportion (5.1%) of the entire undergraduate population at the university.

As Table 2 presents, the majority of students enrolled in PE classes were classified into the "action" stage (N=68, 16.4%) and "maintenance" stage (N=251, 60.6%) in relation to their intentional readiness of engaging in PA outside of PE classes. Both male and female students were similarly distributed across the stages, and the distributions were not significantly different by sex [$\chi^2(1, N=414) = 0.78$, $p = .94$]. In addition, the amount of PA performed outside of PE classes was significantly higher as one advanced across stages ($p < .05$).

Table 3 summarizes the scores of 10 processes of change across the stages with Bonferroni *post hoc* follow-up results. Stage 1 and 2 were combined for the statistical analyses due to small sample sizes.[7] In general, no statistically significant differences were shown in the cognitive processes across the stages in both male and female students with a Bonferroni-adjusted α of .025; however, most of the processes in behavioral processes were significantly different across the stages by sex except for 2 processes (helping relationships and contingency management) in women only. The scores of overall cognitive processes (ie, averages of the 5 cognitive processes) also were not significantly different across the stages ($p = .132$ for women, $p = .196$ for men), whereas the scores of overall behavioral processes showed significant differences between the stages ($p < .001$ for both men and women). The mean scores of cognitive processes were generally higher in early stages (ie, Stage 1&2 and Stage 3) compared to the behavioral processes, whereas the reverse pattern was found in those in later stages.

We found statistically significant differences between the stages in the constructs of self-efficacy and decisional balance (Figure 1.). The mean scores of self-efficacy generally showed incremental changes in both sexes while advancing through the stages ($F(3,278) = 4.195$, $p < .001$) while a continually increased pattern was observed only in male participants. All participants across the stages perceived more benefits than barriers to engage in PA, but more benefits were perceived in later stages in both sexes ($F(3,278) = 9.906$, $p < .001$ for male and $F(3,136) = 4.436$, $p = .001$ for female students) compared to early stages.

DISCUSSION

In this study, we examined additional PA participation performed outside of college PE classes using the TTM. Our results showed that 77% of the participants enrolled in PE classes were classified in either the "action" or "maintenance" stage regarding PA engagement outside of PE classes. Greater levels of PA in later stages were confirmed by both self-reported and objective measurements of PA. The use of 5 cognitive processes were not significantly different across the stages in both sexes whereas the students in later stages used the 5 behavioral processes significantly more frequently than those in early stages. In addition, both male and female students had higher scores of self-efficacy and decisional balance associated with PA engagement outside of PE classes as their stages progressed.

More than three-fourths of the participants were classified in later stages (ie, either action or maintenance). This finding indicates that the majority of the college students enrolled in PE classes had additional PA outside of the classes and the PA levels performed were sufficient to meet or exceed the government's aerobic PA recommendations (Table 2).[1] Objectively determined PA levels (ie, 3.44±2.12 for the action stage and 4.34±2.90 hours/week for the maintenance stage) in this study also support this argument. Importantly, these findings reveal that elective PE classes are primarily taken by physically active students for their additional activities or other reasons such as having fun,

Table 3

Means and Standard Deviations of Processes of Change across PA Stages of Motivational Readiness

	Processes of Change	Sex	Stage 1 & 2	Stage 3	Stage 4	Stage 5	Sig. (p)
Cognitive	Consciousness Raising	W	2.73±1.16	3.39±0.77	3.63±0.93	3.47±0.95	.054
		M	2.88±0.93	2.86±0.98	3.12±0.79	3.19±0.86	.096
	Dramatic Relief	W	2.71±0.70	3.23±0.97	3.10±1.03	2.84±0.90	.258
		M	2.69±1.13	2.51±0.93	2.45±0.87	2.55±0.90	.789
	Environmental Re-evaluation	W	3.08±0.76	3.53±0.62	3.42±0.95	3.27±0.90	.505
		M	2.88±0.93	2.76±0.86	3.11±0.76	3.16±0.87	.040
	Self-Re-evaluation	W	3.94±0.73	4.56±0.42	4.33±0.70	4.18±0.67	.064
		M	3.65±0.92	3.66±0.75	3.94±0.71	3.82±0.82	.309
	Social Liberation	W	2.79±0.58	3.00±0.88	3.04±0.96	3.04±0.83	.807
		M	2.59±0.79	2.58±0.91	2.69±0.80	2.75±0.84	.581
	Total Cognitive Processes	W	3.05±0.42	3.54±0.43	3.51±0.64	3.36±0.65	.132
		M	3.94±0.76	2.87±0.66	3.06±0.47	3.09±0.63	.196
Behavioral	Counter Conditioning	W	3.00±0.66	2.92±0.90	3.46±0.73	3.86±0.75[a,b]	< .001
		M	2.85±0.89	3.06±0.77	3.53±0.63[a,b]	3.84±0.79[a,b]	< .001
	Helping Relationship	W	2.54±0.61	2.66±0.76	3.11±0.94	2.98±0.99	.202
		M	2.63±0.96	2.41±0.83	2.62±0.82	2.99±0.90[a,b]	.001
	Contingency Management	W	3.27±0.69	3.64±0.58	3.75±0.76	3.74±0.72	.191
		M	3.02±0.73	3.03±0.85	3.35±0.67	3.50±0.87[a,b]	.002
	Self-Liberation	W	3.46±0.65	3.95±0.53	4.27±0.67	4.28±0.50[a,b]	< .001
		M	3.59±0.63	3.68±0.63	3.79±0.57	4.07±0.66[a,b]	< .001
	Stimulus Control	W	2.12±0.83	2.09±0.53	2.70±0.95	2.83±0.87[a,b]	.002
		M	1.93±0.70	2.01±0.67	2.44±0.57[a,b]	2.61±0.83[a,b]	< .001
	Total Behavioral Processes	W	2.88±0.51	3.05±0.40	3.46±0.49[a,b]	3.54±0.54[a,b]	< .001
		M	2.81±0.60	2.84±0.59	3.15±0.38[a,b]	3.40±0.60[a,b]	< .001

Note.
Values are mean±standard deviation or frequency (%); Statistical analyses were performed in all groups by MANOVA, followed by Bonferroni post hoc test; Sig. = significance; W = women; M = men.
[a] The mean difference is significant from Stage 1 & 2 at the .05 level
[b] The mean difference is significant from Stage 3 at the .05 level

having structured exercise time, learning new activities, and other reasons[16] rather than utilized by inactive students to increase their PA levels. This may explain the varying degrees of success of college PE to increase PA in the previous literature. Still, 23% of the participants had either none or insufficient PA outside the classes, particularly 10% of the participants (41 out of 414) either had no intention or little intention to engage in PA outside of PE classes. Additional PA engagement outside PE classes is necessary for those student groups to obtain health benefits. These findings suggest a need for developing a new college PE program targeting inactive or early stage students with the purpose of PA promotion while maintaining various PE options for active students to meet their needs.

The processes of change refers to the strategies that were used for the participants to engage in additional PA outside of PE classes. The frequency of using each process was significantly different across the stages in this study. For example, the cognitive processes were more frequently used by the students in early stages compared to the behavioral processes, whereas those in later stages more preferred to

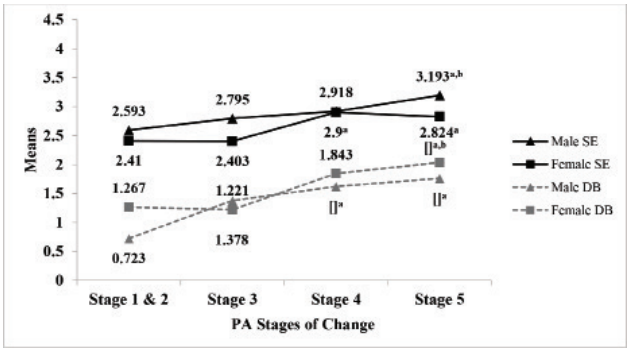

Figure 1
Means of Self-eEfficacy and Decisional-Balance across PA Stages of Change

Note.
Statistical analyses were performed in all groups by MANOVA, followed by Bonferroni post hoc test. PA = physical activity; DB = decisional balance; SE = self-efficacy
a The mean difference is significant from Stage 1 & 2 at the .05 level
b The mean difference is significant from Stage 3 at the .05 level

use the behavioral processes for PA engagement. This result aligns with a previous study[12] demonstrating that the cognitive processes were typically used when people are in the contemplation stage, whereas people in the action stage mostly used behavioral processes rather than cognitive processes. Interestingly, all of the mean scores for the 5 cognitive process in both sexes were not significantly different across the stages, whereas all of the mean scores of each behavioral process were significantly different across the stages in both sexes, except for 2 behavioral processes (ie, helping relationships and contingency management) in female students only. These patterns may be explained by the high number of students in later stages in the present study. As previously mentioned, the active students in this study may primarily use the behavioral processes to maintain their PA levels, and therefore, the statistically significant differences across the stages were observed in behavioral processes only. These findings emphasize the importance of stage-matched intervention programs for PA promotion in college students and provide insight for developing an effective college PE program for voluntarily registered students.

Self-efficacy for PA refers to situational confidence that an individual can perform PA in a difficult situation.[10] The mean scores of self-efficacy generally increased as progressing through the stages in both sexes while a continually increased pattern was observed only for male participants. This finding indicates that self-efficacy may be a useful predictor of PA for male college students to promote PA compared to female students. Similar findings were found with Irish college students, where PA was not associated with self-efficacy among female students, and male students were generally more confident regarding their ability to increase PA.[17] This result suggests interventions designed to promote PA in college students may need to be sex-specific for better study outcomes.

The decisional balance scores indicating the difference in averages of perceived pros and cons of PA significantly increased across the stages in both male and female students in this study. It was interesting that both male and female students in early stages (a combined stage of "precontemplation" and "contemplation") perceived more benefits than barriers to PA. This result was inconsistent with previous studies showing that people in early stages perceived fewer benefits and more harm than those in later stages, and the crossover between pros and cons appeared in the stages of preparation or action.[10,18] One possible reason for the higher scores on pros in early stages could be attributed to the target participants of this study who were already voluntarily registered for the PE classes. Developing a plan for increasing PA, such as enrolling in an activity class and signing up for a gym membership, is a typical process found among those in the "preparation" stage. The students in early stages in this study can be considered to be in the "preparation" stage when their overall PA performed both inside and outside PE classes was targeted. Therefore, the students already may have perceived positive consequences of regular PA, which, in turn, resulted in a higher score of pros than cons in early stages. However, the incremental pattern from early stages through later stages is consistent with previous findings.[10] This continues to support the contention that people in early stages (eg, especially, in contemplation) already realize the positive benefits of PA, but do not intend to engage in regular PA.[11]

A notable strength of this study is that we investigated additional PA performed outside of PE classes among college students in accordance with their intentional readiness of PA engagement. The results of using an integrative framework (ie,TTM) will inform college students' current status of intentional readiness to engage in additional PA in

addition to their PE participation and will provide relevant strategies that can contribute to college PE development, to PA promotion for college students, and thus, to maximize their health benefits. Second, to prove the accuracy of stage classification, both a self-reported measure and an activity monitor were used to estimate actual PA levels. The proper agreement with actual PA levels in this study supports the capability of stages of change in successfully classifying individual into the stages. However, this study also has several limitations that must be acknowledged. The results of this study may not be generalizable to all different types of college PE classes that were not included in the study. Further research is necessary to investigate a larger college population in various college PE options. Second, due to the cross-sectional study design, we are not able to confirm whether the stage changes can occur over time.

In conclusion, our findings indicate that the college PE classes were not designed to reflect the government's PA guidelines, but to improve students' aerobic capacity and muscular endurance. Most college students who voluntarily enrolled in PE classes participated in additional PA outside of the classes – activity that helps them achieve the required PA level for health benefits. The preferred frequent use of behavioral processes in this population to engage in PA suggests the need of readiness-oriented PE programs to enhance the effectiveness of programs (eg, helping students achieve the government's recommended PA guidelines for health benefits). In addition, the constructs of self-efficacy and decisional balance should be used based on the target population for better outcomes.

Human Subjects Approval Statement

This study was approved by the University of Texas at Austin Institutional Review Board. Informed consent was obtained from all participants included in the study.

Conflict of Interest Disclosure Statement

The authors have no conflict of interest to declare.

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