Journal of Counseling and Psychology

Volume 1 | Issue 2 Article 3

September 2016

What You Know Makes a Difference: Physical Activity Maintenance and Adherence of Collegiate Students

Vista Beasley
University of Stirling, vistabeasley@yahoo.com

Brooke Thompson
Gardner-Webb University, bthompson1@gardner-webb.edu

Patrick R. Young
Wingate University, p.young@wingate.edu

Itay Basevitch
Anglia Ruskin University, itay.basevitch@anglia.ac.uk

What You Know Makes a Difference: Physical Activity Maintenance and Adherence of Collegiate Students

Cover Page Footnote
1Department of Health Science and Sport, University of Stirling, Stirling, United Kingdom 2School of Psychology and Counseling, Gardner-Webb University, Boiling Springs, North Carolina 3Department of Psychology, Wingate University, Wingate, North Carolina 4Department of Sport and Exercise Sciences, Anglia Ruskin University, Cambridge, United Kingdom Correspondence concerning this article should be addressed to Vista Beasley1 Faculty of Health Science and Sport, Pathfoot Building, University of Stirling, Stirling, United Kingdom, FK9 4LA (v.l.beasley@stir.ac.uk)

What You Know Makes a Difference: Physical Activity Maintenance and Adherence of Collegiate Students

Vista Beasley[1], Brooke Thompson[2], Patrick R. Young[3], & Itay Basevitch[4]

Author Note

[1]Department of Health Science and Sport, University of Stirling, Stirling, United Kingdom

[2]School of Psychology and Counseling, Gardner-Webb University, Boiling Springs, North Carolina

[3]Department of Psychology, Wingate University, Wingate, North Carolina

[4]Department of Sport and Exercise Sciences, Anglia Ruskin University, Cambridge, United Kingdom

Correspondence concerning this article should be addressed to Vista Beasley[1] Faculty of Health Science and Sport, Pathfoot Building, University of Stirling, Stirling, United Kingdom, FK9 4LA (v.l.beasley@stir.ac.uk)

Abstract

For decades, exercise psychology researchers dismissed health/exercise knowledge as a determinant of physical activity (PA). We sought to overturn this misconception, showing that psychological theory may serve as a basis for informing physical education curriculum. Based on social cognitive and self-determined motivation theories, we examined health/exercise knowledge as a determinant of collegiate students' PA maintenance (i.e., ≥ 6 months of regular PA involvement); adherence to United States Department of Health and Human Services (USDHHS) 2008 PA guidelines; and PA types (i.e., aerobic, weight training). Collegiate students (n = 231) provided data via online survey. ANOVA analyses revealed that knowledge scores differentiated: a) participants in the maintenance stage from non-active participants (medium effect size); b) guideline adherents from non-adherents (medium-large effect size); and c) engagement in both PA types compared to only aerobic (large effect size). Males reported significantly higher perceived knowledge than females (medium-large effect size) though actual scores were not significantly different. This study provided evidence that knowledge is relevant to collegiate students' PA. Future research may aid physical educators in determining knowledge types, based on psychological theory, that increase PA maintenance/adherence.

Keywords: consciousness raising, outcome expectancy, self-determination theory, self-efficacy, transtheoretical model

What You Know Makes a Difference: Physical Activity Maintenance and Adherence of Collegiate Students

Expressions of skepticism by exercise psychology researchers about knowledge as a determinant of PA can be found in the literature as far back as 1985, when Dishman, Sallis and Orenstein declared that "…no evidence supports the idea that increased knowledge about exercise leads to enhanced participation. In fact, less than 5 percent of the population believes that more information on fitness benefits would be likely to increase their participation" (p. 165). Their declaration has largely been echoed by exercise psychology researchers since that time (e.g., Bauman, Sallis, Dzewaltowski, & Owen, 2002; Biddle & Nigg, 2000; Dishman, 1990), and it remains a prevalent contention (Buckworth & Dishman, 2007). It is perhaps unsurprising, therefore, that little research of the relationship between knowledge and PA has been conducted by exercise psychology researchers in recent decades. We contend, however, that more research on the matter is warranted. We examine three areas: operationalization of PA, operationalization of knowledge, and theoretical grounding. When these areas are viewed with a contemporary lens, we suggest that there is a basis for reviving study of the PA-knowledge relationship by exercise psychology researchers, which could contribute to the development of physical education curriculum.

Prior research which failed to detect a knowledge-PA relationship typically operationalized PA as amount and/or frequency. In research thereafter, various models were proposed, as summarized in Figure 1. The models suggest that a person's stage, based on number of continuous months of regular PA involvement, may be more relevant to the analysis of PA than amount/frequency (Hutchison, Breckon, & Johnston, 2009; Marshall & Biddle, 2001; Nigg et al., 2011; Spencer, Adams, Malone, Roy, & Yost, 2006). Rather than merely correlating variables with PA volume, stage analysis permits the study of variables which enhance entry into the maintenance stage (≥ 6 months) separately from those affecting the continuous ricochet between the non-active and adoption (< 6 months) stages. In addition to stage analysis, current research also seeks to determine adherence to PA guidelines, such as those recommended by United States Department of Health and Human Services (USDHHS, 2008). Adherence implies one is doing the minimum amount of PA necessary to induce health-related benefits. Stages are based on number of months one has regularly engaged in PA, but they do not necessarily indicate whether a person adheres to the weekly amount and intensity levels of PA guidelines (Garber, Allsworth, Marcus, Hesser, & Lapane, 2008; Nigg et al., 2011). For example, a person who reports participating in PA an hour total each week at moderate intensity for the past nine months may be classified in the maintenance stage (≥ 6 months), yet this is less than the 150 minutes per week of moderate-intensity PA prescribed by USDHHS guidelines. Maintenance and adherence were not considered in early research on the knowledge-PA relationship.

Knowledge, too, can be operationalized in different ways. In the opening quote, the construct "knowledge" seemed to be limited to knowledge of fitness *benefits*, prompting the conclusion that knowing the benefits (e.g., weight maintenance) has not been a consequential impetus in increasing PA. It may be, however, that this limited focus impaired the ability to detect the possible influence of knowledge on PA (Bauman et al., 2002). Likewise, knowledge, as operationalized by higher scores on tests in physical education curriculum, has also been found to be unrelated to PA, even when well-validated measures have been employed (Ferkel, 2011; Keating et al., 2010). Would knowledge specific to exercise motives (e.g., weight, competition) render a positive knowledge-PA relationship? There have been glimmers in recent research hinting that knowledge of *benefits* and/or available local resources facilitates adoption

(Bauman et al., 2002; Hutchison et al., 2009; Keating, Guan, Castro-Pinero, & Bridges, 2005; Thompson & Hannon, 2010). However, the potentially different knowledge needed to prompt maintenance or adherence is unknown, and would not have been captured in the prior research of knowledge-PA relationship. We propose that type of knowledge is stage-specific, as shown in Figure 2. Per the figure, knowledge of *physiology* and affect may be related to transitioning into the maintenance stage. One process of change which mediates transitions in PA stages (e.g., from non-active to adoption to maintenance) is consciousness raising, which involves increasing knowledge about causes and *outcomes* for a problem behavior (e.g., lack of exercise adherence; Dishman, Jackson, & Bray, 2010). Consciousness raising has been identified as a main component involved in adoption (Marshall & Biddle, 2001; Nigg et al., 2011). Arguably, it may also have a role in the transition to the maintenance stage. For example, in a longitudinal study, participants who remained in the maintenance stage scored higher in regards to consciousness raising than participants who relapsed to non-exerciser status (Plotnikoff, Hotz, Birkett, & Courneya, 2001), yet it is unclear as to what *types* of knowledge could prompt this transition. Examination of a theoretical basis could clarify knowledge types.

The conclusion that knowledge is not related to PA was based on PA research which, particularly prior to 1980, was completed in a theoretical vacuum (Biddle, Hagger, Chatzisarantis, & Lippke, 2007). Subsequently, social cognitive and self-determined motivation theories have contributed to the understanding of PA research. Within social cognitive theory, self-efficacy (e.g., confidence in one's ability to perform exercise, be it one bout, or sustained involvement) is distinguished from outcome expectation (e.g., belief that exercise will produce the desired result). There is evidence of a positive association between outcome expectations and adoption (e.g., Loehr, Baldwin, Rosenfield, & Smits, 2014). Knowledge may be related to adoption via outcome expectancy in the following fashion: Consider an individual who, wishing to lose weight, adopts an exercise program. Being knowledgeable about the potential *benefit*—weight loss—of PA induced initial PA adoption. After a month, the individual has gained weight. At this juncture, the individual, discouraged, may relapse. When a desired physical outcome (e.g. weight loss) is not achieved, outcome expectation is not supported. If the adopter possessed relevant *physiology* knowledge, the adopter would know that muscle weighs more than fat*, and that, along with other reasons (e.g., inflammation) may guide expectations for a temporary weight gain at the onset of exercise. (Note: Astericks (*) indicate examples in text which are the content of items in the knowledge assessment tool used in the study.) Would this *physiology* knowledge, specific to the individual's desired outcome, rather than *benefits* knowledge, or generic PA knowledge about health-related fitness, prompt maintenance? In this way, *physiology* knowledge (e.g., muscle weighs more than fat) may shape expectations about whether actions (e.g., engaging in PA) can produce the desired outcomes (e.g., weight loss). Thus, increased *physiological* knowledge may result in a more accurate understanding and more realistic outcome expectations. Realistic outcome expectations are more likely to be attained, which may affect maintenance via motivation.

If one expects a behavior to produce an outcome, but then the outcome is not produced, motivation to persist in that behavior could be affected (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). Recent research, based on self-determination theory, indicates that one type of extrinsic motivation, identified regulation, is associated with physical activity frequency (e.g., Wilson, Sabiston, Mack, & Blanchard, 2012). Identified regulation appears to induce PA engagement due to the personal importance affixed to *outcomes*, supporting the idea that outcome expectancy is related to PA frequency in a typical week, and initial, short-term PA.

Knowledge related to the short-term outcomes may contribute to *adoption*, but evidence suggests more self-determined forms of motivation are related to long-term *maintenance* (Teixeira, Carraca, Markland, Silva, & Ryan, 2012), increased attendance to an exercise program (Oman & McAuley, 1993), and PA (Biddle & Nigg, 2000). Thus it is of worth to identify factors that contribute to self-determined motivation. Knowledge may be one of those factors, in the form of a rationale. A rationale can be described as an "explanation of why putting forth effort during the activity might be a useful thing to do" (Reeve, Jang, Hardre, & Omura, 2002, p.190). Providing this knowledge promotes more self-determined forms of motivation, enabling an individual to grasp the meaning and importance of the behavior and how it supports goals. The most self-determined form of motivation, intrinsic motivation, involves enjoyment, and has been associated with higher exercise adherence and maintenance (Keating et al., 2005; Ryan et al., 1997; Spencer et al., 2006). Therefore, knowledge related to enjoyment may be most useful in facilitating maintenance/adherence. Because enjoyment has been related to activity type (Ryan et al., 1997) and negatively related to intensity (Ekkekakis, Hargreaves, & Parfitt, 2013), we next consider how knowledge may impact activity type and intensity.

Knowledge may be related to activity type via influence on variety (Bond et al., 2010) and competence (Keating et al., 2005). To demonstrate variety, consider a male with a family history of cardiac-related mortality who believes he must engage in aerobic activity for cardiovascular health. A female, avoiding weight training for fear that it will cause her to bulk up unattractively, may only engage in aerobic activity. A male wishing to reduce abdominal fat does abdominal crunches*. If the three engage only in these activities and become bored, they may relapse. They may lack the knowledge that weight training aids cardiovascular health*, that high repetitions of weight-training exercises would not result in the ever-feared bulking up*, and that weight training increases post-exercise caloric burn more than aerobic *. These examples suggest that knowledge of a variety of goal-related activity type options may increase enjoyment and thus maintenance. However, knowing the activity types that support goals may not be sufficient. As collegiate students "tend to get involved in PA that they already feel competent performing" (Keating et al., 2005, p. 118), those initiating PA may get involved in the activities that require the least amount of knowledge. Few studies have examined differences in the adoption of different types of PA (e.g., aerobic vs. weight training; Bond et al., 2010; Buckworth & Dishman, 2007), but it would appear that weight training requires more knowledge than the relative simplicity of an aerobic activity such as jogging. Thus aerobic activity may be the default choice of a non-active person's initial attempt to engage in regular PA. Without the knowledge to increase competence at a more varied regimen, maintenance may not occur. Likewise, those who start engaging in a goal-based activity type may erroneously believe that exercise must be painful*, that muscle soreness is necessary*, to obtain the desired outcome. Thus, knowledge related to exercise intensity prescription may also aid the transition between adoption and maintenance stages.

As stages of change, self-efficacy, and motivation related to perceived enjoyment have been shown to be applicable to collegiate students (Keating et al., 2005; Lerner, Burns, & Roiste, 2011), the basis for knowledge being a PA determinant related to more self-determined forms of motivation is present with this population. PA--and lack thereof—of collegiate students is closely associated with activity levels of post-collegiate adults (Sparling & Snow, 2002). Therefore, it is essential to identify the PA determinants of this population. Research has shown gender differences in exercise motivations and activity types of collegiate students (e.g., Egli, Bland, Melton, & Czech, 2011). For example, university-aged women tend to participate in PA to improve appearance whereas men may do so to increase strength. Knowledge of how to obtain the different desired outcomes may differentiate PA maintenance and adherence. For this reason, gender was also considered.

Taken altogether, the purpose of this study was to provide evidence that knowledge may be a variable related to PA when theory-based knowledge types are considered, and when PA is operationalized in terms of stages (non-active vs. maintenance), type (aerobic vs. weight-training), and adherence to guidelines set forth by USDHHS (2008). Given previous research, we expected no meaningful correlation between knowledge and PA volume. Instead, we hypothesized that those in the maintenance stage, guideline adherents, and those engaged in weight-training activities would have significantly more *physiology* knowledge than those in the non-active/adoption stages, non-adherents, and those engaged primarily in aerobic activity, respectively.

Method

Participants

Participants (*N* = 231) included male (*n* = 61) and female (*n* = 170) collegiate students ranging in age from 18 – 31 (*M* = 20.68, *SD* = 2.11). Participants were recruited for two semesters from a research pool consisting of students attending education classes at a southeastern university.

Measures

Physical Activity. Questions assessed frequency (times per week), duration (minutes per session), intensity (0-10), and number of months these volumes had been sustained (stage) for each activity type (none, aerobic, weight training, both) marked. This measure was constructed so that all PA constructs (i.e., stage, activity type, and adherence) could be assessed. Existing measures of PA (e.g., LTEQ, IPAQ) were not used because they assessed some but not all of these constructs.

PA Knowledge. This questionnaire was developed to measure three PA knowledge types: Physiology, Benefits, Perceived. After screening for construct validity with input from two exercise physiology professors, 59 items appeared in the final questionnaire; four items that could not be categorized as one of the three knowledge types were later deleted. Items were reverse-scored as applicable such that higher scores indicated more knowledge. Full questionnaire and response options are available from corresponding author.

Physiology Knowledge. Forty items included 10 True/False items (e.g., "Strength training, although beneficial in building muscle and bone, does nothing for cardiovascular health"; "If I want to lose fat in my abdomen, I should do a lot of crunches"; "Physical exercise must be painful to be effective") and 30 multiple-choice items (e.g., "Which type of exercise should I engage in to increase post-exercise caloric burn?).

Benefits Knowledge. Eight True/False items assessed knowledge of PA benefits related to aging, weight control, affect, depression, cardiovascular health, sleep, and sex (e.g., "Regular exercise can help prevent depression").

Perceived Knowledge. Six Yes/No items assessed participants' subjective perception of their *physiology* knowledge (e.g., "I have an understanding of how exercises relate to physical changes."). One True/False item assessed perceived *benefits* knowledge: "I am fully aware of the potential benefits of engaging in exercise."

Procedure

Participants were first required to sign up for the study online to receive course credit. They were then provided with a hyperlink which, when clicked, led them to the online questionnaire, which included questions about age and gender. Completion of the questionnaire, including informed consent, took approximately 30 minutes. Afterwards, participants entered their names to receive course credit for their participation. Study protocol was approved by the university's institutional review board.

Data Analyses

Total volume was calculated by adding the volume (frequency x duration) of each PA type (aerobic, weight training). Researchers classified participants' responses in four ways: 1) Stage of Change: Per stages listed in Figure 1, participants were classified according to number of months they reported regularly engaging in any type of PA: non-active (0), adoption (1-5), maintenance (≥ 6). 2) Aerobic Guideline Adherence: Adherents were those reporting weekly aerobic volumes of ≥ 150 minutes at moderate intensity (i.e., 5 – 6), or ≥ 75 minutes at vigorous intensity (i.e., 7 - 10), per USDHHS (2008) aerobic guidelines. Non-adherents reported lower volumes and/or intensities. 3) Aerobic and Muscle-strengthening Guideline Adherence: Adherents met above aerobic guidelines and additionally reported weight-training activity ≥ 2 times a week. 4) TTM Stage and Aerobic Guideline Adherence (Combined): In accordance with Garber, Allsworth, Marcus, Hesser, and Lapane (2008) based on TTM stages, non-adherents were classified as contemplation (no activity) or preparation (volumes/intensities lower than guidelines); adherents were classified as action (met aerobic guidelines for 1-5 months) or maintenance (met aerobic guidelines for ≥ 6 months). Using SPSS 19, descriptive statistics and correlations were obtained, outliers were removed, missing cases were resolved, and univariate normality was evaluated. Chi-square and ANOVA tests were used to assess differences in gender and classifications. When homogeneity of variance assumption was met per Levene's test, Tukey post-hoc tests were used as a follow-up for significant ANOVAs. When not met, Welch's test was used to further analyze this assumption, with Games-Howell test used as a follow-up. Effect sizes for Cohen's *d* values are deemed small (.2), medium (.5), and large (.8), per Cohen (1992); correlation effect sizes are small (.1), medium (.3), and large (.5).

Results

Participants who failed to complete the questionnaire (n = 7) or whose ages or PA values were outliers (n = 9) were excluded from the study; thus the number of cases was reduced to 231. Seven participants did not provide one answer to the questions assessing PA; missing values were substituted with the mean value of each gender (Kline, 2011).

Per Tables 1 and 2, 69.7% reported engaging in regular activity. In contrast, the percentage adhering to USDHHS (2008) aerobic guidelines was only 39% of all participants; 20.3% did so for ≥ 6 months (maintenance). About 27.3% reported meeting muscle-strengthening guidelines, and even less (13%) adhered to both aerobic and muscle-strengthening guidelines. The mean amounts participants reported for minutes, intensity, and months of regular aerobic activity were more than double those of weight training. Activity type appeared most pertinent to the relationship between gender and PA due to males' mean weight-training values which were significantly higher than those of females. However, the significant association between gender and activity type, χ2 (3) = 19.96, $p < .001$, was small (*Cramer's V* = .29). Though the mean total volume differed significantly between genders (d = .48), the percentage of females (30%) and males (29.5%) reporting no activity was similar. There were no significant associations of gender with stage of change, χ^2 (2) = .09, p = .96, *Cramer's V* = .02, aerobic guideline adherence, χ^2 (1) = .29, p = .65, *Cramer's V* = .04, aerobic and muscle-strengthening guideline adherence, χ^2 (1) = 1.87, p = .19, *Cramer's V* = .09, or TTM stages combined with aerobic guideline adherence, χ^2 (1) = 5.44, p = .14, *Cramer's V* = .15.

The mean Physiology Knowledge score was 57.4% of the maximum achievable score (i.e., 48). The mean Benefits Knowledge score was 94.7% of the maximum achievable score (i.e., 8). Males reported significantly higher Perceived Physiology Knowledge than females, with a medium-large effect size (d = .64). The actual mean Physiology Knowledge scores between genders were not significantly different (p = .83). Correlations between physical activity and knowledge variables were, for the most part, small (Table 3). Both Physiology Knowledge and Benefits Knowledge differentiated activity types [F(3,227) = 11.34, p < .001; F(3,66.52) = 10.53, p < .001], stages of change [F(2,228) = 7.21, p < .01; F(2,144.98) = 5.27, p = .01], aerobic guideline adherence [F(1,229) = 4.96, p = .03; F(1,204.21) = 4.60, p = .03], aerobic and muscle-strengthening guidelines adherence [F(1,229) = 17.08, p <.001; F(1,102.19) = 13.95, p <.001], and TTM stage/aerobic guideline adherence [F(3,227) = 3.37, p = .02; F(3,108.51) = 6.68, p < .001]. The follow-up tests of significant findings are shown in Table 4.

Participants who reported engaging in both aerobic and weight-training activity had significantly higher mean scores than non-active participants in both Physiology Knowledge (d = .97) and Benefits Knowledge (d = .86). Physiology Knowledge differed significantly (d = .85) between those engaged in both activity types and those engaged only in aerobic activity, but Benefits Knowledge did not significantly differ between these two (d = .36). Participants who reported engaging in physical activity regularly for ≥ 6 months scored significantly higher on average than non-active participants in both Physiology Knowledge (d = .59) and Benefits Knowledge (d = .55). Likewise, adherents to both aerobic and muscle-strengthening guidelines scored significantly higher in both Physiology Knowledge (d = .77) and Benefits Knowledge (d = .50) than non-adherents. Benefits Knowledge was significantly higher (d = .71) for those in the preparation stage (i.e., those who reported some regular activity, though the volume or intensity did not meet the aerobic guidelines) in comparison to those who reported no activity. Perceived knowledge did not significantly differentiate activity classifications; results from analyses involving perceived knowledge can be obtained from the corresponding author.

Discussion

The present study proposed that the relationship between PA knowledge and PA would be detected when analyses involved stages of change, adherence, and activity types as supported by social cognitive and self-determination theories. Knowledge scores, PA volumes, and guideline adherence rates were generally low, consistent with other studies with participants of this age (Ferkel, 2011; Keating et al., 2010). As hypothesized, the variables did not strongly correlate, replicating previous research that, when analyzed in this fashion, knowledge does not appear to be related to PA. Increasing knowledge may not result in a proportionate increase in an individual's weekly amount of PA from, for example, 120 minutes to 150 minutes, but such temporary associations appear to have little indication of, or use in increasing, PA maintenance. The proportions of collegiate students in the TTM stages in this study were consistent with other studies (Keating et al., 2005). Of primary interest, both forms of knowledge (benefits and physiology) differentiated which collegiate students maintained regular PA for six or more months, as opposed to those who did not engage in PA, supporting the use of stage analysis when examining the knowledge-PA relationship. The two knowledge types also differentiated students' adherence to USDHHS guidelines. Intuitively, these findings about maintenance and adherence have more significant ramifications for long-term health benefits than snapshot correlations between knowledge and PA volume/frequency. Further study of the process of change, consciousness raising, across stages, is supported, contrasting the emphasis of consciousness raising only in initial stages (Marshall & Biddle, 2001; Nigg et al., 2011).

The PA self-reports in this study identified type of activities rather than merely quantifying the amounts. As predicted, knowledge was relevant to activity type. While knowledge of benefits appeared most relevant to spurring participants from inactivity to some activity, knowledge of physiology appeared most relevant to engagement in both aerobic and weight-training activity. Given the need for muscle-strengthening activity to augment the health benefits of aerobic activity (USDHHS, 2008), this is significant. If activity variety aids self-determined motivation enjoyment which aids persistence and thus health, then knowledge that facilitates PA variety is worth scrutiny. The simple measure of aerobic and weight training activity used in this study supported this notion, but future study of a greater and more-specific range of activity types may reveal the specific knowledge conducive to increased engagement in specific activity types.

Activity type also appeared relevant to the well-known PA gender disparities. Though no gender difference was found in aerobic activity, there was a significant difference between genders in weight-training volumes. A study by Wallace (2003) suggested that the females who reported engaging in weight-training activity were more likely to sustain PA over a lifetime; if weight-training activity is associated with long-term PA adherence, then factors contributing to female weight training are of interest. The significant difference in this study between genders in regards to *perceived* physiology knowledge (i.e., males reported higher than females, though actual physiology knowledge scores did not differ) hints of a possible contributor to females' lower weight-training activity. Considering that self-efficacy toward one activity can differ toward another activity (Biddle & Nigg, 2000), it may be worthwhile to study what forms of knowledge enhance females' self-efficacy about weight-training activity. There were no gender differences between stages or adherence status; however, gender-related findings in PA stages have been inconsistent (Keating et al., 2005), warranting further study.

As predicted, the operationalization of knowledge (i.e., benefits, physiology) impacted results. Both knowledge types differentiated activity types, stages, and adherence status to some degree, but benefit knowledge did so to a lesser extent, as evidenced by smaller effect sizes, than physiology knowledge. Benefits knowledge significantly differed between those who did no activity and those who did aerobic activity, whereas physiology knowledge had more impact on activity variety (i.e., aerobic AND weight training), suggesting that physiology knowledge is conducive to variety which in turn may be relevant to maintenance. Also, we assessed knowledge about a full range of benefits (e.g., aging, cardiovascular health) whereas collegiate students may be primarily interested in benefits such as weight control and muscular appearance; thus future study could examine how desire for those specific benefits, along with the physiology knowledge needed to obtain those specific benefits, impact PA levels.

The primary purpose of this study was to contrast previous methods of analysis of knowledge and PA volume with our proposed analysis of knowledge with PA stages and guideline adherence. Thus, we deemed it appropriate to construct and use a generic knowledge assessment tool with construct validity in alignment with the design of previous studies. Though beyond the scope of this study, future research should involve the development of a psychometrically-valid tool incorporating factor analyses. We strongly recommend this tool include knowledge scales based on theory-based operationalizations such as that proposed in Figure 2, i.e., self-efficacy outcome expectancy and self-determination. The association of these knowledge scales and stages could be examined further. This contrasts previous knowledge assessment tools scales (e.g., cardiovascular endurance, flexibility; Ferkel, 2011) which were assessed in relationship to PA. Due to the numerous possible ways to gauge PA variables such as engagement (e.g., highly active, sufficiently active, insufficiently active, inactive; Carlson, Fulton, Schoenborn, & Loustalot, 2010) and stages (Spencer et al., 2006), we encourage attempts to replicate the results of our study with various classifications and questionnaires. Finally, the cross-sectional nature of this study requires further testing to determine causality in the PA-knowledge relationship.

Noticeably, other than reviews discounting its importance, there are few studies published in the exercise psychology field in the last decades addressing knowledge, due, we believe, to the inability to detect a relationship. We hope to reinvigorate the study of this potentially critical variable to aid physical educators in their selection of curriculum that will increase PA maintenance and adherence. When the work of physiologists, physical educators, and exercise psychology researchers and practitioners is aligned, knowledge presented in curriculum may be applied in stages, rather than memorized en masse for exams and promptly discarded. The line of study extended from the evidence obtained here, and based on the model in Figure 2, may impact funding for PA education programs and exercise psychology practitioners to provide stage-specific PA knowledge.

Acknowledgements

Much appreciation goes to physiologists Dr. Kristen Kane (Morrisville College) and Dr. Beau Kjerful Greer (Sacred Heart University), for expertise in constructing the knowledge assessment tool, and to Dr. Robert Eklund (University of Stirling), for providing feedback on data analyses.

References

Bauman, A. E., Sallis, J. F., Dzewaltowski, D. A., & Owen, N. (2002). Toward a better understanding of the influences on physical activity: The role of determinants, correlates, causal variables, mediators, moderators, and confounders. *American Journal of Preventive Medicine, 23,* 5-14.

Biddle, S. J. H., & Nigg, C. (2000). Theories of exercise behavior. *International Journal of Sport Psychology, 31,* 29-304.

Biddle, S. J. H., Hagger, M. S., Chatzisarantis, N. L. D., & Lippke, S. (2007). Theoretical frameworks in exercise psychology. In G. Tenenbaum and R. C. Eklund (Eds.), *Handbook of Sport Psychology* (3rd ed, pp. 537-559). Hoboken, NJ: John Wiley & Sons

Bond, D. S., Raynor, H. A., Phelan, S., Steeves, J., Daniello, & Wing, R. R. (2012). The relationship between physical activity variety and objectively measured moderate-to-vigorous physical activity levels in weight loss maintainers and normal-weight individuals. *Journal of Obesity, 2012,* 1-7. doi:10.1155/2012/812414

Buckworth, J., & Dishman, R. K. (2007). Exercise adherence. In G. Tenenbaum and R. C. Eklund (Eds.), *Handbook of Sport Psychology* (3rd ed, pp. 509-536). Hoboken, NJ: John Wiley & Sons.

Carlson, S. A., Fulton, J. E., Schoenborn, C. A., Loustalot, F. (2010). Trend and prevalence estimates based on the 2008 physical activity guidelines for Americans. *American Journal of Preventative Medicine, 39,* 305-313.

Cohen, J. (1992). A power primer. *Quantitative Methods in Psychology, 112,* 155-159.

Dishman, R. K. (1990). Determinants of participation in physical activity. In C. Bouchard, R. J. Shephard, T. Stephens, J. R. Sutton and B. D. McPherson (Eds.), *Exercise, fitness, and health* (pp. 75–101). Champaign, IL: Human Kinetics.

Dishman, R. K., Jackson, A. S., & Bray, M. S. (2010). Validity of processes of change in physical activity among college students in the TIGER study. *Annals of Behavioral Medicine, 40,* 164-175.

Dishman, R. K., Sallis, J. F., & Orenstein, D. R. (1985). The determinants of physical activity and exercise. *Public Health Reports, 100*, 158-171.

Egli, T., Bland, H. W., Melton, B. F., Czech, F. R.. (2011). Influence of age, sex, and race on college students' exercise motivation of physical activity. *Journal of American College Health, 59,* 399-406.

Ekkekakis, P., Hargreaves, E. A., & Parfitt, G. (2013). Invited guest editorial: Envisioning the next fifty years of research on the exercise-affect relationship. *Psychology of Sport and Exercise, 14*, 751-758.

Ferkel, R. (2011). Relations among physical fitness knowledge, physical fitness, and physical activity. Unpublished manuscript, Texas Tech University, Lubbock, TX.

Garber, C. E., Allsworth, J. E., Marcus, B. E., Hesser, J., & Lapane, K. L. (2008). Correlates of the stages of change for physical activity in a population survey. *American Journal of Public Health, 98,* 897-904.

Hutchison, A. J., Breckon, J. D., & Johnston, L. H. (2009). Physical activity behavior change interventions based on the Transtheoretical Model: A systematic review. *Health Education & Behavior, 36,* 829-845.

Keating, X. D., Guan, J., Castro-Pinero, J., & Bridges, D. M. (2005). A meta-analysis of college students' physical activity behaviors. *Journal of American College Health, 54*, 116-125.

Keating, X. D., Castro-Pinero, J., Centeio, E., Harrison Jr., L., Ramirez, T., & Chen, L. (2010). Health-related fitness knowledge and its relation to student physical activity patterns at a large U.S. southern state university. *International Council for Health, Physical Education, Recreation, Sport, and Dance Journal of Research, 5,* 3-9.

Kline, R. B. (2011). *Principles and practice of structural equation modeling (3rd ed).* New York, NY: Guilford Press.

Lerner, J., Burns, C., & de Roiste, A. (2011). Correlates of physical activity among college students. *Recreational Sports Journal, 35,* 95-106.

Loehr, V. G., Baldwin, A. S., Rosenfield, D., & Smits, J. A. J. (2014). Weekly variability in outcome expectations: Examining associations with related physical activity experiences during physical activity initiation. *Journal of Health Psychology*, *19*(10), 1309-1319.

Marshall, S. J., & Biddle, S. J. H. (2001). The Transtheoretical Model of behavior change: A meta-analysis of applications to physical activity and exercise. *Annals of Behavioral Medicine, 23,* 229-246.

Nigg, C. R., Geller, K. S., Motl, R. W., Horwath, C. C., Wertin, K. K., & Dishman, R. K. (2011). A research agenda to examine the efficacy and relevance of the Transtheoretical Model for physical activity behavior. *Psychology of Sport and Exercise, 12,* 7-12.

Oman, R. F., & McAuley, E. (1993). Intrinsic motivation and exercise behavior. *Journal of Health Education, 24,* 232-238.

Plotnikoff, R. C., Hotz, S. B., Birkett, N. J., & Courneya, K. S. (2001). Exercise and the Transtheoretical Model: A longitudinal test of a population sample. *Preventative Medicine, 33,* 441-452.

Prochaska, J. O., & Marcus, B. H. (1994). The Transtheoretical Model: Applications to exercise. In R. Dishman (Ed.), *Advances in Exercise Adherence* (pp. 161-180). Champaign, IL: Human Kinetics.

Reeve, J., Jang, H., Hardre, P., & Omura, M. (2002). Providing a rationale for an uninteresting activity as a motivational strategy to support another's self-determined extrinsic motivation. *Motivation and Emotion, 26*, 183-207.

Ryan, R. M., Frederick, C. M., Lepes, D., Rubio, N., & Sheldon, K. M. (1997). Intrinsic motivation and exercise adherence. *International Journal of Sport and Exercise Psychology, 28*, 335-354.

Sallis, J. F., & Hovell, M. (1990) Determinants of exercise behavior. *Exercise and Sport Sciences Reviews, 18*, 307–30.

Sparling P. B, & Snow, T. K. (2002). Physical activity patterns in recent college alumni. *Research Quarterly for Exercise and* Sport, *73*, 200–205.

Spencer, L., Adams, T. B., Malone, S., Roy, L., & Yost, E. (2006). Applying the Transtheoretical Model to exercise: A systematic and comprehensive review of the literature. *Health Promotion Practice, 7*, 428-443.

Teixeira, P. J., Carraca, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 9*, 78. doi:10.1186/1479-5868-9-7

Thompson, A., & Hannon, J. (2010). Health-related fitness knowledge and physical activity of high school students. *Research Quarterly for Exercise and Sport*, 81, A75.

United States Department of Health & Human Services (2008). 2008 physical activity guidelines for Americans. Retrieved May 6, 2014, from http://www.health.gov/paguidelines/guidelines/default.aspx

Wallace, L. S. (2003). Correlates of lifetime physical activity in young women. *American Journal of Health Education, 34,* 41-46.

FIGURES

Stage	CHARACTERISTICS		PA STAGE MODELS		
	Current Activity	**# Months Sustained**	**Natural History** (Sallis & Howell, 1990)	**Lifespan Interaction** (Dishman, 1990)	**Transtheoretical** (Prochaska & Bess, 1994)
Non-active	None or Irregular	0	Sedentary (No prior PA, dropouts)	Planning	Pre-contemplation Contemplation Preparation Relapse
Adoption	Regular	< 6	Adopt / Resume	Adoption	Action
Maintenance	Regular	≥ 6	Maintain	Maintenance	Maintenance Termination

Figure 1. Characteristics of three stages elicited from three models.

STAGE	KNOWLEDGE	MOTIVATION Amotivation Extrinsic Intrinsic
Non-active	Benefits Resources	
Adoption	Goal-specific physiology	
Maintenance	Affect (Intensity, Variety) Injury/Burnout Prevention	

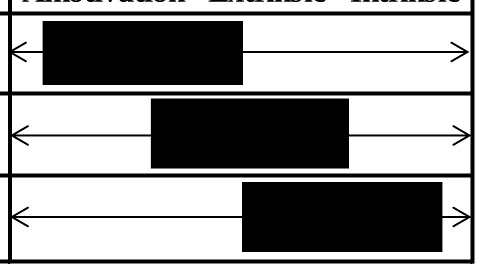

Figure 2. Proposed model integrating stage-specific physical activity knowledge with self-determined motivation.

Table 1

Descriptive Statistics and Gender Differences of Physical Activity and Knowledge Variables

			Total $N = 231$		**Female** $n = 170$		**Male** $n = 61$					
	Variable	**Range**	***M***	***(SD)***	***M***	***(SD)***	***M***	***(SD)***	***df 1, df 2***	***F***	***p***	***d***
Aerobic	Volume	0-1200	127.39	*(182.38)*	117.45	*(154.30)*	155.12	*(243.69)*	1,77.93	1.27[a]	.26	N/A
	Intensity	0-10	4.09	*(3.44)*	4.30	*(3.35)*	3.51	*(3.66)*	1,98.30	2.20[a]	.14	N/A
	Months	0-120	8.07	*(17.46)*	8.28	*(16.96)*	7.49	*(18.94)*	1,229	.09	.76	N/A
Weight	Volume	0-720	49.05	*(107.27)*	27.03	*(63.36)*	110.43	*(166.13)*	1,66.36	14.61[a]	<.001*	.66
	Intensity	0-10	2.05	*(3.26)*	1.51	*(2.80)*	3.54	*(3.94)*	1,82.70	13.68[a]	<.001*	.59
	Months	0-76	3.88	*(11.66)*	2.58	*(9.22)*	7.51	*(16.24)*	1,74.34	5.03[a]	.03*	.37
Total	Volume	0-1680	176.45	*(225.24)*	144.48	*(175.59)*	265.54	*(310.92)*	1,74.17	8.30[a]	.01*	.48
Knowledge	Physiology	11-34	22.96	*(4.37)*	22.92	*(4.20)*	23.07	*(4.83)*	1,229	.05	.83	N/A
	Benefits	3-8	7.58	*(.86)*	7.68	*(.74)*	7.30	*(1.07)*	1,81.67	6.61[a]	.01*	.41
	Perc/Phys	0-6	3.39	*(1.40)*	3.16	*(1.35)*	4.03	*(1.37)*	1,229	18.48	<.001*	.64
	Perc/Bene	0-1	0.89	*(.31)*	0.92	*(.28)*	0.82	*(.39)*	1,82.79	3.30[a]	.07	N/A

Note. Volume: Minutes per week. Intensity: 0 – 10, with 10 being highest. Months: How long reported weekly volume was sustained. Total Volume: Sum of aerobic and weight training volumes in minutes/week. Perc/Phys: Perceived Physiology; Perc/Bene: Perceived Benefits. [a]Homogeneity of variance assumption was violated per Levene's test; corrected using Welch's test. *Statistically significant at indicated *p* value.

Table 2

Descriptive Statistics of Gender and Knowledge by Activity Classifications

	Total		Gender		Knowledge			
	N =231		**Female**	**Male**	**Physiology**		**Benefits**	
Classification	*n* =	%	*n* = 170	*n* = 61	***M***	***(SD)***	***M***	***(SD)***
Activity Type								
None	69	29.9%	30.0%	29.5%	21.49	*(4.74)*	7.30	*(.94)*
Aerobic	91	39.4%	45.3%	23.0%	22.45	*(3.71)*	7.68	*(.81)*
Weight Training	19	8.2%	4.1%	19.7%	23.16	*(3.67)*	7.16	*(1.26)*
Both	52	22.5%	20.6%	27.9%	25.73	*(3.99)*	7.90	*(.30)*
Stage of Change								
Non-active	70	30.3%	30.6%	29.5%	21.51	*(4.71)*	7.31	*(.94)*
Adoption	85	36.8%	37.1%	36.1%	23.06	*(3.82)*	7.64	*(.91)*
Maintenance	76	32.9%	32.4%	34.4%	24.18	*(4.28)*	7.75	*(.64)*
Aerobic Guideline Adherence								
Non-adherents	141	61.0%	60.0%	63.9%	22.45	*(4.23)*	7.48	*(.88)*
Adherents	90	39.0%	40.0%	36.1%	23.76	*(4.48)*	7.72	*(.79)*
Aerobic and Muscle-Strengthening Guideline Adherence								
Non-adherents	201	87.0%	88.8%	82.0%	22.52	*(4.15)*	7.53	*(.90)*
Adherents	30	13.0%	11.2%	18.0%	25.93	*(4.67)*	7.87	*(.35)*
TTM Stage and Aerobic Guideline Adherence								
Contemplation	89	38.5%	34.7%	49.2%	21.87	*(4.54)*	7.28	*(1.01)*
Preparation	53	22.9%	25.9%	14.8%	23.45	*(3.43)*	7.83	*(.43)*
Action	42	18.2%	19.4%	14.8%	23.40	*(4.53)*	7.74	*(.91)*
Maintenance	47	20.3%	20.0%	21.3%	24.09	*(4.52)*	7.70	*(.69)*

Note. Stage of Change (number of months): Non-active (0); Adoption (1-5); Maintenance (≥ 6). Aerobic Guideline Adherents: Aerobic volume ≥ 150 minutes/week at moderate (5-6) intensity, or ≥ 75 minutes at vigorous (7-10) intensity. Aerobic and Muscle-strengthening Guideline Adherents: Met above aerobic guidelines and weight training ≥ 2 times/week. TTM Stage and Aerobic Guideline: Contemplation (no activity); Preparation (volumes/intensities lower than aerobic guidelines); Action (met aerobic guidelines for 1-5 months); Maintenance (met aerobic guidelines for ≥ 6 months).

Table 3

Correlations between Physical Activity and Knowledge Variables (N = 231)

		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	Aerobic Volume	-									
2	Aerobic Intensity	.65**	-								
3	Aerobic Months	.34**	.38**	-							
4	WT Volume	.15*	.07	.07	-						
5	WT Intensity	.20**	.19**	.16*	.79**	-					
6	WT Months	.18**	.16*	.52**	.41**	.57**	-				
7	Total Volume	.88**	.56**	.31**	.60**	.54**	.34**	-			
8	Physiology Knowledge	.19**	.20**	.13	.28**	.36**	.24**	.29**	-		
9	Benefits Knowledge	.16*	.25**	.09	.02	.09	.01	.14*	.37**	-	
10	Perceived Physiology	.19**	.15*	.12	.31**	.38**	.29**	.30**	.28**	.15*	-
11	Perceived Benefits	.13*	.17*	.10	-.004	.01	.08	.10	.16*	.24**	.15*

* $p < .05$; ** $p < .01$

Table 4

Cohen's d Values for Types of Knowledge between Physical Activity Classifications

Classification	***n:n***	**Knowledge**	
		Physiology	**Benefits**
Activity Type			
None : Aerobic	69 : 91	.23	.43*
None : Weight Training	69 : 19	.39	.13
None : Both	69 : 52	.97*	.86*
Aerobic : Weight Training	91 : 19	.19	.49
Aerobic : Both	91 : 52	.85*	.36
Weight Training : Both	19 : 52	.67	.81
Stage of Change			
Non-active : Adoption	70 : 85	.36	.36
Non-active : Maintenance	70 : 76	.59*	.55*
Adoption : Maintenance	85 : 76	.28	.14
Aerobic Guidelines			
Adherents : Non-adherents	90 : 141	.30*	.29*
Aerobic & Muscle-strengthening Guidelines			
Adherents : Non-adherents	30 : 201	.77*	.50*
TTM Stage & Aerobic Guidelines			
Contemplation : Preparation	89 : 53	.39	.71*
Contemplation : Action	89 : 42	.34	.48
Contemplation : Maintenance	89 : 47	.49*	.49*
Preparation : Action	53 : 42	.01	.13
Preparation : Maintenance	53 : 47	.14	.23
Action : Maintenance	42 : 47	.15	.05

*Values are significant minimally at $p < .05$.