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# Applying the Theory of Planned Behavior to Sedentariness and Stress

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## Abstract

Objective: The purpose of this study was to evaluate the predictive value of the theory of planned behavior (TPB) in the sedentary behavior (SB) of young and middle-aged U.S. adults. Relationships between SB over a six-week period were examined using socio-demographic characteristics, TPB constructs, and a stress variable.

Methods: Participants (n=45, mean age=31 years, 70% female, 83% White) completed surveys that included sociodemographic information, TPB constructs, and the Weekly Stress Inventory. Participants wore an activity monitor for six weeks and completed the stress inventory once weekly over the study period. A longitudinal model was estimated to determine the relationship between TPB constructs, socio-demographic characteristics, and stress level with SB across the six weeks.

Results: Activity monitors revealed participants were sedentary for approximately 11 waking hours per day (SD=1.4). Bivariate analyses indicated a small effect between subjective norms and SB. Model fit indices modestly supported TPB constructs in explaining SB (i.e., a 2.3% reduction in person-level error variance); and a modest relationship between greater stress and less SB (i.e., additional 1.4% reduction in person-level error variance).

Conclusions: Results cautiously support continued exploration of the TPB in SB research. Like most behaviors, the TPB alone may not fully explain SB. Future research should continue to explore theoretical determinants of SB, expand to include other theoretical models; and include diverse populations. More research is needed to understand the relationship between SB and stress. Practitioners are encouraged to consider both SB and stress in holistic efforts to improve the health of adults.



## Keywords

theory, sedentary, inactivity, stress

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## Abstract

The purpose of this study was to evaluate the predictive value of the theory of planned behavior (TPB) in the sedentary behavior (SB) of young and middle-aged U.S. adults. Relationships between SB and socio-demographic characteristics, TPB constructs, and a stress variable were examined over a six-week period. Participants (*n* = 45, mean age = 31 years, 70% female, 83% white) completed surveys that included sociodemographic information, TPB constructs, and the Weekly Stress Inventory. Participants wore an activity monitor for six weeks and completed the stress inventory once weekly during the study period. A longitudinal model was estimated to determine the relationship between TPB constructs, socio-demographic characteristics, and stress level and SB across the six weeks. Activity monitors revealed participants were sedentary for approximately 11 waking hours per day (SD = 1.4). Bivariate analyses indicated a small effect between subjective norms and SB. Model fit indices modestly supported TPB constructs in explaining SB (i.e., a 2.3% reduction in person-level error variance), and a modest relationship between greater stress and less SB (i.e., additional 1.4% reduction in person-level error variance). Results cautiously support continued exploration of the TPB in SB research. Like most behaviors, the TPB alone may not fully explain SB. Future research should continue to explore theoretical determinants of SB, expand to include other theoretical models, and include diverse populations. More research is needed to understand the relationship between SB and stress. Practitioners are encouraged to consider both SB and stress in holistic efforts to improve the health of adults.

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Young and middle-aged working adults in the United States experience high rates of chronic disease (Ward, Schiller, & Goodman, 2014) and report high stress levels (Stambor, 2006). A lifestyle factor of concern related to both issues is sedentary behavior (SB); activities that require little energy expenditure, in the range of 1.0 to 1.5 metabolic equivalents of task (METs; Ainsworth et al., 2011; Owen, Bauman, & Brown, 2009). Common SBs include watching television, screen time, sitting at a desk, and inactive commuting (Ainsworth et al., 2011). While it is expected that all persons engage in some SBs related to daily living, engaging in high levels of SB has been associated with cardiovascular disease (Katzmarzyk, Church, Craig, & Bouchard, 2009), obesity (Hu, Li, Colditz, Willett, & Manson, 2003), type II diabetes (Ford et al., 2010), premature mortality (Patel, Rodriguez, Pavluck, Thun, & Calle, 2006), and some cancers (Gierach et al., 2009; Howard et al., 2008), and these associations are notably independent of physical activity levels (Owen, Healy, Matthews, & Dunstan, 2010). Objectively measured SB data from the National Health and Nutrition Examination Survey (NHANES) estimate American adults spend more than seven waking hours per day engaging in SBs (Matthews et al., 2008).

The theory of planned behavior (TPB; Ajzen, 1991) has been used widely in health behavior research to help explain and understand health behavior-related choices (Godin & Kok, 1996). The TPB's predictive ability in explaining physical activity (PA) is particularly well established (Hagger, Chatzisarantis, & Biddle, 2002). Although PA and SB are distinct (Owen et al., 2010), they are related, and a framework with strong predictive value of PA may also be useful in explaining SB. Because of this, researchers have begun applying the TPB to SB, though the understanding of the relationship is in its nascent stages. To the best of the authors' knowledge, only eight published studies evaluate TPB constructs with SB (Hamilton, Spinks, White, Kavanagh, & Walsh, 2016; Hamilton, Thomson, & White, 2013; Hume, van der Horst, Brug, Salmon, & Oenema, 2010; Ickes, 2010; Lowe et al., 2015; Prapavessis, Gaston, & DeJesus, 2015; Rhodes & Dean, 2009; te Velde et al., 2011). Table 1 presents a brief description of the scope of each of these eight studies.

This body of literature shows promise in applying the TPB to SB, but there is limited research concerning: U.S. populations; adult populations; use of objective activity measures; and study design. In addition, the current literature supports experimentation with construct measures (i.e., worded for PA or SB). No studies to date have been conducted applying the TPB to longitudinally and objectively measured SB. Therefore, the purpose of this study was to evaluate relationships between SB and variables of interest, using PA-focused TPB constructs in young and middle-aged U.S. adults. Specifically, relationships between SB objectively measured over a six-week period, socio-demographic characteristics, and TPB constructs were examined. Figure 1 depicts the theoretical framework along with hypothesized relationships.

A secondary objective was to examine the relationship between stress and SB. Although this area of research is also limited, some evidence links higher levels of SB to an increased likelihood of developing a stress-related mental health condition (e.g., depression; Sanchez-Villegas et al., 2008; Teychenne, Ball, & Salmon, 2010). Additional evidence acknowledges the relationship between stress and SB, but the direction of the relationship has not yet been determined (e.g., stress may be the cause or the result of sedentary behavior; Hamer et al., 2010; Sanchez-Villegas et al., 2008). Given the need for more research in this area and to examine adult health more holistically, a stress variable measured over 6 weeks was included to determine if stress impacted SB.


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Table 1

*Brief Description of Studies Measuring Sedentary Behavior with Theory of Planned Behavior Constructs (n = 8)*

| *Study and Location* | *Population; Sample Size; and Study Design* | *Measurement of Sedentary Behavior* | *TPB Constructs Included* | *Authors support continued use of the TPB in SB Research?* |
|---|---|---|---|---|
| Hamilton et al., (2013); *Australia* | Adults (*n* = 162); mothers only Design: Cross-sectional | *Subjective*; Survey items addressing limiting hours per day of screen time allowed for children | Attitude, SN, PBC, & Intention related to ensuring appropriate screen time for children | Yes |
| Hamilton et al., (2016); *Australia* | Adults (*n* = 207); parents only Design: Cross-sectional | *Subjective*; Survey items addressing hours per day of screen time allowed for children | Attitude, SN, PBC, & Intention related to ensuring appropriate screen time for children | Yes |
| Hume et al., (2010); *The Netherlands* | Adolescents (*n* = 338) Design: Cross-sectional | *Subjective*; Survey items measuring hours per day spent watching television | Attitude, SN, PBC, & Intention related to television viewing | No |
| Ickes, (2011); *United States* | Adolescents (*n* = 318) Design: Cross-sectional | *Subjective*; Survey items measuring screen time | Attitude, SN, PBC, & Intention related to sedentary behavior | Yes |

*Note.* TPB = Theory of Planned Behavior; SN = Subjective Norm; PBC = Perceived Behavioral Control; Adolescents = ages 12-15

Table 1 (continued)

*Brief Description of Studies Measuring Sedentary Behavior with Theory of Planned Behavior Constructs (n = 8)*

| | | | | |
|---|---|---|---|---|
| Prapavessis et al., (2015); *Canada* | Adults (n = 372) Design: Cross-sectional | *Subjective*; Modified version of the Sedentary Behavior Questionnaire | Attitude, SN, PBC, & Intention related to time spent sitting | Yes |
| Rhodes and Dean (2009); *Canada* | Adults (n = 206 adults; 174 undergraduate students) Design: Cross-sectional | *Subjective*; Survey items measuring leisure time spent playing videogames, watching television, using a computer, or reading | Attitude, SN, PBC, & Intention related to four sedentary behaviors: television viewing, computer use, reading/music, and socializing | Yes |
| te Velde et al., (2011); *The Netherlands* | Adolescents (n = 1,256) Design: Cross-sectional | *Subjective*; two items addressing time spent viewing television from the Activity Questionnaire for Adolescents and Adults | Attitude, SN, PBC, & Intention related to television viewing | Yes |

*Note.* TPB = Theory of Planned Behavior; SN = Subjective Norm; PBC = Perceived Behavioral Control; Adolescents = ages 12-15

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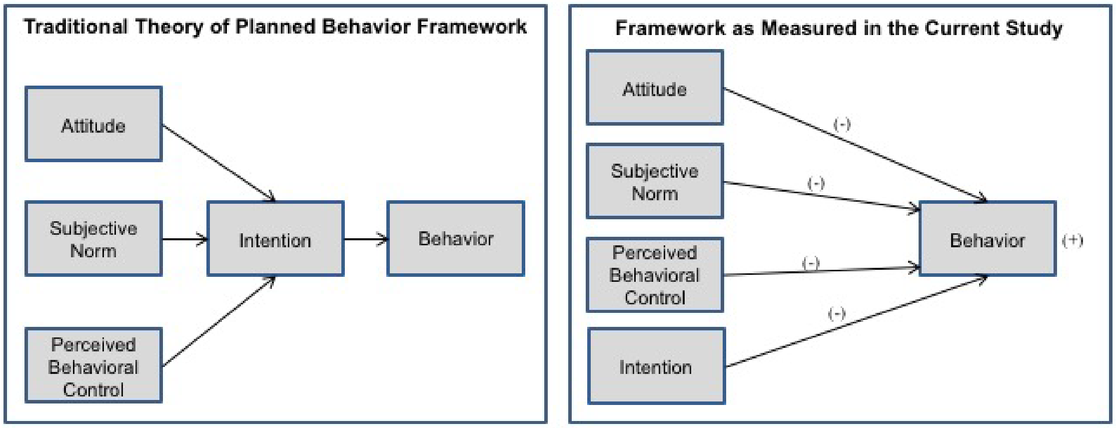


*Figure 1*. The conceptual framework of the Theory of Planned Behavior as originally conceived versus the model measured in the present study. Hypothesized relationships between constructs are indicated as positive and negative signs in parentheses (e.g., a more negative attitude towards leisure-time physical activity will be associated with higher levels of sedentary behavior; lower scores for subjective norm will be associated with greater sedentary behavior, etc.).

## Methods

### Participants

A convenience sample of adults aged 20-49 were recruited from local businesses, a university, and church congregations in central Texas through flyers and email announcements. Initial participant contact, including initial survey completion, took place in local churches, community sites, and university classrooms. The remainder of the study took place in participants' free-living environments (e.g., home, workplace, community). Institutional Review Board approval (#238853-5) was received by the referent institution prior to participant recruitment.

### Procedures

Upon providing informed consent, participants completed questionnaires that included socio-demographic information, all TPB variables, and the Weekly Stress Inventory (WSI; Brantley, Jones, Boudreaux, & Catz, 1997). Participants were also provided with and instructed in the use of an activity monitor that they were asked to wear daily during waking hours only for the following six weeks. Participants were randomly assigned to one of three groups: 1) wearing an Actigraph GT1M monitor, 2) wearing a SenseWear Armband MF-SW, or 3) wearing both monitors. At the end of each week for six weeks, participants also completed the WSI. As incentive, participants were compensated with $10 for every week that they completed the WSI and wore their activity monitor for at least five days (four weekdays and one weekend day). Participants exhibiting complete compliance across the six-week study were compensated with $60 total.

## Measures

**Sociodemographic characteristics.** Survey items from the Behavioral Risk Factor Surveillance Survey (Centers for Disease Control, 2014) were used to ascertain age, sex, race/ethnicity, height, weight, annual household income, number of children, and marital status. Body mass index (BMI) was calculated through self-reported height and weight (weight [kg] / height [meters$^2$]); American College of Sports Medicine, 2013).

**Stress impact.** Stress was measured using the WSI (Brantley et al., 1997), a self-report survey consisting of 87 events that commonly cause a stressful experience. Participants indicate if the event ocurred during the previous week, and rate the amount of stress evoked by each event on a 7-point Likert scale ranging from 1 "happened, but not stressful" to 7 "extremely stressful. " Sample items include: "argued with a coworker," and "had a job or assignment overdue." Participants completed the WSI at baseline and once weekly at the end of each week for six-weeks. The WSI is particularly well-suited for assessing stress levels over a multiple-week period (Brantley & Jones, 1989). Two scores are derived from the WSI: WSI-Event and WSI-Impact. The WSI-E is the sum of the number of events marked as stressful by participants, while the WSI-I includes the number of events indicated with their perceived severity ratings. Both scores have concurrent validity with their counterparts on their Daily Stress Inventory-Event and Impact scales ($r$ = .77 and .84, respectively; Brantley & Jones, 1989), and these scores have demonstrated convergent validity with endocrine measures of stress (Brantley et al., 1988). Consistent with Ledoux et al.'s procedures, and because the WSI-Impact score encompasses the Event score, WSI-I scores were used in analyses (Ledoux et al., 2012).

**Theory of planned behavior constructs.** A TPB-based survey was created to measure each construct of the TPB. The survey was completed by participants during baseline data collection and included 26 items. All items were written with leisure time PA as the behavior of interest following Ajzen's guidelines for developing TPB surveys (2006). Attitude towards PA was assessed using 11 opposite adjective pairs anchored on a seven-point scale (e.g., useful/useless, unenjoyable/enjoyable; α = .82). Measurement of subjective norm included four items that addressed injunctive norms (i.e., what important people think a person should do; α = .84) and four items that addressed descriptive norms (i.e., what important people actually do; α = .78). All items were related to friends, family, "group," and co-workers, respectively, and were anchored on a seven-point scale ranging from "strongly disagree" to "strongly agree." Perceived behavioral control (PBC) was measured with three items on a seven-point scale ranging from "strongly disagree" to "strongly agree" and addressed a person's ability to "find time" to engage in PA, whether or not the behavior is "up to them," and if it is "easy" to engage in PA (α = .74). Intention for PA was measured with three items using a seven-point scale ranging from "very unlikely" to "very likely," that assessed participants' intention to engage in PA in the next six weeks (α = .91). Similar scales using the same behavior of interest have demonstrated acceptable levels of reliability and validity (Okun et al., 2002, 2003).

**Sedentary behavior.** SB data were collected using two objective measures. Data collected from Actigraph GT1M accelerometers were analyzed using cut points developed by Freedson in 1998 (e.g., SB < 100 counts per minute; the equivalent of ≤ 1.5 METs; Evenson, Buchner, & Morland, 2011; Matthews et al., 2008; Freedson, Melanson, & Sirard, 1998). Non-


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wear and wear-time intervals were classified using the algorithm developed by Choi, Matthews, and Buchowski (2011). Data collected from SenseWear Armband MF-SW devices were downloaded and analyzed using SenseWear Professional 7.0 Software (BodyMedia Inc., Pittsburgh, PA). Minutes spent in SB were defined as 1.5 METs or lower for analyses (Ainsworth et al., 2011; Owen et al., 2009).

Because two monitors were worn by participants in this study, model estimates were first computed separately, once using data collected from Actigraph accelerometers ($n$ = 21) and once using data collected from SenseWear Armbands ($n$ = 33), where each model included the respective data collected from the nine participants who were asked to wear both devices. Estimates from both models were similar (e.g., a correlation between the fixed effect estimates of .93). Given this, and to use the largest sample possible, we proceeded by estimating only one model that included data collected from both devices ($n$ = 45). To do this, data from the Actigraph accelerometers were regressed onto data from SenseWear Armbands. The regression equation was used to find the predicted amount of SB for those who wore only SenseWear Armbands had they worn Actigraph accelerometers instead. The equation used is as follows: Y = 389.492 + (.56203*X), where X = SenseWear data and Y = predicted Actigraph output. While evidence demonstrates both devices are valid, Actigraph accelerometers have been more widely used by researchers, and are used in national surveillance studies such as NHANES (Troiano et al., 2008), and thus were selected as the primary measure. Additionally, research-specific SenseWear Armbands are no longer produced or supported by the company (i.e., BodyMedia has been acquired by Jawbone, San Francisco, CA, USA). Average daily waking hours spent in SB over a one-week period for each of the six weeks was used in data analyses.

**Data Analyses**

All data analyses were conducted using R (version 3.0.1, R Core Team, 2013). Descriptive statistics were computed for each variable of interest. A correlation matrix using Pearson product correlation coefficients for continuous variables and Point Biserial correlations for categorical variables were used to examine bivariate relationships across variables of interest.

A multilevel model was estimated to answer the research questions. Because of the dynamic nature of SB and stress levels, measurement of these variables for each participant took place over six weeks, resulting in six data points for each participant. Multilevel models do not assume independence and thus were selected as the method of analysis to account for the hierarchical nesting of data. A longitudinal model was estimated to determine the relationships between SB and TPB constructs, relevant socio-demographic characteristics, and perceived stress over the six-week study period. Time was nested within participants, where time is the level-1 unit and participants are the level-2 units. The model was estimated using the lme4 package in R (Bates, Mächler, Bolker, & Walker, 2014).

First, an unconditional model was estimated. The unconditional model provides baseline values of Alkaike's information criterion (AIC) and Bayesian information criterion (BIC), measures of model fit, to which successive models can be compared. Across AIC and BIC measures, smaller values represent better fit (i.e., AIC and BIC value reductions in successive models indicate better fit). The intaclass correlation coeffecient (ICC) is also computed and provides an estimate of the amount of the total variability in SB that is attributable to differences in people (level-2 units) as opposed to differences across time (level-1 units). The following two models (Models 2 and 3) build upon the unconditional model to be conditioned on time, where time is first treated as a fixed effect and then as a random effect. Model 4 includes level-2 predictors (e.g., TPB constructs, sociodemographic characteristics). The final model (Model 5) includes the stress impact variable by itself to determine its unique contribution. The goal of the model building process is to estimate the most parsimonious model possible given the data.

Diagnostic assessments were conducted prior to model estimation using the MIXED_DX SAS macro® (Bell, Schoeneberger, Morgan, Kromrey, & Ferron, 2010). For detailed discussion of these assumptions and evaluation of diagnostic output, see Raudenbush and Bryk (2002) and Bell and colleagues (2010). Altogether, no violations were detected among level-1 or level-2 variables.

## Results

### Descriptive Statistics

Based on recruitment efforts, 59 participants enrolled in the study. Data from 45 participants met inclusion criteria based on measurement completeness and were retained in these analyses. Given that data were collected from each participant across six points in time, the effective sample size is 270. At least three time points are necessary to have adequate information to estimate the necessary parameters for a linear growth model; the inclusion of six increases the statistical power of the model. Furthermore, the average correlations between time points for the outcome variable SB were .80. The strength of the average correlations adds statistical power as well. Approximately, 67% of the variability in the outcome variables is attributable to characteristics about the participants. Overall, power calculations are complex in multilevel frameworks because they are dependent on many elements of the model. The findings from Bell, Morgan, Kromrey, & Ferron (2010) can be generalized to this study and support the use of a linear growth model with adequate power. Table 2 displays socio-demographic characteristics of the sample. Participants in this sample were mostly female, had a mean age of 31, were overweight, were married, and identified their race as white.

The average daily hours participants spent in SB for each of the six weeks as reported by the activity monitors was computed. Only wear-time was included and showed participants spent an average of 10.69 waking hours per day engaged in SBs (SD = 1.41; range = 6.40 to 15.08 hours). Correlation analyses of data points of SB across the six weeks of the study period were also computed. A medium to large effect was found across weeks of SB (range: $r$ =.502 [week 1 and week 6] to $r$ =.841 [week 2 and week 3]; Sullivan & Feinn, 2012). Results of bivariate analyses are reported in Table 3. Only a small effect was seen between SB and subjective norm variables, with more positive injunctive norms related to more time in SB ($r$ = .200) and more positive descriptive norms related to less time engaged in SB ($r$ = -.226; Sullivan & Feinn, 2012).

### Inferential Statistics

A multilevel model was estimated to examine the predictive value of TPB constructs, sociodemographic characteristics, and stress impact on SB across the six-week study period. Results of the model building process are shown in Table 4.


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Table 2

*Descriptive Statistics (n = 45)*

| Variables | Mean/Count *(range)* | SD/% |
|---|---|---|
| Sex | | |
| Female | 32 | 69.6% |
| Male | 13 | 28.3% |
| Age | 30.61 *(20-50)* | 8.11 |
| Race | | |
| White | 38 | 82.6% |
| African American | 4 | 8.7% |
| Hispanic | 4 | 8.7% |
| BMI | 26.04 *(16.4-57.6)* | 6.4 |
| Number of children | .84 *(0-4)* | 1.2 |
| Marital Status | | |
| Married | 29 | 63.0% |
| Non-married | 17 | 37.0% |
| Income | | |
| <$19,000 | 11 | 23.9% |
| $20,000 - $39,000 | 12 | 26.1% |
| $40,000 - $59,000 | 8 | 17.4% |
| $60,000 - $79,000 | 7 | 15.2% |
| $80,000 - $99,000 | 3 | 6.5% |
| $100,000 or greater | 4 | 8.7% |
| WSI-Impact | 62.89 *(15.71-119.86)* | 27.60 |

*Note.* WSI = Weekly Stress Inventory

**Model interpretation and selection.** The ICC computed from the unconditional model was .67, indicating 67% of the variance in SB was explained by person-level differences. Time was thus nested within person in the proceeding models. Model 2 estimated the impact of time, and indicated a fixed effect value of .70. With every week that passed, participants, on average, increased their SB by .70 units. To determine if the average change in SB varied across participants, Model 3 provided an estimate where time was treated as a random effect. The variance estimate of the random effect for time differed from zero indicating the average change in SB did differ across participants. Time was treated as a random effect in proceeding models. Model 4 included level-2 predictors (e.g., sociodemographic characteristics, TPB constructs). Level-2 residual variances were compared between models 3 and 4 to determine the percentage to which the level-2 variance was reduced with the inclusion of covariates using the following equation:

$$\frac{\tau_{00,Model\ 4} - \tau_{00,Model\ 3}}{\tau_{00,Model\ 4}}.$$

Table 3

*Pearson and Point-biserial Correlation Coefficients for Associations between Variables (n = 45)*

| Variables | 1 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Age | - | | | | | | | | | | | |
| 2 BMI | .256$^{*}$ | | | | | | | | | | | |
| 3 Income | .538$^{**}$ | -.122 | | | | | | | | | | |
| 4 Marital Status | -.115 | .058 | -.271$^{*}$ | | | | | | | | | |
| 5 Number of Children | .410$^{*}$ | .222$^{*}$ | .293$^{*}$ | -.277$^{*}$ | | | | | | | | |
| 6 Attitude | .009 | .180 | .018 | .157 | .004 | | | | | | | |
| 7 SN-Injunctive | .111 | .045 | .151 | -.079 | .190 | .091 | | | | | | |
| 8 SN-Descriptive | .012 | -.172 | .285$^{*}$ | -.015 | .151 | -.040 | .698$^{**}$ | | | | | |
| 9 PBC | .009 | -.314$^{*}$ | .171 | .195 | .001 | .119 | .332$^{*}$ | .306$^{*}$ | | | | |
| 10 Intention | .028 | -.359$^{*}$ | .210 | .212$^{*}$ | .008 | -.066 | .567$^{**}$ | .505$^{**}$ | .745$^{**}$ | | | |
| 11Sedentary Behavior | .049 | .135 | .078 | -.063 | -.048 | .040 | .118 | .200$^{*}$ | -.226$^{*}$ | -.153 | | |
| 12 Stress[a] | -.163 | -.159 | .108 | -.125 | -.038 | -.302$^{*}$ | -.075 | .053 | -.128 | -.060 | -.064 | - |

*Note.* $^{*}$Small effect size (.2); Medium effect size (.5); (Sullivan & Feinn, 2012); [a] average across 6 weeks of measurement; BMI = body mass index; SN = subjective norm.

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Table 4

*Estimates from Multilevel Model Predicting Sedentary Behavior*

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| *Fixed Effects* | | | | | |
| Intercept (SE) | 640.03 (10.72) | 638.37 (11.58) | 638.98 (11.35) | 648.68 (109.87) | 649.16 (112.91) |
| Time | | .70 (1.85) | .35 (2.36) | .39 (2.40) | .31 (3.66) |
| Age | | | | 1.04 (1.46) | .99 (1.47) |
| Sex | | | | -0.55 (25.20) | -3.76 (25.42) |
| BMI | | | | -.58 (3.16) | -.33 (3.19) |
| PBC | | | | -14.18 (15.62) | -15.94 (15.74) |
| SN-I | | | | 2.52 (13.69) | 1.66 (13.78) |
| SN-D | | | | 19.14 (13.05) | 19.89 (13.15) |
| Intent | | | | -9.84 (13.43) | -8.76 (13.59) |
| Attitude | | | | 3.14 (10.03) | 3.32 (10.12) |
| Stress | | | | | -.02 (.17) |
| *Error Variance* | | | | | |
| Level-1(SE) | 2360.09 (231.40) | 2730.11 (232.94) | 1935.90 (217.90) | 1918.50 (214.69) | 1923.69 (217.92) |
| Intercept (SE) | 4744.71 (1102.20) | 4740.27 (1101.67) | 4733.54 (1163.51) | 4845.77 (1309.70) | 4912.79 (1327.08) |
| Time (SE) | | | 121.00 (53.15) | 129.36 (54.92) | 130.41 (56.33) |
| *Model Fit* | | | | | |
| AIC | 2792.0 | 2788.8 | 2780.4 | 2725.5 | 2687.4 |
| BIC | 2795.7 | 2792.4 | 2785.8 | 2730.9 | 2692.8 |

*Note.* BMI = body mass index, PBC = perceived behavioral control, SN-I =subjective norm, injunctive; SN-D = subjective norm, descriptive

TPB constructs age, sex, and BMI accounted for 2.3% of the variability attributable to the person-level effects. The inclusion of the person-level predictors reduced the AIC and BIC in the model substantially. Model 5 included the stress impact variable by itself in an effort to determine its unique contribution to SB. Stress was included as a time-varying covariate, and the level-1 residual variances were compared to determine the impact of stress on SB using the following equation:

$$\frac{\sigma^2_{Model\ 5} - \sigma^2_{Model\ 4}}{\sigma^2_{Model\ 5}}.$$

The additional parameter of stress level accounted for an additional 1.4% of the within-person variability in this sample. The AIC and BIC were further reduced, and Model 5 was selected as the best fitting model.

Results also indicated greater amounts of SB with older age, and that females engaged in more SB than males. Greater PBC and behavioral intention for PA were related to lower SB. Greater scores for injunctive and descriptive norms were related to greater SB. A more positive attitude towards PA was also associated with greater SB.

## Discussion

The primary objective of this study was to evaluate the predictive value of TPB constructs in examining SB. Results cautiously support the use of the TPB as framework through which to view SB, as evidenced by reductions in measures of model fit (i.e., AIC and BIC). The inclusion of TPB and sociodemographic covariates in explaining sedentariness reduced the person-level error variance within this sample, albeit only by 2.3%, indicating only a small amount of the behavior was explained by TPB constructs. A secondary aim was to determine if the addition of stress contributed to the model. The inclusion of stress was supported by model fit indices, although it only reduced person-level error variance by 1.4%.

Results from the final model indicated the following expected relationships in TPB constructs: (1) less time spent in SB was associated with greater PBC for PA, and (2) greater behavioral intention for PA; and the following unexpected relationships: (1) greater injunctive and descriptive norms were associated with greater SB, and (2) more positive attitudes towards PA were associated with greater SB. It is possible for a person to have positive feelings about PA, but still spend a large amount of time in SB (i.e., where a person is both highly active and highly sedentary; Owen et al., 2010). Future research should continue to explore the relationships between attitude towards both PA and SB and actual levels of SB, emphasizing the distinction between the two behaviors. Unexpected relationships may also be the result of the unique characteristics of this sample, a smaller sample size, or the use of an objective measure of SB over a six-week period.

A unique aspect of this study is that SB was predicted using survey items developed for leisure-time PA. While SB and PA represent distinct classes of activities (Ainsworth et al., 2011), SB often replaces leisure-time PA in persons exhibiting high levels of SB (Owen et al., 2010), and may or may not be planned to the extent that PA behaviors are planned (e.g., intentions are weaker in predicting volitional SBs when compared to non-volitional activities; Prapavessis et al., 2015). A previous research team (Lowe et al., 2015) examined SB through survey items worded for PA (2015) and drew applicable conclusions for their sample. Future research should continue to compare the predictive ability of TPB items written with SB stems


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and PA stems, keeping in mind that relationships related to intention for SB cannot be assessed, and that a full model should be analyzed instead.

In this study, injunctive and descriptive norms were assessed independently of one another within the subjective norm construct. In PA research, there has been mixed evidence supporting the use of the subjective norm construct in explaining behavior (Godin & Kok, 1996; McEachan, Conner, Taylor, & Lawton, 2011). Some researchers (Courneya, Plotnikoff, Hotz, & Birkett, 2000) have argued for the removal of the construct, while others (Okun et al., 2002) have called for the independent assessment of the two types. Following the suggestion of Okun, Karoly, and Lutz, and applying it to SB, injunctive and descriptive norms were entered into the model independently. Results indicated higher levels of SB were related with higher scores for norms, though only slightly. This is consistent with findings reported in PA research, questioning the utility of the construct. In the study conducted by Prapavessis et al. (2015) however, subjective norms played a significant role in explaining SB. Given the mixed evidence, it is suggested that future research continue to include the subjective norm construct in examining SB, and to assess the two types independently.

The secondary objective of this study was to examine the unique contribution of stress measured over 6 weeks on SB. Given the prevalence and burdens of both stress and SB in young and middle-aged adults, understanding relationships between the two can contribute to the overall health of this population. Model fit indices supported the inclusion of stress impact in explaining sedentariness, and the person-level error variance was reduced; though only by 1.4%. Specifically results indicated that a decrease in SB was associated with an increase in stress. Previous research indicates that high levels of stress are associated with an increase in unhealthy behaviors (e.g., consumption of energy dense foods, less frequent exercise, smoking; Ng & Jeffery, 2003), but this was not the case for SB. This may be in part due to the uniqueness of SB as an unhealthy behavior, where SB is often a default behavior and some SBs are necessary for living (Kanosue, Oshima, Cao, & Oka, 2015).

Other researchers have previously reported mixed evidence regarding the relationship between SB and stress. Hamer, Stamatakis, and Mishra (2010) reported time spent sitting in front of a screen was associated with higher stress levels ($n$ = 3,920 Scottish adults), while Rebar, Duncan, Short, and Vandelanotte (2014) found overall sitting time was not associated with the severity of stress symptoms ($n$ = 1,104 Australian adults). These findings combined with the results from this study indicate a need for better understanding the relationship between stress and SB.

Other results from this study revealed the following relationships: (1) SB was higher in females than males; (2) SB was shown to increase with increasing age; and (3) although bivariate analyses indicated a negative relationship between BMI and SB, this was not supported by the final model results. The first two findings are consistent with previous research (Healy et al., 2011; Sallis, 2000) and indicate special attention should be paid to female and aging populations. The third finding is unique to this sample given that the relationship between BMI and SB is well-documented. This may be due to participants being overweight on average. Number of children was also not related to SB and was not included in the final model as a person-level predictor. Previous research supports a relationship between parenthood and lower levels of PA participation (Bellows-Riecken & Rhodes, 2008), and Walsh, Umstattd Meyer, Stamatis, and Morgan previously reported having fewer children to be associated with greater SB in a sample of 156 working women (2015). Future research is needed to better understand the relationship between SB and parenting characteristics for both parents, not just mothers.

Descriptive analyses revealed higher levels of SB in this sample than what has been previously reported (i.e., ~11 hours per day compared to ~8 hours per day in NHANES data; Healy et al., 2011; Matthews et al., 2008), despite identical minimum wear time criteria (i.e., 10 hours of wear time per day). This difference could be caused by participants in this study wearing their monitors for more hours per day overall than in previous research. Regardless, the finding strengthens evidence that SB is pervasive across U.S. adults and substantiates the need for immediate and effective interventions to reduce SB. Successful worksite interventions include: standing desks (Pronk, Katz, Lowry, & Payfer, 2012), treadmill desks (Tudor-locke, Schuna, Frensham, & Proenca, 2014), walking meetings (Mackey et al., 2011), and email prompts (Andersen et al., 2013). In addition to workplace interventions, reducing SB during leisure is also important, through the replacement of common leisure SBs with physical activities.

Limitations to note in this study include the relatively small sample size ($n = 45$), although multiple data points support adequate power for the analyses. The study sample also lacked racial/ethnic and geographic diversity. Because participants volunteered for the study, there is a chance of selection bias. It is therefore possible that different findings could appear in less homogenous groups, and that findings may not be generalizable to other populations. It is also possible that a more complex relationship among stress, TPB, and SB exists; however, the limited sample size of this study prevented this from being further examined. Although we did not see a strong relationship between stress and SB, potential mediating relationships should be considered and examined with a larger sample size (Baron & Kenny, 1986). The Hawthorne effect, or the possibility that participants may have modified their behavior in some way because they were being observed, should also be acknowledged and may have influenced results. However, a strength of the study is that participants wore their monitors for 6 weeks, which reduced the likelihood of this occurring. Lastly, although using an objective measure of SB is a strength of this study, issues remain in using objective measures to evaluate SB (e.g., differentiating between sitting and standing behaviors given the similarly low levels of energy expenditure; Ainsworth et al., 2011). More finite measures for objectively measuring SB are necessary to advance the field. Despite these limitations, our findings further the SB conversations within the literature in meaningful ways. First, an objective measure of SB was used, which removes some of the biases and recall issues associated with self-reported measures seen across many studies. Additionally, SB was measured over a six-week period instead of the more commonly used one-week period. Although high correlations across weeks of activity indicate that six weeks of measurement may not be necessary to assess habitual activity, this method strengthened the current study. Lastly, a measure of stress over 6 weeks was used to further develop the research in this area.

## Implications for Health Behavior Research

The results of this study indicate that the TPB may be an effective framework through which SB can be viewed, and that more work is needed in understanding the relationship between stress and sedentariness. Future researchers should continue to explore theoretical determinants of SB, including models other than the TPB, and using more diverse populations. Given that both stress and SB are independently associated with negative health consequences, and exist in high levels in young and middle aged adults, researchers and public health professionals are urged to consider both stress and SB in any efforts to improve the health status in this population.

### Discussion Questions

1. Sedentary behavior has only recently been identified as a public health problem. How have theorists in the past explored emergent health behaviors, and what lessons can be applied to understanding sedentary behavior? Do approaches need to be altered given the uniqueness of sedentariness as a health behavior, where sedentary activities are necessary for daily living, and the exclusion of all sedentary behaviors would be contraindicated for the health of adults?

2. The literature review conducted for this study of all published articles that applied the Theory of Planned Behavior to the understanding of sedentary behavior revealed that all authors developed their own instruments to measure the theoretical constructs. To progress health behavior theories, do researchers need standardized instruments? To what other behaviors and theories might this applicable?

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