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The Utility of a Protection Motivation Theory Framework for Understanding Sedentary Behavior

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The utility of a protection motivation theory framework for understanding sedentary behavior

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ABSTRACT

Multilevel determinants of sedentary behavior (SB), including constructs couched within evidence-based psychological frameworks, can contribute to more efficacious interventions designed to decrease sitting time. This study aimed to: (1) examine the factor structure and composition of sedentary-derived protection motivation theory (PMT) constructs and (2) determine the utility of these constructs in predicting general and leisure sedentary goal intention (GI), implementation intention (II), and self-reported SB. Sedentary-derived PMT (perceived severity, PS; perceived vulnerability, PV; response efficacy, RE; self-efficacy, SE), GI, and II constructs, and a modified SB questionnaire were completed by undergraduate students ($n = 596$). SE was broken into three psychological (productive, focused, tired), and two situational (studying, leisure) constructs to capture the main barriers to reducing sitting time. After completing socio-demographics and the PMT items, participants were randomized to complete general or leisure GI and II. Based on model assignment, they completed either the general or leisure SB questionnaire one week later. Irrespective of model, exploratory followed by confirmatory factor analysis revealed that the PMT items grouped into eight coherent and interpretable factors consistent with the theory's threat and coping appraisal tenets: PV, PS, RE, and five scheduling SE constructs (tired, productive/focused, TV/video games/computer, studying at home, studying in library/Wi-Fi area). Using linear regression, general and leisure models predicted 5% and 1% of the variance in GI, 10% and 16% of the variance in II, and 3% and 1% of the variance in SB, respectively. Variables that made unique and significant contributions were: RE (general) and SE (leisure) for goal intention; PV and RE (general), PV, RE, and SE (leisure) for implementation intention; and only goal intention (leisure) for SB. Support now exists for the tenability of an eight-factor PMT sedentary model and its utility in predicting II and to a lesser extent GI and behavior.

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sedentary behavior; protection motivation theory; intention; self-efficacy; health psychology

Sedentary behavior has permeated almost all aspects of North American daily living for the past 30 years (Katzmarzyk & Tremblay, 2007). Population-based accelerometer studies indicate that only 15% of Canadian adults are meeting physical activity guidelines

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(at least 150 minutes of moderate to vigorous intensity physical activity [MVPA] per week), and that 68% of males and 69% of females' daily waking hours are spent sedentary (Colley et al., 2011). Behaviors such as screen viewing and sitting in an automobile can be defined as sedentary, a distinct class of waking behaviors characterized by an energy expenditure of ≤1.5 metabolic equivalents (METs) while in a sitting or reclining posture (Canadian Society for Exercise Physiology, 2014). Studies indicate that regardless of MVPA levels, individuals who engage in uninterrupted sitting remain at higher risk for certain health conditions, including obesity, type 2 diabetes, and all-cause mortality (Hamilton, Healy, Dunstan, Zderic, & Owen, 2008).

Metabolic deterioration, characterized by increased plasma triglyceride levels, decreased high-density lipoprotein cholesterol levels, and decreased insulin sensitivity is strongly associated with sedentary behavior (Tremblay, Colley, Saunders, Healy, & Owen, 2010). Results from a five-day bed rest study demonstrated significant increases in total cholesterol, plasma triglycerides, glucose, and a 67% greater insulin response to a glucose load after the intervention (Hamburg et al., 2007). In addition, evidence from Healy et al. (2008) found a 3.1 cm (95% CI 1.2–5.1) larger waist circumference with each 10% increase in sedentary time in physically active adults. Given the detrimental role sedentary behavior appears to play in the current obesity and diabetes epidemics, it is imperative to start looking at its determinants more closely (Owen, Healy, Matthews, & Dunstan, 2010).

Owen's (2011) ecological model of sedentary behavior is one of the few models that has thoroughly identified the factors that influence sedentarism. It is suggested that time spent in four sedentary domains (leisure time, household, occupation, transportation) will have distinct determinants that can help tailor more effective interventions. However, very few studies have examined the role of psycho-social variables in explaining sedentary behavior (Rhodes, Mark, & Temmel, 2012). Studies utilizing a social-cognitive theoretical framework (e.g. theory of planned behavior, Ajzen, 1985; transtheoretical model, Prochaska & DiClemente, 1982; protection motivation theory (PMT), Rogers, 1975) have been valuable in developing our understanding of the conscious, reasoned processes involved in health-related behavior adoption including physical activity and exercise (Plotnikoff, Lubans, Penfold, & Courneya, 2013). Consequently, the social-cognitive constructs that represent these theories can enhance our current lack of understanding of sedentarism, of which its absence in the literature has been commented in a systematic review, thus supporting the need for future research (Rhodes et al., 2012).

To date, only the theory of planned behavior (TPB; Ajzen, 1985) has examined the psycho-social context of sedentarism. In a recent study by Prapavessis, Gaston, and DeJesus (2015), findings revealed the tenability of a five factor TPB model, consistent with the theory. Other main findings include TPB items explaining 9–58% of the variance in intention with subjective norms being the strongest predictor, as well as 8–43% of the variance in behavior with intentions being the strongest predictor.

In light of Prapavessis et al.'s (2015) findings, it is likely that social-cognitive theories other than the TPB have the potential to enhance our understanding of sedentarism. The PMT is one of the major health psychology theories that has proven useful for gaining a better understanding of the conscious processes underlying the adoption of health-related behaviors such as physical activity (Plotnikoff et al., 2010). In the PMT model, Rogers (1975) proposes that two threat appraisal constructs (perceived severity and perceived vulnerability) and two coping appraisal constructs (response efficacy and

self-efficacy) lead to goal intention (i.e. protection motivation), and goal intention leads to the behavior. In brief, perceived severity (PS) assesses how serious an individual believes that the threat would be to his or her own life, perceived vulnerability (PV) assesses how susceptible an individual feels to the communicated threat, response efficacy (RE) assesses how effective an individual believes the coping response is in averting the threat, and self-efficacy (SE) assesses how confident an individual believes that he/she can perform the coping response (Milne, Sheeran, & Orbell, 2000; Plotnikoff et al., 2010).

In addition to examining the threat and coping appraisals, some researchers have modified the PMT framework to include a post-intentional process, implementation intention (Gaston & Prapavessis, 2009). While goal intention measures one's intention to perform a future behavior, implementation intention allows one to switch from conscious and effortful control to being automatically controlled by a selected situational cue (Gollwitzer, 1999). Thus, it is subordinate to goal intentions and follows the structure, "When situation ***x*** arises, I will perform response ***y***." The addition of implementation intention has proved to be beneficial by improving the initiation and performance of health behaviors (Milne, Orbell, & Sheeran, 2002). Hence, we deemed it useful to add implementation intention to the PMT model, summarized in Figure 1.

Despite the wide application of PMT to various health and safety-related behaviors, PMT has not been used to predict sedentary behavior. Unlike other social-cognitive theories, PMT can identify the role of threat and coping perceptions in one's intentions to decrease sedentary behavior and in turn, actual sedentary time. Considering the deleterious and extensive consequences of sedentarism, a PMT model grounded in fear appeals may be an important route in enhancing our current understanding of sedentarism. With this understanding, current and future studies can be better informed on designing more efficacious interventions given the added value theoretical interventions have over atheoretical interventions in changing health behaviors (Plotnikoff et al., 2010). These findings can also provide researchers with a reliable, validated, and theoretically based instrument to measure sedentary cognitions.

The purpose of this study is to: (1) examine the factor structure and composition of sedentary-derived PMT constructs and (2) determine whether general and leisure PMT models can predict sedentary goal intention, implementation intention, and behavior in university students. University students represent an ideal population for studying sedentary behavior and cognitions for several reasons. First, research has shown that

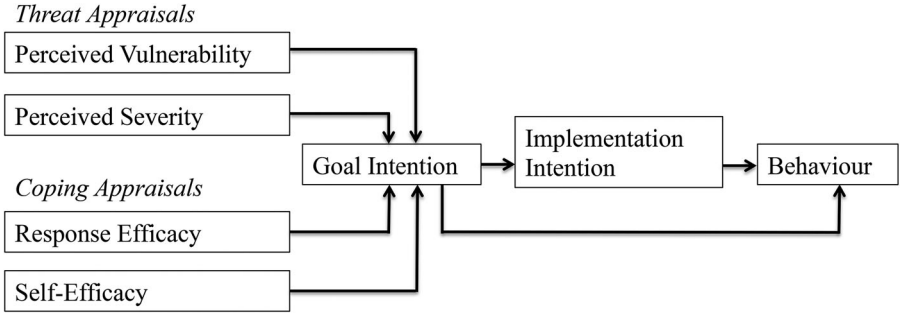

Figure 1. Conceptual model of the modified protection motivation theory.

undergraduate students report high levels of sedentariness, averaging more than 12 hours of sedentary behavior per day (Prapavessis et al., 2015). Second, the transition to university is a life event associated with a steep decrease in physical activity among young men and women (Kwan, Cairney, Faulkner, & Pullenayegum, 2012).

The general model combined volitional (i.e. leisure or recreational) and less-volitional (i.e. work or school) activities whereas the leisure model only measured volitional activities. It was hypothesized that the volitional model would perform better than the general model as PMT was designed to predict and explain human behavior in specific contexts. Irrespective of model type, we also hypothesized that: (1) the two coping appraisals (RE and SE) will contribute to greater variance in goal intention than the two threat appraisals (PS and PV), (2) goal intention and the four PMT variables will explain unique variance in implementation intention, but the former will contribute to greater variance than the latter four, (3) both goal intention and implementation intention will directly explain variance in behavior but the latter will contribute to greater variance than the former, and (4) the four PMT constructs will explain implementation intention and behavior through goal intention, and goal intention will explain behavior through implementation intention.

Methods

Participants

Participants represented a convenience sample of university students ($n = 787$). Inclusion criteria was as follows: (1) aged 18–35 years, (2) able to read and understand English, and (3) had Internet access. Exclusion criteria included suffering from a medical condition or physical limitation that prevented them from being physically active. Incomplete or implausible data were removed from the study.

Instruments

Modified PMT questionnaire

A 34-item PMT questionnaire derived from an existing PMT scale for physical activity measured the two threat appraisals (PV, PS), two coping appraisals (RE, SE) and two intention items (goal intention, implementation intention) for sedentary behavior (Gaston & Prapavessis, 2009). Only PV, PS, RE, and SE items were tested for factor structure and composition.

Threat term

Metabolic deterioration was selected as the threat term and defined as the following which was included in the stem for the PV, PS, and RE items:

> When you see "metabolic deterioration" in the following questions, this refers to problems with chemical reactions in the body, specifically (1) Problems with insulin. Insulin is a hormone that lowers glucose levels (a type of sugar) in the blood. When there are problems with insulin, glucose cannot easily enter the body's cells. This means blood sugar levels go up and can remain high. This can lead to serious damage to the heart, kidneys, eyes, and feet, (2) Increases in fat around the stomach region. This can lead to type 2 diabetes, high blood pressure, and heart disease, and (3) Higher levels of fat in the bloodstream. This can lead to diseases of the heart.

This definition is supported by the literature including systematic reviews (Hamburg et al., 2007; Proper, Singh, Van Mechelen, & Chinapaw, 2011; Saunders, Larouche, Colley, & Tremblay, 2012; Thyfault & Krogh-Madsen, 2011), as well as findings from a focus group that was conducted prior to the study to determine the relevancy of the threat to the sample age group. The reading level for this definition (grade 6.6) was suitable for the general population based on guidelines outlined by DeVellis (2012) and the Flesch grade level readability formula (http://readibility-score.com, 2015).

Threat appraisals

PV was assessed by five 7-point items and PS was assessed by four 7-point items (1 = strongly disagree to 7 = strongly agree), commonly used in the PMT literature (Courneya & Hellsten, 2001). Example items included, "I feel vulnerable to developing metabolic deterioration" (PV) and "I feel metabolic deterioration is a serious health condition" (PS).

Coping appraisals

RE was assessed by four 7-point items (1 = strongly disagree to 7 = strongly agree). For example, "I feel that sitting less would help me reduce my risk of developing metabolic deterioration."

SE was assessed prospectively by 15 items rated on a scale from 0% (not at all confident) to 100% (completely confident). Specifically, one's confidence about scheduling a break from sitting (e.g. standing or doing some light activity) every two hours in the face of common challenges to decrease sitting – a type of self-regulatory efficacy – was assessed. Scheduling challenges consisted of psychological and situational events where people have difficulty sitting less. Each SE item was assessed in three durations of break time (1–5 minutes, 6–10 minutes, 11–15 minutes) similar to the SE Scale, which assessed confidence about exercising in increasing durations (McAuley & Mihalko, 1998). Although task SE is traditionally used in PMT, scheduling SE was determined to be the most appropriate assessment because of the little variation that would arise from assessing one's confidence to perform the basic motor skills of "not sitting."

Scheduling SE was categorized into three psychological subcategories (productivity, focused, tired) and two situational subcategories (studying, screen time leisure; Chastin, Fitzpatrick, Andrews, & DiCroce, 2014; Greenwood-Hickman, Renz, & Rosenberg, 2015). Each subcategory was measured by three items, totaling to nine psychological items and six situational items. Sample items for psychological events were: "when you are productive doing your work, how confident are you in scheduling a break from sitting every two hours for a duration of … " (productivity), "when you are very focused (i.e. "in the zone") how confident are you in scheduling a break from sitting every two hours for a duration of … " (focused) and "when you are feeling worn out, how confident are you in scheduling a break from sitting every two hours for a duration of … " (tired). Sample items for situational events were: "when you are studying in the library, how confident are you in scheduling a break from sitting every two hours for a duration of … " (studying) and "when you are watching TV or playing video games how confident are you in scheduling a break from sitting every two hours for a duration of … " (screen time leisure).

Goal intention

Intentional goals for sitting time were assessed using three items adapted from Graham, Prapavessis, and Cameron (2006), which exhibited adequate reliability ($\alpha = 0.81$). Items were rated on the same scale as the Sedentary Behavior Questionnaire (SBQ; Rosenberg et al., 2010) with extended responses (i.e. 10 h, 11 h, 12 h … 18 h) similar to the intention items from the TPB questionnaire (Prapavessis et al., 2015). A sample item was, "How much time do you expect to spend sitting over the next week." A neutral goal intention measure (i.e. intentional goals for sitting time, but not for sitting less) was used due to the phenomenon of mere measurement effect (Morwitz, Johnson, & Schmittlein, 1993).

Implementation intention

Implementation intention was assessed using three items adapted from Norman, Boer, and Seydel (2005). Participants were asked whether they knew when, where, and what they can do to sit less over the next week. Responses were rated on a 7-point scale (1 = strongly disagree to 7 = strongly agree). A sample item was, "I know what I can do to sit less on a typical day over the next week."

Sedentary Behavior Questionnaire

The modified 12-item SBQ measured the quantity of time spent sitting on a typical day over the previous week. The SBQ was a separate survey that was completed one week following the PMT questionnaire to correspond with the future-tense time frames of scheduling SE, goal intention and implementation intention. Thus, the stem of the SBQ (" … how much time did you spend doing the following this past week") matched the time frame of goal intention and implementation intention (" … over the past week"). The same modifications Prapavessis et al. (2015) made to the SBQ (i.e. addition of three items, expended response items) were also employed in the current study. A sample item was, "On a typical day, how much time did you spend (from when you wake up until you go to bed watching TV) sitting and watching TV." Seven items assessed leisure-specific, volitional sedentary activities: watching TV, using the computer for recreational purposes, listening to music, reading for pleasure, doing arts and crafts, driving/riding in a motor vehicle for leisure-related transportation purposes, socializing/visiting or non-work related phone conversations. The leisure-specific model computed an average daily score from the seven leisure-specific, volitional items, whereas the general model computed an average daily score from all 12 items.

Leisure Score Index

Exercise behavior was assessed using the Leisure Score Index (LSI) of the Leisure Time Exercise Questionnaire (Godin & Shephard, 1985). The LSI is a four-item assessment that measures intensity and frequency of physical activity. Participants were asked to estimate the number of strenuous, moderate, and mild exercises that lasted over 15 minutes from the past seven days. The frequency of each intensity level was multiplied by the respective metabolic equivalents (METs) for the activities (9 for strenuous, 5 for moderate, 3 for mild) to obtain three activity scores (Jacobs, Ainsworth, Hartman, & Leon, 1993). Jacobs et al. (1993) have shown the LSI to exhibit acceptable test-retest reliability and concurrent validity (correlates with objective measures such as CALTRAC accelerometer and VO_2 max).

Procedure

Ethical approval was granted by the Research Ethics Board at the host university prior to commencing the study. Random sampling was not possible due to restrictions upon receiving contact information for all students enrolled in the university. Thus, recruitment was accomplished by contacting 22 professors from different faculties and asking for their permission to invite their students to participate in the study. Twelve professors agreed and male and female undergraduate students were recruited through an in-class, in-person invitation by the primary investigator to participate in a two-part online survey. Participation was voluntary, anonymity was preserved, and compensation was granted (chance to win 1 out of 5 $100 gift cards to a grocery store). The study information as well as the survey link was posted on the course website for students to complete outside of class time. On the first survey link, participants were directed to the letter of information, asked to provide informed consent before proceeding to the questionnaire package. The questionnaire package included socio-demographics (gender, age, ethnicity, level of education, employment, height and weight, and medical conditions), the LSI, and modified PMT questionnaire. Upon completion of the modified PMT questionnaire (PS, PV, RE, SE), participants were randomized to two models (general, leisure) through an internal computer-generated randomization scheme (via Survey Monkey) when completing the goal intention and implementation intention items. The stem of the general and leisure model included specific sedentary contexts taken directly from the SBQ to ensure correspondence between behavioral and cognitive measures (Ajzen, 2002). At the end of the first survey, participants were asked to enter their email address in order to receive the link to the second survey one week later. Participants were emailed the second survey link one week later, which included the modified SBQ. This ensured that the temporal sequence (PMT cognitions were assessed prior to sedentary behavior) of assessment was in line with the proposed model being tested, as recommended by Prapavessis et al. (2015). Completion of both surveys signified the end of their involvement in the study.

Statistical analysis

ANOVA and chi-square analyses were used to examine group equivalency with respect to demographic characteristics and LSI scores between participants with complete and incomplete data.

The sedentary-derived PMT items were subjected to psychometric analysis. Using an online computer randomization generator, participants who provided complete PMT data were randomized into exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) groups. EFA was conducted first because EFA is usually conducted during the early stages of scale development and testing and sedentary-derived PMT constructs have not been tested before (Schutz & Gessaroli, 1993).

Prior to performing EFA, the data were inspected for factorability (suitability for factor analysis) based on correlations ($r > .30$; Tabachnick and Fidell, 2013), Bartlett's test of sphericity ($p < .05$; Bartlett, 1954), and the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO; >.50; Kaiser, 1970, 1974). Unique factors were extracted using principal factor analysis based on eigenvalues (>1; Kaiser, 1970), visual inspection of Catell's scree test (Catell, 1966), and pattern matrix loadings. Factors were rotated with oblique

Table 1. Pearson correlations for the modified protection motivation theory variables and sedentary behavior.

Variable	*n*	Mean	SD	2	3	4	5	6	7	8	9	10	11
Model 1 (general)													
1. Perceived severity	496	5.92	1.13	.01	.13**	.14**	.09	.03	.09	.08	−.05	.01	−.02
2. Perceived vulnerability	496	3.01	1.25	–	.02	−.17**	−.18**	−.11*	−.13**	−.14**	.09	−.19**	.11
3. Response efficacy	496	5.11	1.02		–	.04	.05	.09	.13**	.06	−.16*	.25**	.02
4. SE – tired	496	68.13	29.49			–	.41**	.35**	.47**	.43**	.04	.06	−.08
5. SE – productive/focused	496	59.69	27.23				–	.47**	.71**	.67**	−.05	.21**	−.13*
6. SE – TV/VG/computer	496	58.23	30.43					–	.39**	.46**	.03	.14*	−.09
7. SE – Studying at home	496	73.47	25.33						–	.59**	−.12	.07	−.03
8. SE – studying in library and Wi-Fi area	496	52.99	27.63							–	−.10	.12	−.14*
9. Goal intention	237	8.68	3.77								–	.01	.13
10. Implementation intention	236	5.33	1.22									–	−.06
11. Sedentary behavior	236	13.71	4.92										
Model 2 (leisure)													
1. Perceived severity	496	5.92	1.13	.01	.13**	.14**	.09	.03	.09	.08	.04	.14*	.03
2. Perceived vulnerability	496	3.01	1.25	–	.02	−.17**	−.18**	−.11*	−.13**	−.14**	−.00	−.26**	.12*
3. Response efficacy	496	5.11	1.02		–	.04	.05	.09	.13**	.06	−.05	.24**	−.01
4. SE – tired	496	68.13	29.49			–	.41**	.35**	.47**	.43**	−.07	.09	−.08
5. SE – productive/focused	496	59.69	27.23				–	.47**	.71**	.67**	−.10	.21**	−.10
6. SE – TV/VG/computer	496	58.23	30.43					–	.39**	.46**	.03	.07	−.13*
7. SE – studying at home	496	73.47	25.33						–	.59**	−.14*	.24**	−.11
8. SE – studying in library and Wi-Fi area	496	52.99	27.63							–	−.00	.23**	−.11*
9. Goal intention	253	7.92	3.66								–	−.07	.20*
10. Implementation intention	252	5.38	1.27									–	−.07
11. Sedentary behavior	297	8.16	5.51										

Note: SE, self-efficacy; VG, video games.
*$p < .05$.
**$p < .01$.

Table 2. Linear regression analyses predicting goal intention.

Variable	Model 1 (general) (n = 237 GI; 496 PMT)		Model 2 (leisure) (n = 253 GI; 496 PMT)	
	B (SE *B*)	β	*B* (SE *B*)	β
Perceived severity	−.11 (.22)	−.03	.20 (.21)	.06
Perceived vulnerability	.33 (.20)	.11	−.07 (.19)	−.02
Response efficacy	−.59 (.24)**	−.16	−.16 (.23)	−.05
SE – tired	.02 (.01)	.14	−.01 (.01)	−.05
SE – productive/focused	.02 (.01)	−.14	−.01 (.01)	−.11
SE – TV/VG/computer	.01 (.01)	.08	.01 (.01)	−.10
SE – studying at home	−.03 (.01)*	−.21	−.02 (.01)	−.16
SE – studying in library and Wi-Fi area	−.02 (.01)	.14	.02 (.01)	.14
Adjusted R^2	.05*		.01	
ΔF (df1, df2)	2.41 (8228)		1.40 (8244)	

Note: Only PMT variables which were significantly correlated with intention were entered in each regression model.
*$p < .05$.
**$p < .01$.
***$p < .001$; SE, self-efficacy; VG, video games.

Table 3. Hierarchical linear regression analyses predicting implementation intention.

Variable	Model 1 (general) (n = 236 II; 237 GI; PMT 496)		Model 2 (leisure) (n = 252 II; 253 GI; 496 PMT)	
	B (SE *B*)	*β*	*B* (SE *B*)	*β*
Step 1				
Goal intention	.00 (.02)	.01	−.02 (.02)	−.07
Adjusted R^2	−.00		.00	
ΔR^2	.00		.01	
ΔF (df1, df2)	.02 (1234)		1.25 (1250)	
Step 2				
Goal intention	.02 (.02)	.06	−.02 (.02)	−.07
Perceived severity	−.02 (.07)	−.02	.12 (.07)	.11
Perceived vulnerability	−.18 (.06)***	−.18	−.25 (.06)***	−.25
Response efficacy	.28 (.08)***	.24	.27 (.07)***	.22
SE – tired	−.00 (.00)	−.04	−.00 (.00)	−.09
SE – productive/focused	.01 (.01)*	.24	−.00 (.00)	−.03
SE – TV/VG/computer	.00 (.00)	.07	−.00 (.00)	−.06
SE – studying at home	−.01 (.01)	−.13	.01 (.00)*	.18
SE – studying in library and Wi-Fi area	−.00 (.00)	−.03	.01 (.00)	.15
Adjusted R^2	.10***		.16***	
ΔR^2	.14***		.19***	
ΔF (df1, df2)	4.54 (8226)		6.98 (8242)	

Note: Only PMT variables which were significantly correlated with intention were entered in each regression model.
*$p < .05$.
**$p < .01$.
***$p < .001$; SE, self-efficacy; VG, video games.

rotation (Direct oblimin method) because constructs were assumed to be related. The reliability of the items that deemed to be one factor was assessed by Cronbach's alpha in order to measure each scale's internal consistency.

CFA was performed on the factors that emerged from EFA from the second half of the data set. Items were restricted to load on their corresponding factor, latent factors were not allowed to correlate with other latent factors, and the errors of measurement associated with each observed variable were allowed to be correlated. Model fit was assessed using chi-square (χ^2) test, Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), Normed Fit Index (NFI), Incremental Fit Index (IFI), and chi-square/degree of freedom ratio (CMIN/DF). AMOS was used to conduct all CFAs in

Table 4. Hierarchical linear regression analyses predicting sedentary behavior.

	Model 1 (general) ($n = 236$ SB,II; 237 GI; 496 PMT)		Model 2 (leisure) ($n = 297$ SB; 252 II; 253 GI; 496 PMT)	
Variable	*B* (SE *B*)	*β*	*B* (SE *B*)	*β*
Step 1				
Implementation intention	−.25 (.39)	−.06	−.29 (.35)	−.07
Adjusted R^2	−.01		−.00	
ΔR^2	.00		.01	
ΔF (df1, df2)	.42 (1107)		.70 (1153)	
Step 2				
Implementation intention	−.26 (.39)	−.06	−.23 (.35)	−.05
Goal intention	.17 (.13)	.13	.30 (.12)**	.20
Adjusted R^2	.00		.03**	
ΔR^2	.02		.04**	
ΔF (df1, df2)	1.78 (1106)		6.28 (1152)	
Step 3				
Implementation intention	−.13 (.42)	−.03	−.07 (.39)	−.02
Goal intention	.19 (.13)	.14	.31 (.12)**	.21
Perceived severity	−.04 (.44)	0.01	.15 (.40)	.03
Perceived vulnerability	.23 (.41)	.06	.43 (.38)	.10
Response efficacy	.33 (.50)	.07	.00 (.45)	.00
SE – tired	−.01 (.02)	−.05	.00 (.02)	.00
SE – productive/focused	−.03 (.03)	−.16	.01 (.03)	.06
SE – TV/VG/computer	−.01 (.02)	−.03	−.02 (.02)	−.11
SE – studying at home	.04 (.03)	.19	−.01 (.03)	−.03
SE – studying in library and Wi-Fi area	−.02 (.03)	−.09	−.02 (.02)	−.08
Adjusted R^2	−.03		.01	
ΔR^2	.04		.03	
ΔF (df1, df2)	.54 (8,98)		.59 (8, 144)	

Note: Only PMT variables which were significantly correlated with intention were entered in each regression model.
*$p < .05$.
**$p < .01$.
***$p < .001$; SE, self-efficacy; VG, video games.

this study. According to Kenny's (2014) recommendations for evaluating fit scores, CFI, IFI and NFI >.9 was considered marginal fit, RMSEA <.08 was considered mediocre fit, and CMIN/DF > 3.0 was considered acceptable fit (Carmines & McIver, 1981).

Pearson bivariate correlations were used to examine relationships between the four PMT constructs and sedentary behavior. After ensuring there was no violation of the assumptions of normality, linearity, homoscedasticity, and multicollinearity, the PMT constructs significantly related to goal intention were entered in a linear regression model (see Table 2). Items that were significantly related to implementation intention were entered in a hierarchical linear regression model with goal intention entered in step 1, and the PMT constructs entered at step 2 (see Table 3). Finally, items that were significantly related to sedentary behavior were entered in a hierarchical linear regression model with implementation intention entered in step 1, goal intention entered in step 2, and the PMT constructs entered in step 3 (see Table 4). Each regression model was assessed by the R^2, adjusted R^2, R^2 change, and the standardized beta (β) associated with each individual construct. The fit of the general and leisure models was compared using Fisher's Z which was computed using Garbin's (n.d.) FZT.exe program.

As proposed by the modified model (Figure 1), two mediation analyses, the Sobel test and bootstrapped sampling distribution (Preacher & Hayes, 2004) computed the indirect effect of the three relationships: (1) PMT constructs on implementation intention through goal intention, (2) PMT constructs on sedentary behavior through goal intention, and (3)

goal intention on sedentary behavior through implementation intention. A significant indirect effect is represented by a significant Sobel test ($p < .05$, two-tailed), or when the 95% confidence interval (CI) derived from 1000 bootstrap resamples do not cross zero. The level of significance was at $p < .05$ for all statistical analyses.

Missing data

Out of the 787 students who responded to survey #1, 615 students finished the survey (students could complete the survey even if some questions were incomplete). A total of 191 students were excluded due to incomplete data ($n = 190$) and not within the age range ($n = 1$). Out of the 431 students who responded to survey #2, 411 students finished the survey. A total of 124 students were excluded due to incomplete data ($n = 20$) and implausible data (reported sedentary response times as >24 hours; $n = 104$). Fifty-six participants who reported suffering from a medical condition were removed only for the predictability analyses (i.e. linear regression, hierarchical linear regression). Therefore, 596 participants who provided complete PMT data were analyzed for factor analysis. See Figure 2 for the flow of participants.

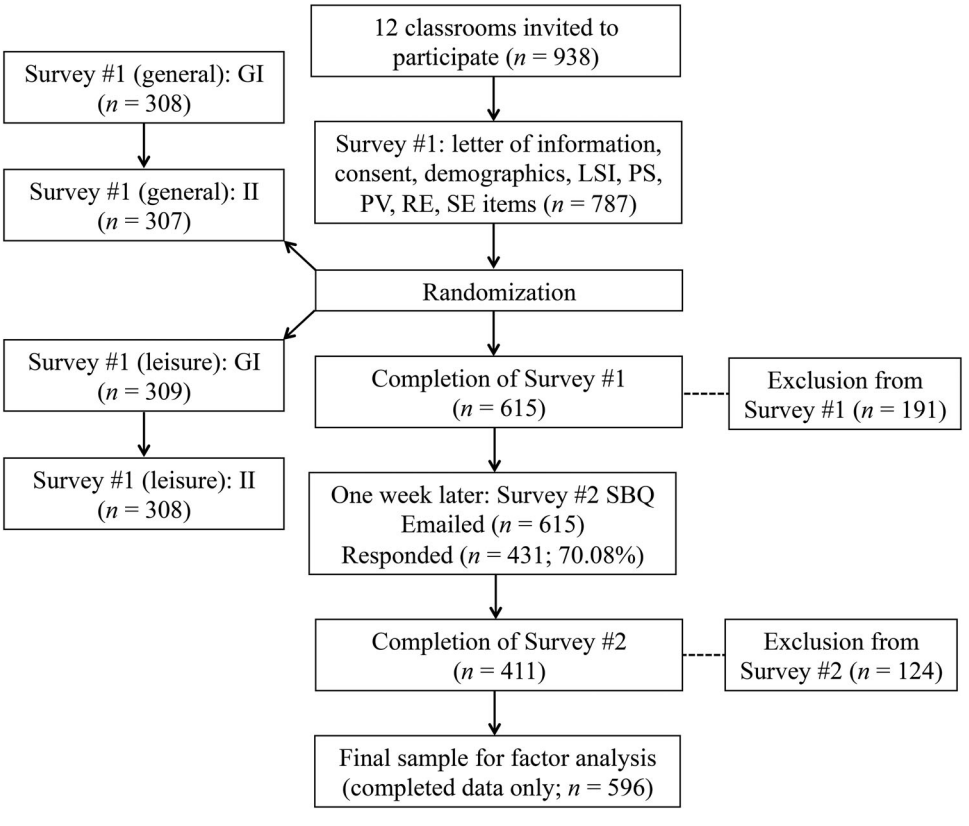

Figure 2. Flow of participants. Note: LSI, Leisure Score Index, PS, perceived severity, PV, perceived vulnerability, RE, response efficacy, SE, self-efficacy, GI, goal intention, II, implementation intention, SBQ, Sedentary Behavior Questionnaire.

Results

Group equivalency

One-way ANOVAs revealed a significant difference between complete and incomplete data for age, $F(1, 721) = 6.74$, $p = .01$, however, the mean age between the two groups were very similar (19.49 (SD = 1.79) complete; 18.84 (2.03) incomplete). There were no significant differences between complete and incomplete data for strenuous LSI score, moderate LSI score, light LSI score, weekly leisure activity score, BMI, and gender.

Psychometric analysis

Inspection of the correlation matrix revealed the presence of all coefficients of .3 and above for both models. The KMO value was .88 (general) and .89 (leisure), exceeding the recommended value of .6 (Kaiser, 1970, 1974). Bartlett's Test of Sphercity (Barlett, 1954) reached statistical significance ($p < .00$) for both models, supporting the factorability of the correlation matrix. After examining the pattern matrices, the criteria for the factor loadings included: (1) primary loading > .58, (2) secondary loading < .3, and (3) minimum of two items were required to load onto each factor. Principal axis factor analysis with oblique rotation revealed the presence of nine factors. However, one of the factors (scheduling SE cellphone) was excluded because the secondary loadings were greater than .3. Thus, a total of eight factors emerged: PV, PS, RE, scheduling SE tired, scheduling SE productive/focused, scheduling SE TV/videogames/computer, scheduling SE studying at home, scheduling SE studying in a Wi-Fi area/library.

The CFA results from an eight-factor PMT model revealed the following fit index scores: χ^2 (845) = 2313.130, $p = .000$; RMSEA = .079 (90% CI = .075–.083), CFI = .915, IFI = .916, NFI = .874, CMIN/DF = 2.737.

Bivariate Pearson correlations are presented in Table 1. In the general model, scheduling SE productive/focused and scheduling SE studying in library/Wi-Fi area were significantly related to sedentary behavior. In the leisure model, PV, scheduling SE TV/video games/computer, scheduling SE studying in library/Wi-Fi and goal intention were significantly related to sedentary behavior.

Linear regression analyses

Linear regression analyses of each model are presented in Tables 2–4. For goal intention, 5% and 1% of the variance was explained in the general and leisure model, respectively. RE and scheduling SE studying at home were significant contributors for the general model only. For implementation intention, 10% and 16% of the variance was explained in the general and leisure model, respectively. In the general model, PV, RE, and scheduling SE productive/focused were significant contributors. For the leisure model, PV, RE, and scheduling SE studying at home were significant contributors. For sedentary behavior, 3% and 1% of the variance was explained in the general and leisure model, respectively. Goal intention was a significant contributor in the leisure model only.

Fisher's Z. Post hoc analysis using Fisher's Z (Garbin, n.d.) revealed no significant difference between the two models (goal intention, $Z = .819$, $p = .413$; implementation intention, $Z = .867$, $p = .386$; sedentary behavior $Z = .294$, $p = .767$).

Table 5. Mediation analyses examining the indirect effect of PMT constructs on sedentary intention and behavior.

	Sobel test				95% CI for bootstrap indirect effect		
Model	Value	SE	*z*	*p*-value	Mean	SE	LL 95% CI
Model 1 (general)							
PV → Goal Intention → SB	0.09	0.09	0.95	0.34	0.08	0.10	−0.10, 0.28
PS → Goal Intention → SB	−0.03	0.06	−0.48	0.63	−0.02	0.06	−0.15, 0.12
RE → Goal Intention → SB	−0.08	0.09	−0.87	0.38	−0.07	0.08	−0.27, 0.07
Prod/Foc → Goal Intention → SB	0.00	0.00	0.63	0.53	0.00	0.00	−0.00, 0.09
Tired → Goal Intention → SB	0.06	0.00	1.23	0.22	0.00	0.00	−0.00, 0.01
TV/VG/Comp → Goal Intention → SB	−0.00	0.00	0.60	0.55	0.00	0.00	−0.00, 0.01
Study Library → Goal Intention → SB	0.00	0.00	0.49	0.63	0.00	0.00	−0.00, 0.01
Study Home → Goal Intention → SB	0.00	0.00	1.05	0.29	0.00	0.00	−0.00, 0.01
PS → Goal Intention → Imp Intention	−0.00	−.00	−0.16	0.87	−0.00	0.01	−0.01, 0.01
PV → Goal Intention → Imp Intention	0.00	0.00	0.34	0.73	0.00	0.01	−0.01, 0.02
RE → Goal Intention → Imp Intention	−0.09	0.01	−0.72	0.47	−0.01	−.01	−0.04, 0.01
Prod/Foc → Goal Intention → Imp Intention	0.00	0.00	−0.12	0.90	0.00	0.00	−0.00, 0.00
Tired → Goal Intention → Imp Intention	0.00	0.00	0.09	0.93	0.00	0.00	−0.00, 0.00
TV/VG/Comp → Goal Intention → Imp Intention	0.00	0.00	0.03	0.98	0.00	0.00	−0.00, 0.00
Study Library → Goal Intention → Imp Intention	0.00	0.00	−0.17	0.86	0.00	0.00	−0.00, 0.00
Study Home → Goal Intention → Imp Intention	−0.00	0.00	−0.20	0.84	0.00	0.00	−0.00, 0.00
Goal Intention → Imp Intention → SB	−0.02	0.02	−0.78	0.43	−0.01	0.02	−0.06, 0.23
Model 2 (leisure)							
PV → Goal Intention → SB	0.00	0.08	0.07	0.95	0.00	0.08	−0.16, 0.16
PS → Goal Intention → SB	0.13	0.11	1.11	0.27	0.12	0.11	−0.08, 0.37
RE → Goal Intention → SB	0.04	0.10	0.38	0.71	0.04	0.10	−0.17, 0.24
Prod/Foc → Goal Intention → SB	−0.00	0.00	−0.98	0.33	−0.00	0.00	−0.01, 0.00
Tired → Goal Intention → SB	−0.00	0.00	−1.06	0.29	−0.00	0.00	−0.01, 0.00
TV/VG/Comp → Goal Intention → SB	−0.00	0.00	−0.40	0.69	−0.00	0.00	−0.01, 0.01
Study Library → Goal Intention → SB	0.00	0.00	0.27	0.79	0.00	0.00	−0.01, 0.01
Study Home → Goal Intention → SB	−0.00	0.00	−1.14	0.26	−0.00	0.00	−0.02, 0.00
PV → Goal Intention → Imp Intention	−0.00	0.01	−0.34	0.73	−0.00	0.00	−0.01, 0.01
PS → Goal Intention → Imp Intention	−0.00	0.01	−0.38	0.70	−0.00	0.00	−0.02, 0.01
RE → Goal Intention → Imp Intention	0.00	0.01	0.34	0.74	0.00	0.01	−0.01, 0.02
Prod/Foc → Goal Intention → Imp Intention	0.00	0.00	0.37	0.71	0.00	0.00	−0.00, 0.00
Tired → Goal Intention → Imp Intention	0.00	0.00	0.49	0.62	0.00	0.00	−0.00, 0.00
TV/VG/Comp → Goal Intention → Imp Intention	0.00	0.00	−0.14	0.89	0.00	0.00	−0.00, 0.00
Study Home → Goal Intention → Imp Intention	0.00	0.00	0.37	0.71	0.00	0.00	−0.00, 0.00
Study Library → Goal Intention → Imp Intention	0.00	0.00	0.30	0.76	0.00	0.00	−0.00, 0.00
Goal Intention → Imp Intention → SB	−0.00	0.01	−0.10	0.92	−0.00	0.02	−0.03, 0.04

Note: PV, perceived vulnerability; PS, perceived severity; RE, response efficacy; Prod/Foc, productive/focused; VG, video games; Comp, computer; SB, sedentary behavior; Imp Intention, implementation intention.

Mediation analyses

The results of the Sobel tests and bootstrapped sampling distributions are presented in Table 5. There was virtually no support for significant indirect effects.

Discussion

Exploratory followed by CFA findings support the tenability of an eight-factor PMT sedentary model representing PV, PS, RE, and five scheduling SE constructs (tired, productive/focused, TV/video games/computer, studying at home, studying in library/Wi-Fi area). All constructs demonstrated a high degree of internal consistency. Moderate-to-strong evidence was found for the prediction of implementation intention (Table 3)

whereas weaker evidence was found for the prediction of goal intention (Table 2) and sedentary behavior (Table 4). Specifically, 10% and 16% of the variance in implementation intention was explained in the general and leisure model, respectively. In contrast, the models only explained 1–5% of the variance in goal intention and 1–3% of variance in sedentary behavior. This study provides theoretical inroads for the PMT. The addition of implementation intention, the substitution of task SE with scheduling SE, the expansion of scheduling SE into psychological and situational events, and the assessment of scheduling SE items through ascending durations of break time (1–5 minutes, 6–10 minutes, 11–15 minutes) further develops the traditional PMT framework and may increase the effectiveness in engendering sedentary behavior change for future interventions.

Hypothesis 1 was supported, in that the coping appraisals (RE, SE) contributed to greater variance in goal intention than the threat appraisals (see Table 2). Specifically, RE and scheduling SE studying at home were significant and salient independent contributors to goal intention ($\beta = -.16, -.21$, respectively) in the general model. It appears that increases in the endorsement of sitting less to reduce the risk of metabolic deterioration is associated with concomitant decreases in intention to engage in sitting. It also appears that scheduling breaks from sitting while studying at home may be an optimal context in which students may feel more in control to reduce their sedentary behavior intentions, as opposed to studying in the library or Wi-Fi area where social norms may play a larger role. These findings are in line with the Milne et al.'s (2000) meta-analysis on PMT research. They reported that overall, coping variables were more strongly and consistently associated with goal intention than threat appraisal variables.

Hypothesis 2 was partially supported as the PMT constructs of PV and RE but not goal intention made significant and unique contributions to the prediction of implementation intentions in both general and leisure models (see Table 3). Pearson correlation findings also indicated no significant relationship between goal intention and implementation intention. It is possible that the difference in the sedentary goals between the two intentions constructs explains this non-significant relationship (Gollwitzer, 1999). Goal intention measured the expected amount of time one would sit over the next week, whereas implementation intention measured when, where, and how one would sit *less* over the next week. Goal intention may have led to stronger associations with implementation intention if it assessed goal intentions to sit *less*, but our study was merely understanding individuals' current sedentary cognitions, not aiming to decrease individuals' sitting time. As well, goal intention was measured temporally (i.e. none, 15 min, 30 min, 1 h … etc.) whereas implementation intention was measured on a 7-point Likert scale of agreement. Future studies should try to maximize the scale correspondence between these two intention constructs. Overall these implementation intention findings are encouraging because this construct is the closest proxy to sedentary behavior and has the most tangible application for future interventions (i.e. identifying when, where, and how to sit less).

Hypothesis 3 was only partially supported as goal intention explained a statistically significant amount of the variance in sedentary behavior in the leisure model only (see Table 4). Implementation intention did not explain more variance than goal intention in either model. In contrast to our findings, Prapavessis et al. (2015) found sedentary goal intention to explain greater variance in sedentary behavior (2–36%). This is likely attributable to the short time interval between the assessment of intentions and behavior in the Prapavessis et al. (2015) study. Participants completed the SBQ on the same day prior to the TPB

questionnaire, possibly reflecting on their sitting time right before their TPB cognitions. In the present study, sedentary behavior was assessed one week after participants completed the PMT questionnaire. It is suggested that the strength of association between intention and behavior diminishes as the time interval between intention and behavior increases, because intention becomes more malleable to new information (Conner, Sheeran, Norman, & Armitage, 2000). This is further supported by evidence from Milne et al. (2000) who found intention to have the strongest and most consistent association with concurrent behavior, in comparison to only medium to strong correlations for subsequent behavior. In short, the one-week lapse may have weakened the association between sedentary intention and behavior in the present study.

There are plausible explanations for why implementation intention performed so poorly in predicting sedentary behavior. Our sample of university students (M_{age} = 19.44 years, SD = 1.81) was considerably younger than Prapavessis et al. (2015) sample of working professionals, summer and graduate students (M_{age} = 39.93 years, SD = 12.69). University students have varying durations of class time per day and as well as possible extracurricular commitments, likely weakening the association between implementation intention and behavior. Thus, it may have been more difficult for students to plan when, where, and how they would sit less during the upcoming week in comparison to working professionals who may have a routine and fixed 9 am to 5 pm work schedule each day. Second, action initiation may have been too easy to begin with (i.e. sitting less on a typical day), and thus, automatization through implementation intention may not have produced an additional advantage. Furthermore, the lack of rigid adherence to plans (i.e. high commitment) was not surprising to see since the study assessed (but not did manipulate) students' current perceptions on sedentary behavior (Gollwitzer, 1999). It is also suggested that while specific plans may facilitate the quick and accurate identification of cues to action, vague plans allow for flexibility in the event that specific cues are not identified or missed (Mistry, Sweet, Rhodes, & Latimer-Cheung, 2015). Unlike other health behaviors (e.g. physical activity, smoking cessation) that require conscious thought and planning, sedentary behavior is much more pervasive and habitual, indicating that general planning may be more suitable. For example, general plans to stand up while taking the bus may be more beneficial than forming specific plans to stand up while taking the bus on Monday, Wednesday, and Friday. Creating restrictions on exactly when to decrease sedentary behavior may actually make the execution more complicated and harder to remember because it happens so frequently. However, very few studies have tested the effects of vague plans relative to specific plans (Mistry et al., 2015; de Vet, Oenema, & Brug, 2011). Another explanation may be that the situational cues in the stem of the intention items needed to be more specific to the SBQ in order to prompt heightened recognition and activation that typically occurs during implementation intention. For example, rather than using the stem, "for personal, leisure, or recreational pursuits" in the leisure model, an alternative such as, "when watching TV, on the computer for recreational purposes, reading for pleasure, listening to music, doing arts and crafts, in a motor vehicle for leisure-related transportation purposes, or socializing for non-work related phone conversations" may have lead to stronger associations. A final explanation is that the implementation intention construct was not congruent with the behavior construct. For instance, the former used a Likert scale while the latter used a temporal scale. Previous physical activity research has shown the intention-behavior relationship to be

stronger when there is scale congruence between the measures (Courneya & McAuley, 1995; Maddison & Prapavessis, 2004).

There was no support for mediation (Hypothesis 4) in the present study. The Sobel test and bootstrapping procedure indicated no significant indirect relationships in either model between (a) PMT and implementation intentions via goal intentions (b) PMT and behavior via goal intentions, and (c) goal intention and sedentary behavior via implementation intention. The lack of mediation findings were inconsistent with those reported by Prapavessis et al. (2015), which indicated attitudes consistently affecting sedentary behavior time through goal intentions.

Of the four PMT constructs, reported PV scores were the lowest ($M = 3.7$, SD = 1.25 on the 7-point scale). This may be due to defensive denial where participants discount themselves from the threat in order to blunt its psychological impact (Wiebe & Korbel, 2003). Alternatively, since the immediacy, visibility, and the rate onset of metabolic deterioration is gradual, these vulnerability rates may reflect rational appraisal of personal risk (Smith-Klohn & Rogers, 1991). Future studies should focus on developing the vulnerability of metabolic deterioration, given its potential to significantly reduce sedentary behavior.

Overall, our sample sat for 13.71 hours (SD = 4.92) and 8.16 hours (SD = 5.51) in volitional and less-volitional settings and volitional-only settings, respectively, per day. Future interventions using a undergraduate student demographic, should target sitting for school or work in addition to sitting and using the computer for recreation purposes due to its highest reported hours of sitting time ($M = 6.14$, SD = 2.50; $M = 2.99$, SD = 2.50, respectively).

There are a number of strengths in the present study including a robust factor analysis design where both EFA and CFA were employed. Sedentary behavior was assessed prospectively (i.e. one week after sedentary intentions), which extends the existing cross-sectional research. Thus, reliability and validity evidence was provided. Moreover, there was scale correspondence between goal intention and sedentary behavior measurements, which has been shown to strengthen the intention-behavior relationship from physical activity research (Courneya & McAuley, 1995; Maddison & Prapavessis, 2004). Lastly, conducting a focus group to determine the most relevant health consequence was advantageous because it informed our decision to select metabolic deterioration as the health problem for PMT.

Despite the aforementioned strengths, the study is not without limitations. Sedentary behavior was measured using a self-report method (SBQ). Subsequently, a large portion of data were considered implausible and were removed due to an over-reporting of sedentary time (>24 h). Future studies should objectively measure sedentary behavior (e.g. activPAL). Due to the prospective design, 30% of the sample that completed the first survey failed to complete the second survey. Due to the sampling method, these results only represent a sample of an undergraduate population and cannot be generalizable to the overall undergraduate population. More work needs to be done to determine its applicability to other populations such as children, adults, and older adults. It is likely that an older age group may have a stronger threat perception towards metabolic deterioration compared to university students, which could strengthen the predictability of the model. Furthermore, scale correspondence was not optimal between goal intention and implementation intention and implementation intention and behavior.

Conclusion

The present study explored the utility of a modified PMT framework for understanding sedentarism. Preliminary findings now exist to support the tenability of a PMT sedentary model comprised of PV, PS, RE, and five unique scheduling SE constructs (tired, productive/focused, TV/video games/computer, studying at home, studying in library/Wi-Fi area) in university students. Stronger evidence was found for the utility of a sedentary-derived PMT framework for predicting implementation intentions than for predicting goal intention and sedentary behavior. No evidence was found for indirect effects. Separating general and leisure sedentary behavior may not be necessary, but more predictive evidence is required before PMT can be used as a framework to guide intervention studies to more effectively reduce sedentary behavior.

Disclosure statement

No potential conflict of interest was reported by the authors.

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