UNIVERSITY OF CALIFORNIA, MERCED

# Predicting Adolescents' Physical Activity Intentions: Testing an Integrated Social Cognition Model

A Thesis in partial satisfaction of the requirements for the degree of Master of Arts

in

Psychological Sciences

by

Jessica Elizabeth Balla

Committee in charge:

Professor Martin Hagger, Chair

Professor Deborah Wiebe

Professor Sarah Depaoli

2022

The Thesis of Jessica Elizabeth Balla is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

_____

Martin Hagger, Chair

_____

Deborah Wiebe

_____

Sarah Depaoli

University of California, Merced

2022

## Table of Contents

List of Tables

List of Figures

Acknowledgements

Thank you to my dad, my family, and my friends for your endless support. I am here, and will grow further still, because of you. I love you.

Thank you to my advisor, lab, faculty committee, fellow graduate students, and collaborators at the University of Jyväskylä for your guidance, which has made this thesis possible.

## Abstract

Predicting Adolescents' Physical Activity Intentions: Testing an Integrated Social Cognition Model

by Jessica Elizabeth Balla for the partial satisfaction of the requirements for the degree of

Master of Arts in Psychological Sciences

University of California, Merced 2022

Dr. Martin Hagger, Chair

Although regular participation in physical activity is associated with physical and psychological health benefits in adolescents, few adolescents meet guideline physical activity levels highlighting the need for intervention. Interventions promoting physical activity in this population should target modifiable theory-based constructs and associated processes. We applied a unique integrated social cognition model to identify the theory-based constructs and processes that relate to physical activity intentions in two samples of Finnish adolescents. Participants from the *Liitu 2018* study (*n*=455) completed self-report measures of social cognition constructs from theory of planned behavior, habit, self-discipline, past and current physical activity. Participants from the *Liitu 2020* study (*n*=3,878) completed identical measures and measures of socio-structural and environmental factors. Participants from the *Liitu 2018* study also wore accelerometers for one week concurrent with self-report measures. Hypothesized model effects were tested in the *Liitu 2018* study sample and subsequently confirmed in a pre-registered analysis of the *Liitu 2020* study sample. Across both samples, habit, attitude, perceived behavioral control, and self-reported past behavior predicted physical activity intention. Effects of self-reported past behavior on intention were partially mediated by the social cognition constructs; in contrast, effects of accelerometer-based physical activity were small. Effects of socio-structural and environmental factors on intention in the *Liitu 2020* study sample were partially mediated by the social cognition constructs. Results corroborate beliefs and habit as consistent correlates of adolescents' physical activity intentions, and provide initial evidence that social cognition constructs account for effects of socio-structural and environmental factors on intentions.

## Introduction

Participating in regular moderate-to-vigorous physical activity during childhood and adolescence is associated with multiple health benefits, including reduction in risk factors for chronic disease (Hallal et al., 2006) and optimal psychological functioning (Janssen & LeBlanc, 2010). In addition, physical activity levels in young people tend to track into adulthood, potentially yielding lifelong protection from chronic disease risk (Telama et al., 2013). However, most adolescents worldwide do not meet guideline levels for physical activity (World Health Organization [WHO], 2020a). Health policy organizations have, therefore, identified promotion of physical activity in young populations as a priority worldwide (WHO, 2020b). Thus, there is a need to develop optimally efficacious behavioral interventions to promote physical activity in young populations. Such interventions should be based on knowledge of the fundamental determinants that drive physical activity participation and the processes involved. To this end, researchers have applied psychological theories to provide an evidence base to inform behavior intervention development. The value of these theories lies in their capacity to identify correlates of physical activity in adolescents that can be potentially modified through intervention.

Theories of social cognition have featured prominently in research seeking to identify these correlates (Nisson & Earl, 2020). Such theories focus on psychological constructs that reflect the belief-based considerations in which individuals engage prior to making decisions to act, such as deciding to engage in a health behavior like physical activity (Ajzen, 1985). Examples of social cognition beliefs include beliefs about the utility of the behavior in producing desired or useful outcomes, or *attitudes*, or beliefs in personal capacity to perform the behavior in the future, or *perceived control* or *self-efficacy* (Ajzen, 1991; Bandura, 1986). However, such theories have been criticized for the narrow assumption that behavior is a function of a deliberative decision-making process. This has led researchers to incorporate additional constructs that represent other important processes in behavioral performance, and to provide a more comprehensive account of the determinants of physical activity. Such approaches are expected to account for a greater proportion of explained variance in physical activity intentions and behavior. These integrated models have incorporated variables that reflect the influence of social structure (e.g., access to resources, socio-economic status) and environment (e.g., friend and peer support) on behavior, and constructs that represent non-conscious processes that lead individuals to form intentions and enact behavior through less deliberation. However, research applying these extended theories number relatively few, particularly when examining the determinants of physical activity in children.

To address this evidence gap, the current study sought to identify salient, potentially modifiable correlates of intention to participate in physical activity among Finnish adolescents using an integrated model informed by multiple theories. This research is expected to contribute to an evidence base of viable, potentially modifiable constructs that could be the target of interventions to promote physical activity in this population.

### An Integrated Approach to Physical Activity Determinants

Social cognition theories have been frequently applied to identify the determinants of health behaviors, including physical activity (Rhodes et al., 2019).

Prominent among these theories is the theory of planned behavior (Ajzen, 2020). A key prediction of the theory is that intention toward the future performance of a given target behavior (e.g., physical activity) is the most proximal predictor of that behavior. Intention is a function of three belief-based constructs: attitude, an individual's positive or negative evaluation with respect to performing the behavior in future; subjective norm, an individual's belief that significant others want them to perform the behavior in future; and perceived behavioral control, an individual's belief concerning their ability to carry out the behavior in future and overcome obstacles to its performance. Perceived behavioral control is also specified as a direct predictor of behavior when an individual's perceptions of control closely match their actual behavioral control. Perceived behavioral control is also expected to moderate the relationships between attitude, subjective norm, and intention (Ajzen, 2020), although these effects have not been consistently tested. The relationships between attitude, subjective norm, perceived behavioral control, and future behavior are expected to be mediated by intention. The theory has been widely applied to predict behavior in various contexts. Meta-analyses of research have supported the direct and indirect effects proposed in the model across health behaviors, including physical activity (McEachan et al., 2011), and the moderating effect of perceived behavioral control on the intention-behavior relationship (Hagger et al., 2022).

Despite meta-analytic support for theory predictions, several limitations have been noted. While the theory explains substantive variance in intentions and behavior across multiple behaviors, a considerable amount of variance in these constructs remains unexplained (Armitage & Conner, 2001). The theory also assumes behaviors are a function of belief-based deliberation, represented by its constructs, and does not incorporate constructs that represent non-conscious or *automatic* processes that may lead to intention formation or behavioral enactment (Sheeran & Gollwitzer, 2013). To address these limitations, researchers have suggested integrating additional constructs into the theory that could account for these other processes (Hagger & Hamilton, 2020a).

Past behavior and habit are candidate additional constructs that have been incorporated into social cognition model tests in health contexts (Gardner, 2015). Inclusion of past behavior as an additional predictor of intention and behavior in theories such as the theory of planned behavior provides a test of theory sufficiency; if the theory constructs do not uniquely predict intention and behavior independent of past behavior, then the theory provides an insufficient account of behavior (Hagger, 2019). If relations between past behavior and future behavior are accounted for, or *mediated*, by the social cognition constructs, then the theory provides a sufficient explanation of behavioral consistency, and the indirect effects illustrate the extent to which its constructs are informed by past experience (Ajzen, 2002).

Past behavior has also been used as a proxy for measurement of habit, considering that repeated performance of a behavior may facilitate habit formation (Hagger, 2019). However, past behavior is not a social cognition construct, and, therefore, does not formally capture all characteristics of the habit construct, such as the experienced automaticity of the behavior or the omnipresence of stable contexts or cues that covary with behavioral performance (Hagger, 2019). Researchers testing habit effects in social cognition theories have turned to self-reported habit measures that aim to capture key characteristics of habit as a construct (Hagger, 2019; Verplanken & Orbell, 2003). Within

theory tests, self-reported habit is expected to directly predict behavior, or, at least, the *instigation* of complex behaviors like physical activity (Hagger, 2019).
Research has also shown that habit is associated with intentions to be physically active (e.g., Rhodes et al., 2010). This effect may be because individuals who have performed behaviors habitually are likely to express intentions and beliefs about performing these behaviors in future (Hagger, 2019). In fact, effects of habit on intentions may model the extent to which habits serve as a source of information for individuals when they estimate their beliefs and intentions with respect to performing the behavior in future. Habits are, therefore, expected to predict intentions to perform physical activity, and reflect an alternative process leading to intention formation.

Researchers seeking to extend the predictive capability of social cognition theories have also included variables that represent environmental effects on performance of health behaviors like physical activity. For example, socio-structural and environmental factors have been identified as important correlates of intention and behavior alongside social cognition constructs, although research examining effects of these constructs within these theories is relatively sparse (Schüz, 2017). These environmental and socio-structural factors have been proposed to predict performance of health behaviors indirectly through the mediation of specific beliefs about the behavior (Conner & Norman, 2005). Such mediation effects reflect the role that social and physical environmental plays in informing individuals' beliefs about performing a behavior in future. Research has indicated that socio-structural factors, such as income (Hagger & Hamilton, 2020b) and perceived access to facilities and local opportunities for physical activity (de Bruijn et al., 2006), and socio-environmental factors, such as perceived peer support of physical activity (Cheng et al., 2014), predict intentions and behavior mediated by social cognition constructs such as attitudes (Godin et al., 2010).

In addition to socio-structural and environmental factors, intra-individual traits have also been identified as prominent determinants of physical activity intentions and behavior. In particular, self-discipline, a generalized tendency to initiate and persevere with tasks despite the presence of distractions or availability of more appealing tasks (Costa et al., 1991), has been identified as a trait that may inform intention formation and performance of health behaviors such as physical activity (e.g., Hagger-Johnson & Whiteman, 2007). This is based on the premise that such individual traits act as a source of information from which individuals draw when estimating their beliefs and intentions to perform a given health behavior in future. Such predictions reflect how generalized tendencies serve to bias beliefs and intentions. They are therefore considered distal behavioral determinants and predict behavior mediated by social cognition beliefs (e.g., attitudes, subjective norms) and intentions (Hagger et al., 2019). This hypothesis has been supported in previous research examining self-discipline as a predictor of intention and behavior in physical activity in the theory of planned behavior (e.g., Hagger et al., 2019).

**The Present Study**

The importance of regular physical activity participation to physical and mental health in adolescents, and the observed low levels of regular physical activity participation in this population, creates an impetus for identifying the psychological and environmental correlates of physical activity intentions and behavior to identify viable targets for behavioral interventions aimed at promoting physical activity in this

population. The present study aimed to contribute to an evidence base of potentially modifiable correlates of adolescents' physical activity intentions in two large samples of Finnish adolescents using an integrated social cognition approach derived from predictions of the theory of planned behavior, a prototypical social cognition theory, and constructs representing non-conscious processes (past behavior, habit), a key individual difference construct (self-discipline), and socio-structural (perceived access to exercise facilities, cost) and socio-environmental (perceived peer and friend support for physical activity) factors. Data for each sample were collected in 2018 and 2020 as part of the larger *Liitu* study, which aimed to identify correlates of physical activity intentions and behavior in Finnish youth (Kokko et al., 2019; Kokko et al., 2021).

The proposed integrated models, along with the hypothesized relations among the model constructs, are presented in Figure 1. The first model (Figure 1, panel 'a') was tested in the sample from the *Liitu 2018* study. We predicted that attitude, subjective norm, and perceived behavioral control would be direct predictors of intention, and that perceived behavioral control would moderate the attitude-intention and subjective norm-intention relationships, consistent with the theory of planned behavior. We predicted that habit and self-discipline would also be direct predictors of intention. We also expected self-reported and accelerometer-based past physical activity behavior would predict intention directly, and also indirectly via the social cognition constructs and habit, consistent with prior research (Ajzen, 2002;, Ouellette & Wood, 1998).

The second model (Figure 1, panel 'b') was tested in the sample from the *Liitu 2020* study. In this model, we conducted a pre-registered analysis aimed at replicating key predictions from model tested in the *Liitu 2018* study, and also included perceived socio-structural and socio-environmental factors as additional predictors of intention. Specifically, we expected the pattern of effects of the social cognition constructs and self-discipline specific in the first model would be replicated in the second model. In additional analysis that were not pre-registered, we expected that perceived socio-structural and socio-environmental factors would predict physical activity intentions, and the effects would be mediated by the social cognition constructs in the model, consistent with previous research (Ajzen, 1991; Hagger & Hamilton, 2022). Hypotheses relating to habit and theory of planned behavior moderation effects were not pre-registered, but were common across the two models.

Our procedure involved testing the hypotheses of the first proposed integrated model in the existing *Liitu 2018* sample, and subsequently, pre-registering and testing these hypotheses using data from the *Liitu 2020* sample. The research team pre-registered the proposed model hypotheses prior to receiving the *Liitu 2020* data from the data custodians (https://osf.io/h75p4/?view_only=6e9a4225a5004f2e81fbd33591e5a92d) and performed the analyses once it was received – the research team conducting the pre-registered analyses was not involved in the collection or management of the data. An email trail is available to verify the chain of custody of the data to verify pre-registration occurred prior to receipt of the data. Hypotheses tests conducted in the *Liitu 2020* sample concerning habit, perceived socio-structural and socio-environmental factors, and theory of planned behavior moderation effects should be considered exploratory.

## Method

### Liitu 2018 Sample

### *Participants and Recruitment*

Participants in the *Liitu 2018* sample were children and adolescents aged least 7 years attending either Finnish- or Swedish-speaking schools in Finland. Schools ($N$ = 311) were recruited using a random selection procedure. Schools were randomly sampled from the Statistics Finland database according to WHO protocol, and students were then randomly selected from the schools that agreed to participate in the study. Students ($N$ = 9,940) were approached to participate in the study, with 7,132 agreeing to complete the final survey. In addition, a subsample of the students ($N$ = 3,013) consented to wear an accelerometer with useable accelerometer data available from 2,782 participants. Written informed consent from both the student and parents was required for participation in accelerometer measurements, while participation in the survey did not require consent; however, parents could withdraw their child from the study at their discretion. A subsample of participants from the main study ($n$ = 455; girls, $n$ = 285; boys, $n$ = 170; $M$ age = 15.69, $SD$ = 1.69) completed social cognition measures and comprised the final sample used in the current study. Data were collected from March 2018 to May 2018. Full sample characteristics are shown in Table 3.

### *Design and Procedure*

A cross-sectional correlational design was adopted. Students consenting to participate completed self-report measures of demographic characteristics (age, gender, grade level, locality of residence, parent employment status), social cognition constructs from the theory of planned behavior, self-discipline, habit, and self-reported past physical activity. Participants wore an accelerometer for one week. Participants completed the questionnaire on a computer or tablet in the classroom under the supervision or aid of a teacher during a 45-minute lesson and the following 15-minute break. Accelerometers were administered and collected by either research assistants or teachers in close proximity to the survey data collection (i.e., a few days before or after the survey data collection), and were worn regularly for seven days. Study procedures were approved by the research ethics committee of the University of Jyväskylä. Full details of data collection methods are reported elsewhere (Kokko et al., 2019).

### *Measures*

Study measures comprised validated self-report survey measures alongside accelerometer measures of physical activity. Full study measures and response scales are presented in Table 4.

**Demographic Variables.** Participants self-reported their demographic characteristics including year of birth, gender, grade level, locality of residence, and mother/father employment status.

**Social Cognition Constructs.** Measures of attitude, subjective norm, and perceived behavioral control were developed according to published guidelines (Ajzen, 2006). Attitudes toward physical activity were measured using a common stem ("Participating in active sports and/or vigorous physical activities during my leisure time in the next 5 weeks is…"), with responses measured on two seven-point scales anchored by the bipolar adjectives "unpleasant-pleasant" and "useless-useful". Subjective norm ("Most people who are important to me think I should do active sports and/or vigorous physical activities during my leisure time for the next 5 weeks") and perceived behavioral control ("I am confident I could do active sports and/or vigorous physical activities

during my leisure time in the next 5 weeks") were measured using single items with responses provided on seven-point scales (1 = *strongly disagree* to 7 = *strongly agree*).

**Self-Discipline.** Self-discipline was measured using six items (e.g., "I start tasks right away") of the self-discipline scale from the NEO-PI-R (IPIP, 2017). Participants were presented with the following instructions prior to completing the measure: "Select the option that describes what kind of person you are usually. Everyone thinks about themselves in a different way so there are no right or wrong answers. Select one option from each row" with responses provided five-point scales (1 = *not at all* to 5 = *very much*).

**Habit.** Habit was measured using four items (e.g., "Physical activity is something I do without thinking") from the Self-Report Habit Index (Verplanken & Orbell, 2003). Responses were provided on seven-point scales (1 = *not true* to 7 = *absolutely true*).

**Past Physical Activity Behavior.** Self-reported past behavior was assessed using two items (e.g., "Think about the last 7 days. On how many days have you exercised at least 60 minutes a day?") that captured participants frequency of physical activity performed during a usual week. Responses to this question were provided on eight-point scales (0 = *zero days* and 7 = *seven days*).

**Accelerometer Past Physical Activity.** Accelerometer-based physical activity was measured as the average number of minutes spent in moderate (between 3.0 and 5.9 metabolic equivalents) or vigorous (>6.0 metabolic equivalents) physical activity per day using UKK RM42 wearable accelerometers (UKK, Tampere, Finland). Participants were directed to wear the accelerometer device on the hip during waking hours, and on the wrist of the non-dominant hand while sleeping. Accelerometers were removed only during aquatic activities. Mean amplitude deviation and angle for posture estimation were calculated from the raw acceleration data using a 6-second sampling interval. Adequate use of the accelerometer was defined as wearing the device for at least four days out of seven, with at least 10 hours of use per day. Accelerometer data was used alongside self-report measures of past behavior to account for recall bias associated with self-report methods for measuring physical activity (Prince et al., 2008).

## Liitu 2020 Sample

### *Participants and Recruitment*

All high schools and vocational schools in Finland ($N$ = 119) were invited to participate in the study, with a final sample of 100 schools represented. A total of 5,333 students aged 16 to 20 years of age provided informed consent to participate in the study, with 4,958 students from high schools and 375 from vocational schools. A subsample of participants completed the social cognition measures ($n$ = 3,878; girls, $n$ = 2,161; boys, $n$ = 1, 694; not reported, $n$ = 20; $M$ age = 16.64, $SD$ = 0.72) and were included in the current analysis. Data were collected using online surveys from September to December 2020. Sample characteristics are listed in Table 3.

### *Design and Procedure*

The design and procedure of the *Liitu 2020* study nearly identical to the *Liitu 2018* study. However, data for the 2020 study were collected during the COVID-19 pandemic. Consequently, a variety of restrictions on movement and activities were in place in different parts of Finland during the study, which resulted in administration of self-report measures online using Webropol, an online survey tool, rather than in person

during collection of data on physical measures. The online questionnaire had a 60-minute time limit to answer all measures. Full details of data collection methods are reported in Kokko et al., 2021.

***Measures***

The measures administered to participants in the 2020 sample were the same as the *Liitu 2018* study, with a few exceptions. As most of the accelerometer measurements were missing in this dataset, so only self-reported past physical activity behavior was included in the model for this sample. In addition, measures of perceived socio-structural and socio-environmental variables were included for the 2020 sample, these measures are described next. Full study measures and response scales are provided in Table 4.

**Perceived Socio-Structural Factors.** Perceived socio-structural factors were measured using three items (e.g., "Doing sports/exercise is too expensive") tapping the perceived social structural elements that may impede physical activity participation, with responses provided on five-point scales (1 = *very much* to 5 = *not at all*).

**Perceived Socio-Environmental Factors.** Perceived socio-environmental factors were measured using two items (e.g., "Appreciation towards exercise among my peers is low") capturing the perceived social environmental influences expected to affect physical activity participation, with responses provided on five-point scales (1 = *very much* to 5 = *not at all*).

**Data Analysis**

We conducted preliminary analyses to check whether the subsamples of participants from the total *Liitu 2018* and *Liitu 2020* samples that responded to the social cognition constructs differed from those who did not complete these measures in terms of gender and age. We also applied Little's MCAR test (Little, 1988) in each sample with a non-significant value providing evidence that missing cases in each data set were missing completely at random. Analyses were conducted using the SPSS v 27 software. The hypothesized models illustrated in Figure 1, panels 'a' and 'b', were tested using data from the *Liitu 2018* and *Liitu 2020* samples, respectively, using variance-based structural equation modeling and the WarpPLS v 7.0 software. Variance-based structural equation modeling has been recommended for use with data where there is potential for deviation from normality and for estimating complex models (Kock, 2020). The Stable3 estimation method was used, which uses a robust resampling algorithm to provide precise estimates of standard errors (Kock, 2020). Each construct in the proposed models was a latent variable indicated by its respective items with proposed model relationships included as free parameters. Effects of self-reported past behavior and past physical activity measured via accelerometer on all social cognition constructs in the model were also included as free parameters. Demographic variables such as gender, age, residential locale, and weight or BMI were included as covariates. Missing data were imputed using multiple regression imputation as recommended (Kock, 2020).

Solution estimates were used to evaluate the construct validity, internal consistency, and discriminant validity of the latent variables. Convergent validity was determined by examining the combined factor loadings and cross-loadings after oblique rotation, which should produce statistically significant factor loadings greater than or equal to .500. Internal consistency was assessed using composite reliability coefficients, which should be greater than or equal to .700. Discriminant validity was verified by using

the average variance extracted (AVE). The square root of the AVE for all constructs should be greater than the correlations between that variable and other model variables to support discriminant validity.

We used multiple criteria to assess the adequacy of the fit and quality of the hypothesized models: the Tenenhaus goodness-of-fit (GoF) index, average $R^2$ (ARS), average full collinearity variance inflation factor (AFVIF), average block VIF (AVIF), average path coefficient (APC), Simpson's paradox ratio (SPR), $R^2$ contribution ratio (RSCR), statistical suppression ratio (SSR), and the nonlinear bivariate causality direction ratio (NLBCDR) were used. For the Tenenhaus GoF, an index greater than or equal to .10, .25, and .36 indicates small, medium, and large effect sizes, respectively. The average $R^2$, which provides information on a model's explanatory power, should be statistically significant at the .05 level. The AVIF and AFVIF were used to check for multicollinearity among model variables, and their ideal thresholds are less than or equal to 3.3. The APC, which is based on the absolute values of the path coefficients of the tested model, should have a p-value equal to or less than .05. The SPR measures the absence of Simpson's paradox occurrences, which is when a path coefficient has an opposite sign compared to the correlation of the two variables; this implies that the hypothesized path might be reversed in direction or have issues with causality. The SPR's ideal threshold should be 1.0, but is acceptable if greater than or equal to 0.7. The RSCR indicates the absence of negative $R^2$ contributions (when a predictor decreases the amount of variance explained in a criterion variable) and is acceptable if greater than or equal to 0.9, ideally approaching 1.0. The SSR, which measures the absence of statistical suppression with similar implications as the Simpson's paradox, should be greater than or equal to 0.7, ideally approaching 1.0. The NLBCDR provides partial confirmation that the directions of the hypothesized paths are accurate compared to the inverse direction, and should ideally be greater than or equal to 0.7.

In addition to sample specific models estimated in data from the *Liitu 2018* and *Liitu 2020* samples, we also tested the invariance of the parameter estimates for the common effects in the models across samples. This 'nested' common model comprised effects of social cognition constructs, self-discipline, and habit on physical activity intentions, moderating effects of perceived behavioral control on the attitude-intention and subjective norm intention relationships, and effects of self-reported physical activity on all constructs in the model. Effects of accelerometer-based physical activity in the *Liitu 2018* sample, and effects of perceived socio-structural and socio-environmental variables in the *Liitu 2020* sample were not common to both models and not, therefore, subject to the invariance tests. Invariance tests were conducted using multi-group analysis testing for significant differences in the parameter estimates across the samples using the Satterthwaite method (Kock, 2020).

## Results

### Preliminary Analyses

Preliminary analyses indicated that participants included in the analysis (*M* age = 15.69, *SD* = 1.69) were significantly older than those that were not (*M* age = 13.45, *SD* = 1.96) in the *Liitu 2018* sample ($t(1,554) = 21.28$, $p < .001$, $d = 1.18$, CI [2.03, 2.44]). This difference, however, is because the social cognition measures were not administered to children in grades one and three as they were not considered to have sufficient reading

ability to comprehend the measures. Participants included in the *Liitu 2020* analysis (*M* age = 16.64, *SD* = 0.72) did not significantly differ in age than those excluded (*M* age = 16.65, *SD* = 0.79; $t(4,939) = -.169$, $p = .866$, $d = -.006$, CI [-.05, .04]). There was a larger proportion of girls among included participants (girls, $n = 285$; boys, $n = 170$) relative to those that were not (girls, $n = 811$; boys, $n = 647$) in the *Liitu 2018* sample ($\chi^2(1, N = 1,913) = 6.97$, $p = .008$, $d = .120$). Similarly, there was a greater proportion of girls among participants included in the *Liitu 2020* sample relative to those excluded (girls, $n = 646$; boys, $n = 413$) in the *Liitu 2020* study ($\chi^2(2, N = 4,944) = 10.71$, $p = .005$, $d = .092$).

Less than 1% of the total data points were missing in both samples. Little's MCAR test (Little, 1988) for the *Liitu 2018* sample supported the hypothesis that missing cases were missing completely at random ($p = .364$), while results for the *Liitu 2020* sample suggested missing cases were not missing completely at random ($p = .011$).

## Structural Equation Models

**Solution estimates and model fit**. Examination of the solution estimates in each structural equation model suggested good construct validity for each latent variable, with all factor loadings exceeding .50 with statistically significant coefficients ($p$s < .001). Composite reliability estimates for the constructs and variables with multiple items surpassed the recommended .700 threshold, indicating good internal consistency. Values for the square root of the AVE surpassed all the correlations between that variable and other model variables, supporting discriminant validity. Full solution estimates from the structural equation models in both samples are presented in Table 2.

Model fit and quality indices demonstrated adequate fit of the proposed models with the data and acceptable model quality in the *Liitu 2018* (GoF = 0.462; ARS = 0.233, $p < .001$; AFVIF = 1.900; AVIF = 1.359; APC = 0.113, $p = .004$, SPR = 0.805; SSR = 0.829; NLBCDR = 0.805) and *Liitu 2020* (GoF = 0.542; ARS = 0.326, $p < .001$; AFVIF = 1.722; AVIF = 1.246; APC = 0.107, $p < .001$, SPR = 0.767; SSR = 0.977; NLBCDR = 0.965) samples. In addition, the models accounted for a substantial proportion of the variance in physical activity intentions in both samples (*Liitu 2018* sample, $R^2 = .582$; *Liitu 2020* sample, $R^2 = .727$).

### *Model Effects*

***Liitu 2018* sample**. Standardized path coefficients for the proposed models are presented in Figure 1 and full parameter estimates and variability and effect size statistics presented in Table 1. Focusing on the direct effects of the model, we found statistically significant effects of self-reported past physical activity on attitude, subjective norm, perceived behavioral control, self-discipline, habit, and intention. There were also significant effects of past accelerometer-based physical activity on subjective norm, perceived behavioral control, self-discipline, and habit. In addition, there were significant effects of attitude, perceived behavioral control, and habit on intention. Effects of subjective norm and self-discipline on intention, however, were not significant, and perceived behavioral control did not significantly moderate the attitude-intention or subjective norm-intention relationships.

Turning to model indirect effects, the effect of self-reported past physical activity on intention through attitude was statistically significant. However, indirect effects of self-reported past physical activity on intention through perceived behavioral control, subjective norm, self-discipline, and habit were not statistically significant. Indirect

effects of accelerometer-based past physical activity on intention through all other psychological variables were non-significant.

Sums of indirect effects indicated that the effect of self-reported past physical activity on intention was statistically significant, but the effect of past physical activity measured via accelerometer on intention was not significant. We also found significant total effects of self-reported and accelerometer-based past physical activity on intention. The significant total effect of accelerometer-based past physical activity was due to the cumulative effect of the small, non-significant effects of accelerometer-based past physical activity on all model constructs which, taken together, translated to a small but significant total effect.

***Liitu 2020* sample**. We found statistically significant direct effects of perceived socio-structural and socio-environmental factors on attitude, subjective norm, perceived behavioral control, and intention. There were also significant direct effects of attitude, subjective norm, perceived behavioral control, and habit on intention, although the effect of self-discipline on intention was not significant. Self-reported past physical activity had significant effects on attitude, subjective norm, perceived behavioral control, self-discipline, habit, and intention.

Indirect effects showed that the effects of self-reported past physical activity on intention through perceived behavioral control, attitude, and habit were statistically significant. In contrast, the effects of self-reported past physical activity on intention through subjective norm and self-discipline were not statistically significant. Indirect effects of perceived socio-structural factors on intention through perceived behavioral control and attitude were statistically significant, while the effect of perceived socio-structural factors on intention through subjective norm was not statistically significant. The effects of perceived socio-environmental factors on intention through perceived behavioral control and attitude were statistically significant, but the effect of perceived socio-environmental factors on intention through subjective norm was not significant.

Sums of indirect effects indicated that the effects of self-reported past physical activity, and perceived socio-structural and socio-environmental factors, on intention through all social cognition constructs were statistically significant. In addition, total effects of self-reported past physical activity, and perceived socio-structural, and socio-environmental factors, on intention were statistically significant.

**Multi-Group Analysis**

Tests of invariance of sets of parameters common to the models estimated in each sample using multi-group analysis indicated several statistically significant differences in these parameter estimates: self-reported past physical activity on habit, self-reported past physical activity on subjective norm, self-reported past physical activity on perceived behavioral control, attitude on intention, and perceived behavioral control on intention. In most cases, except for the estimated effects of attitude on intention, parameter estimates were larger in the *Liitu 2020* sample relative those in the *Liitu 2018* sample. In addition, we found that moderating effect of perceived behavioral control on the attitude-intention relationship was larger in the *Liitu 2018* sample relative to the *Liitu 2020* sample. However, it must be stressed that while we identified differences in the parameter estimates for these effects across samples, the differences were in the relative size of the effects not in their statistical significance, suggesting that the overall pattern of effects

was consistent across samples. Full results from the multi-group analysis are presented in Table 7.

## Discussion

We investigated the correlates of physical activity intentions in two samples of adolescents from the *Littu 2018* and *2020* studies using an integrated model that included social cognition constructs from the theory of planned behavior, which represented reasoned deliberative processes that lead to intention estimation, and constructs and variables representing non-conscious, more implicit decision making (past behavior, habit), intra-individual differences (self-control), and perceived socio-structural and socio-environmental factors, all factors likely to be considered in when adolescents estimate their physical activity intentions. Structural equation models indicated statistically significant effects of attitude, subjective norm, perceived behavioral control, habit, self-discipline, and self-reported past physical activity on intention in both samples, with the social cognition constructs mediating the effect of self-reported past physical activity on intention. Multi-group analysis revealed a similar pattern of effects across both samples, although model parameter estimates tended to be larger in the *Liitu 2020* sample. In addition, we tested effects of past physical activity measured via accelerometer in the *Liitu 2018* sample, and effects of perceived socio-structural and socio-environmental factors in the *Liitu 2020* sample, on physical activity intentions. Results revealed total indirect effects of perceived socio-structural and socio-environmental factors on intentions mediated by the social cognition constructs, and a significant total effect of accelerometer-based past physical activity on intention.

### Consistency with Previous Social Cognition Theories

That attitude and perceived behavioral control were consistent predictors of physical activity intentions in both samples is consistent with theory predictions and previous research applying the theory of planned behavior in physical activity (e.g., Hagger et al., 2002) although the effect size for the relationship between subjective norm and intentions was smaller and, in the case of the *Liitu 2018* sample, not statistically significant. This pattern has been noted in meta-analytic research applying the theory in younger samples and in a physical activity context elsewhere – attitudes and perceived behavioral control tend to have larger effects on intentions than subjective norms (McEachan et al., 2011). This is consistent with the idea that the beliefs in the utility of physical activity, and beliefs in capacity to perform it, are foremost when young people make decisions to participate in physical activity. We also found no moderating effects of perceived behavioral control on the attitude-intention and subjective norm-intention relationships, consistent with recent meta-analytic findings (Hagger et al., 2022). Research seems to more consistently support the moderation of the intention-behavior relationship by perceived behavioral control rather than the effects of attitude and subjective norms on intentions. However, scale score coverage of the variables included in the interaction may be a possible moderator of these interaction effects, which should be a consideration for future research.

### Value of the Integrated Approach

An important contribution of the current research is that effects of constructs representing non-conscious processes were included alongside the social cognition constructs that typically represent the processes by which individuals make deliberative,

reasoned decisions to perform physical activity. This augmentation is consistent with the consideration that individuals who have formed intentions to perform a given target behavior in the past are more likely to make similar decisions in future, and, therefore, are more likely to form beliefs and intentions that are congruent with their past experience. Sure enough, consistent with previous research indicating that past behavior and future behavior are important sources of information for intention formation (Gardner et al., 2011; Ouellette & Wood, 1998), current data indicated significant direct effects of past behavior and habit on intentions. Adolescents in this sample, therefore, tend to estimate their intentions toward participating future behavior by drawing on their past experiences with the behavior, obviating the need for substantial forethought or consideration of the current merits and detriments of the upcoming activity, as captured by effects of social cognition constructs such as attitudes.

Importantly, the residual effect of past behavior on intention suggests that past behavior does not exclusively reflect habit, otherwise the effect would be entirely subsumed by habit. The residual effect of past behavior on intention may represent effects of other unmeasured variables that reflect automatic processes (e.g., implicit attitudes, identity) or dispositions that may bypass more deliberative 'routes' to intentions (e.g., personality). While self-reported past behavior was a significant predictor of all model variables and intentions, these results did not align with those for accelerometer-based past physical activity. Overall, effects for accelerometer-based physical activity had modest effect on study constructs, but, together, indicated a significant total effect. Differences in these patterns of effects may be attributable to recall bias in the self-report measure, or effects of common method variance, both of which have the potential to inflate effects (Manfredo & Shelby, 1988). By contrast, accelerometer-based physical activity is not subject to these kinds of biases. However, there are also limitations with using these types of devices – for example, they do no capture certain types of activity, are subject to interference, and often do not specifically correspond to the target behavior. This does not mean that either measure lacks value – and both are likely to have their place, but it is important to recognize their strengths and limitations, and indicate the imperative of including self-report and non-self-report behavioral measures of behavior when testing social cognition models.

A dispositional construct that was included as an additional predictor of physical activity intentions in the test of the integrated model in the current study was self-discipline. This construct did not predict intention in either sample, nor did it mediate the relationship between past physical activity and intention. These results are in contrast with previous research that reported associations between self-control, physical activity intentions, and behavior (e.g., Hagger et al., 2019). It may be that self-discipline is less relevant for this specific behavior and population, and there is relatively little research verifying independent effects of this construct on physical activity intentions in younger populations. Other individual differences factors may be worth considering as determinants of physical activity intentions and behavior, such as the activity facet of extraversion from the NEO conceptualization of personality, which has been consistently linked with physical activity intentions and behavior (Kekäläinen et al., 2022; Rhodes et al., 2006; Vo & Bogg, 2015).

The indirect effects of perceived socio-structural and socio-environmental factors on physical activity intention mediated by the social cognition constructs identified in the model tested in the *Liitu 2020* sample is an important and unique contribution. These results indicate that participants beliefs about the utility of, social norms toward, and personal capacity to perform physical activity is informed by their perceptions of the social and physical environmental barriers or facilitating factors that may hinder or scaffold their physical activity. It is also important to note that residual effects of these factors on physical activity suggest that the mediation effects were partial. The direct effects suggest that the social cognition factors do not fully account for the effects of these factors on intentions, which may reflect the extent that individuals' perceptions reflect actual barriers or facilitators. However, it may also be the case that the measures of the social cognition constructs are insufficiently precise in capturing individuals' beliefs with respect to physical activity behavior, or that other unmeasured beliefs may account for the effects of these structural variables, such as anticipated regret, affect, or moral norms. Nevertheless, the indirect effects provide some preliminary evidence of a potential process by which individuals' social and physical environment relates to intentions, and is consistent with previous theory and research highlighting the importance of beliefs as sources of information that inform individuals' decisions to act (Ajzen, 1991; Hagger & Hamilton, 2022).

These data may contribute to the evidence base of correlates of physical activity intentions in young people, which may signal potential intervention targets. These targets include the social cognition constructs, particularly attitudes and perceived behavioral control, and habits given their consistent effects across model tests in the current samples. Such constructs have been shown to be potentially malleable through behavior change techniques such as persuasive communication (Ajzen & Schmidt, 2020; Hamilton & Johnson, 2020), and habit formation (Gardner et al., 2020; Orbell & Verplanken, 2020). But these data need corroboration as they cannot provide sufficient basis to claim that changing a particular social cognition construct will lead to intention formation, such effects need to be established through longitudinal or experimental designs that model change. We are therefore loath to make recommendations for intervention based on these data alone. Nevertheless, the current data signal theory-related constructs and processes that may identify targets for future intervention research that could provide corroboration of the direction and causal effects in the model proposed here.

**Strengths, Limitations, and Avenues for Future Research**

The current study has several notable strengths. It adopted a robust theoretical approach integrating multiple constructs representing various processes that lead to physical activity intention formation; key hypotheses in the proposed integrated model were tested in an initial sample from the *Liitu 2018* study, and confirmed in a subsequent pre-registered analysis in a subsequent sample from the *Liitu 2020* study; and we used appropriate analyses and robust measures in the model tests. Despite these strengths, there are several limitations that restrict the scope and inferences that can be made based on these data. First, the current study adopted a correlational, cross-sectional design; thus, causality of the examined relationships cannot be inferred from the data, and the directionality of effects was drawn from theory alone. Second, the study lacked a behavioral outcome measure, which means the tested models cannot account for variance

in actual physical activity. Third, data in the *Liitu 2020* sample were not missing completely at random (Little, 1988). While less than 1% of the data points were missing in this sample, and the multiple regression imputation method used did not require data to be missing completely at random (Sinharay et al., 2001), systematic data missingness should be considered a limitation and results should be interpreted accordingly. Finally, data in the *Liitu 2020* sample were collected during the COVID-19 pandemic, which may have influenced participants' responses, so results may not be generalizable outside of the pandemic context.

## Conclusion

The present study identified correlates of physical activity intentions in two samples of Finnish adolescents based on an integrated social cognition approach that incorporated constructs representing non-conscious processes, individual differences in self-control, and perceived structural and environmental factors. Results demonstrated consistent effects of belief-based constructs, self-reported physical activity, habit, and perceived socio-structural and socio-environmental factors on intention. Perceived socio-structural factors, socio-environmental factors, and self-reported past physical activity were indirectly related to intention via the belief-based constructs. Results highlight the utility of integrating these factors into theories of social cognition to account for the multiple processes that inform intention formation. Findings suggest that utility and capacity beliefs, habit experience, access to exercise facilities and equipment, and past experiences are instrumental factors that inform intentions to be physically active in young people. Further research should aim to establish experimental and intervention support for model predictions, measure subsequent behavioral performance over time, and verify model effects in different populations and contexts.

**References**

Ajzen, I. (1991).The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In *Action control*. Springer, Berlin, Heidelberg. pp. 11-39.

Ajzen, I. (2002). Residual effects of past on later behavior: Habituation and reasoned action perspectives. *Personality and Social Psychology Review*, *6*(2), 107-122. https://doi.org/10.1207/S15327957PSPR0602_02

Ajzen, I. (2006). Constructing a theory of planned behavior questionnaire. University of Massachusetts Amherst: Amherst, MA, USA.

Ajzen, I. (2020). The theory of planned behavior: Frequently asked questions. *Human Behavior and Emerging Technologies*, *2*(4), 314–324. https://doi.org/10.1002/hbe2.195

Ajzen, I., & Schmidt, P. (2020). Changing behavior using the theory of planned behavior. In Hagger, M. S., Cameron, L., Hamilton, K., Hankonen, N., & Lintunen, T. (Eds.), *The handbook of behavior change* (pp. 17-31). New York, NY: Cambridge University Press. https://doi.org/10.1017/ 9781108677318

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology*, *40*(4), 471-499. https://doi.org/10.1348/014466601164939

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of Social and Clinical Psychology*, *4*(3), 359-373.

Cheng, L. A., Mendonça, G., & Farias Júnior, J. C. D. (2014). Physical activity in adolescents: analysis of the social influence of parents and friends. *Jornal de Pediatria*, *90*(1), 35-41. http://dx.doi.org/10.1016/j.jped.2013.05.006

Conner, M. & Norman, P (2005). Predicting health behaviour: A social cognition approach. In Conner, M. & Norman, P. (Eds.), *Predicting health behaviour* (2nd ed., pp. 1-27). Open University Press.

Costa Jr, P. T., McCrae, R. R., & Dye, D. A. (1991). Facet scales for agreeableness and conscientiousness: A revision of the NEO Personality Inventory. *Personality and Individual Differences*, *12*(9), 887-898. https://doi.org/10.1016/0191-8869(91)90177-D

de Bruijn, G. J., Kremers, S. P., Lensvelt-Mulders, G., de Vries, H., van Mechelen, W., & Brug, J. (2006). Modeling individual and physical environmental factors with adolescent physical activity. *American Journal of Preventive Medicine*, *30*(6), 507-512. https://doi.org/10.1016/j.amepre.2006.03.001

Gardner, B. (2015). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behaviour. *Health Psychology Review*, *9*(3), 277–295. https://doi.org/10.1080/17437199.2013.876238

Gardner, B., de Bruijn, G. J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the self-report habit index to nutrition and physical activity behaviours. *Annals of Behavioral Medicine*, *42*(2), 174-187. https://doi.org/10.1007/s12160-011-9282-0

Gardner, B., Rebar, A.L., & Lally, P. (2020). Habit interventions. In Hagger, M. S., Cameron, L., Hamilton, K., Hankonen, N., & Lintunen, T. (Eds.), *The handbook*

*of behavior change* (pp. 599-616). New York, NY: Cambridge University Press. https://doi.org/10.1017/ 9781108677318

Godin, G., Sheeran, P., Conner, M., Belanger-Gravel, A., Cecilia, M., Gallani, B. J., & Nolin, B. (2010). Social structure, social cognition, and physical activity: A test of four models. *British Journal of Health Psychology, 15*(1), 79-95. https://doi.org/10.1348/135910709x429901

Hagger, M. S. (2018). Habit and physical activity: Theoretical advances, practical implications, and agenda for future research. *Psychology of Sport and Exercise, 42*, 118–129. https://doi.org/10.1016/j.psychsport.2018.12.007

Hagger, M., Chatzisarantis, N., & Biddle, S. (2002). A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: Predictive validity and the contribution of additional variables. *Journal of Sport & Exercise Psychology, 24*(1), 3-32. https://doi.org/10.1123/jsep.24.1.3

Hagger, M. S., Cheung, M. W. L., Ajzen, I., & Hamilton, K. (2022). Perceived behavioral control moderating effects in the theory of planned behavior: A meta-analysis. Advance online publication. *Health Psychology*. https://doi.org/10.1037/hea0001153

Hagger, M.S., & Hamilton, K. (2020a). Changing behavior using integrated theories. In Hagger, M. S., Cameron, L., Hamilton, K., Hankonen, N., & Lintunen, T. (Eds.), *The handbook of behavior change* (pp. 208-224). New York, NY: Cambridge University Press. https://doi.org/10.1017/ 9781108677318

Hagger, M. S., & Hamilton, K. (2020b). Effects of socio-structural variables in the theory of planned behavior: A mediation model in multiple samples and behaviors. *Psychology & Health, 36*, 1–27. https://doi.org/10.1080/08870446.2020.1784420

Hagger, M.S, Hamilton, K. (2022). Predicting COVID-19 booster vaccine intentions. *Applied Psychology: Health and Well-Being*. https://doi.org/10.1111/aphw.12349

Hagger, M. S., Hankonen, N., Kangro, E., Lintunen, T., Pagaduan, J., Polet, J., Ries, F., & Hamilton, K. (2019). Trait self-control, social cognition constructs, and intentions: Correlational evidence for mediation and moderation effects in diverse health behaviours. *Applied Psychology: Health and Well-Being, 11*(3), 407–437. https://doi.org/10.1111/aphw.12153

Hagger-Johnson, G. E., & Whiteman, M. C. (2007). Conscientiousness facets and health behaviors: A latent variable modeling approach. *Personality and Individual Differences, 43*(5), 1235–1245. https://doi.org/10.1016/j.paid.2007.03.014

Hallal, P.C., Victora, C.G., Azevedo, M.R., & Wells, J.C.K. (2006). Adolescent physical activity and health: A systematic review. *Sports Medicine*. *36*(12), 1019–1030.

Hamilton, K., & Johnson, B.T. (2020). Attitudes and persuasive communication interventions. In Hagger, M. S., Cameron, L., Hamilton, K., Hankonen, N., & Lintunen, T. (Eds.), *The handbook of behavior change* (pp. 445-460). New York, NY: Cambridge University Press. https://doi.org/10.1017/ 9781108677318

IPIP. (2017). Self-discipline scale from the NEO-PI-R. Retrieved June 25, 2021, from https://ipip.ori.org/newNEOKey.htm#Self-Discipline

Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity, 7*(1), 1-16

Kekäläinen, T., Tammelin, T. H., Hagger, M. S., Lintunen, T., Hyvärinen, M., Kujala, U. M., Laakkonen, E. K., & Kokko, K. (2022). Personality, motivational, and social cognition predictors of leisure-time physical activity. *Psychology of Sport and Exercise*, *59*, 102135. https://doi.org/10.1016/j.psychsport.2022.102135

Kock, N. (2020). WarpPLS user manual: Version 7.0. Laredo, TX: ScriptWarp Systems.

Kokko, S., Hämylä, R., Martin, L., Rinta-Antila, K., Villberg, J., Simonsen, N., ... & Välimaa, R. (2021). *Nuorten liikuntakäyttäytyminen Suomessa: LIITU-tutkimuksen tuloksia 2020* [Sports behavior of young people in Finland: The results of the LIITU 2020 survey]. *Valtion liikuntaneuvoston julkaisuja*. *2021:1*. Retrieved from https://www.liikuntaneuvosto.fi/lausunnot-ja-julkaisut/liitu2020/

Kokko, S., Martin, L., Husu, P., Villberg, J., Mehtälä, A., Jussila, A.-M., . . . Välimaa, R. (2019*). Lasten ja nuorten liikuntakäyttäytyminen Suomessa: LIITU-tutkimuksen tuloksia 2018* [Physical activity behavior in Finnish children and adolescents: Results from the LIITU study 2018]. *Valtion liikuntaneuvoston julkaisuja, 2019:1*. Retrieved from https://www.liikuntaneuvosto.fi/wp-content/uploads/2019/09/VLN_LIITU-raportti_web-final-30.1.2019.pdf

Little, R. J. (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association*, *83*(404), 1198-1202.

Manfredo, M. J., & Shelby, B. (1988). The effect of using self-report measures in tests of attitude—behavior relationships. *The Journal of Social Psychology*, *128*(6), 731-743. https://doi.org/10.1080/00224545.1988.9924553

McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the theory of planned behaviour: A meta-analysis. *Health Psychology Review*, *5*(2), 97-144. https://doi.org/10.1080/17437199.2010.521684

Nisson, C., & Earl, A. (2020). The theories of reasoned action and planned behavior. In Paul, R.H., Salminen, L.E., Heaps, J., & Cohen, L.M. (Eds., pp. 755–761), *The Wiley encyclopedia of health psychology*. John Wiley & Sons, Ltd https://doi.org/10.1002/9781119057840.ch129

Orbell, S., & Verplanken, B. (2020). Changing behavior using habit theory. In Hagger, M. S., Cameron, L., Hamilton, K., Hankonen, N., & Lintunen, T. (Eds.), *The handbook of behavior change* (pp. 178-192). New York, NY: Cambridge University Press. https://doi.org/10.1017/ 9781108677318

Ouellette, J. A., & Wood, W. (1998). Habit and intention in everyday life: The multiple processes by which past behavior predicts future behavior. *Psychological Bulletin*, *124*(1), 54. https://doi.org/10.1037/0033-2909.124.1.54

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Gorber, S. C., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. *International Journal of Behavioral*

*Nutrition and Physical Activity*, *5*(1), 1-24. https://doi.org/10.1186/1479-5868-5-56

Rhodes, R., de Bruijn, G. J., & Matheson, D. H. (2010). Habit in the physical activity domain: Integration with intention temporal stability and action control. *Journal of Sport and Exercise Psychology*, *32*(1), 84-98. https://doi.org/10.1123/jsep.32.1.84

Rhodes, R. E., Courneya, K., & Jones, L. (2006). Personality, the theory of planned behavior, and exercise: A unique role for extroversion's activity facet. *Journal of Applied Social Psychology*, *32*, 1721–1736. https://doi.org/10.1111/j.1559-1816.2002.tb02772.x

Rhodes, R. E., McEwan, D., & Rebar, A. L. (2019). Theories of physical activity behaviour change: A history and synthesis of approaches. *Psychology of Sport and Exercise*, *42*, 100–109. https://doi.org/10.1016/j.psychsport.2018.11.010

Schüz, B. (2017). Socio-economic status and theories of health behaviour: Time to upgrade a control variable. *British Journal of Health Psychology*, *22*(1), 1–7. https://doi.org/10.1111/bjhp.12205

Sheeran, P., Gollwitzer, P. M., & Bargh, J. A. (2013). Nonconscious processes and health. *Health Psychology*, *32*(5), 460. https://doi.org/10.1037/a0029203

Sinharay, S., Stern, H. S., & Russell, D. (2001). The use of multiple imputation for the analysis of missing data. *Psychological Methods*, *6*(4), 317. https://doi.org/10.1037/1082-989X.6.4.317

Telama, R., Yang, X., Leskinen, E., Kankaanpaa, A., Hirvensalo, M., Tammelin, T., & Raitakari, O. T. (2014). Tracking of physical activity from early childhood through youth into adulthood. *Medicine and Science in Sports and Exercise*, *46*(5), 955-962.

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology*, *33*(6), 1313-1330. https://doi.org/10.1111/j.1559-1816.2003.tb01951.x

Vo, P. T., & Bogg, T. (2015). Testing theory of planned behavior and neo-socioanalytic theory models of trait activity, industriousness, exercise social cognitions, exercise intentions, and physical activity in a representative U.S. sample. *Frontiers in Psychology*, *6*, 1114. https://doi.org/10.3389/fpsyg.2015.01114

World Health Organization (2020a). *Physical activity*. Retrieved March 19, 2021, from https://www.who.int/news-room/fact-sheets/detail/physical-activity

World Health Organization. (2020b). *WHO guidelines on physical activity and sedentary behaviour*. Retrieved April 22, 2021, from https://www.who.int/publications-detail redirect/9789240015128

**Table 1**

*Parameter and Variability Estimates for the Proposed Models in Each Sample*

| 2018 sample | | | | 2020 sample | | | |
|---|---|---|---|---|---|---|---|
| Effect | β | *SE* | ES | Effect | β | *SE* | ES |
| Direct effects | | | | Direct effects | | | |
| PA-SR→SD | .185*** | .046 | .042 | Soc.Str.→Int. | .029* | .016 | .008 |
| PA-SR→Habit | .446*** | .044 | .216 | Soc.Str.→Att. | .086*** | .016 | .023 |
| PA-SR→Int. | .102** | .046 | .046 | Soc.Str.→SN | .068*** | .016 | .013 |
| PA-SR→Att. | .405*** | .045 | .165 | Soc.Str.→PBC | .105*** | .016 | .031 |
| PA-SR→SN | .149*** | .046 | .024 | Soc.Env.→Int. | .038** | .016 | .012 |
| PA-SR→PBC | .364*** | .045 | .148 | Soc.Env.→Att. | .182*** | .016 | .059 |
| SD→Int. | .020 | .047 | .006 | Soc.Env.→SN | .099*** | .016 | .019 |
| Habit→Int. | .116** | .046 | .062 | Soc.Env.→PBC | .161*** | .016 | .050 |
| Att.→Int. | .484*** | .044 | .364 | PA-SR→SD | .264*** | .016 | .073 |
| SN→Int. | .059 | .047 | .025 | PA-SR→Habit | .633*** | .016 | .403 |
| PBC→Int. | .125** | .046 | .081 | PA-SR→Int. | .180*** | .016 | .114 |
| PA-A→SD | .080* | .046 | .015 | PA-SR→Att. | .428*** | .016 | .211 |
| PA-A→Habit | .135** | .046 | .039 | PA-SR→SN | .288*** | .016 | .097 |
| PA-A→Int. | .068 | .046 | .017 | PA-SR→PBC | .448*** | .016 | .231 |
| PA-A→Att. | .052 | .047 | .009 | SD→Int. | -.004 | .016 | .001 |
| PA-A→SN | .082* | .046 | .007 | Habit→Int. | .197*** | .016 | .132 |
| PA-A→PBC | .150*** | .046 | .038 | Attitude→Int. | .266*** | .016 | .193 |
| PBC x Att.→Int. | .047 | .047 | .022 | SN→Int. | .059*** | .016 | .029 |
| PBC x SN→Int. | .008 | .047 | .003 | PBC→Int. | .327*** | .016 | .243 |
| Indirect effects | | | | PBC x Att.→Int. | -.016 | .016 | .007 |
| PA-SR→PBC→Int. | .046 | .033 | .021 | PBC x SN→Int. | .025 | .016 | .010 |
| PA-SR→Att.→Int. | .196*** | .032 | .088 | Indirect effects | | | |
| PA-SR→SN→Int. | .009 | .033 | .004 | PA-SR→PBC→Int. | .147*** | .011 | .093 |
| PA-SR→SD→Int. | .004 | .033 | .002 | PA-SR→Att.→Int. | .113*** | .011 | .072 |
| PA-SR→Habit→Int. | .052 | .033 | .023 | PA-SR→SN→Int. | .017 | .011 | .011 |
| PA-A→PBC→Int. | .019 | .033 | .005 | PA-SR→SD→Int. | -.001 | .011 | .001 |
| PA-A→Att.→Int. | .025 | .033 | .006 | PA-SR→Habit→Int. | .125*** | .011 | .079 |
| PA-A→SN→Int. | .005 | .033 | .001 | Soc.Str.→PBC→Int. | .035** | .011 | .009 |
| PA-A→SD→Int. | .002 | .033 | .000 | Soc.Str.→Att.→Int. | .022* | .011 | .006 |
| PA-A→Habit→Int. | .016 | .033 | .004 | Soc.Str.→SN→Int. | .004 | .011 | .001 |
| Sums of indirect effects | | | | Soc.Env.→PBC→Int. | .053*** | .011 | .017 |
| PA-SR→Int. | .306*** | .045 | .137 | Soc.Env.→Att.→Int. | .048*** | .011 | .016 |
| PA-A→Int. | .066 | .046 | .017 | Soc.Env.→SN→Int. | .006 | .011 | .002 |
| Total effects | | | | Sums of indirect effects | | | |
| PA-SR→Int. | .408*** | .045 | .182 | Soc.Str.→Int. | .061*** | .016 | .017 |
| PA-A→Int. | .134** | .046 | .034 | Soc.Env.→Int. | .107*** | .016 | .035 |
| | | | | PA-SR→Int. | .401*** | .016 | .253 |
| | | | | Total effects | | | |
| | | | | Soc.Str.→Int. | .090*** | .016 | .025 |
| | | | | Soc.Env.→Int. | .145*** | .016 | .047 |
| | | | | PA-SR→Int. | .581*** | .016 | .367 |

*Note*. β = Standardized path coefficient; *SE* = Standard error; ES = Effect size; SN = Subjective norm; PBC = Perceived behavioral control; PA-SR = Moderate-to-vigorous physical activity behavior (self-reported); PA-A = Moderate-to-vigorous physical activity behavior (accelerometer); SD = Self-discipline; Soc.Str. = Socio-structural factors; Soc.Env. = Socio-environmental factors; Att. = Attitude; Int. = Intention. $^{*}p < .05$ $^{**}p < .01$ $^{***}p<.001$.

**Figure 1**

*Standardized Parameter Estimates for the Integrated Model in the Liitu 2018 (Panel a) and Liitu 2020 (Panel b) Samples*

$^{*}p < .05$ $^{**}p < .01$ $^{***}p<.001$.

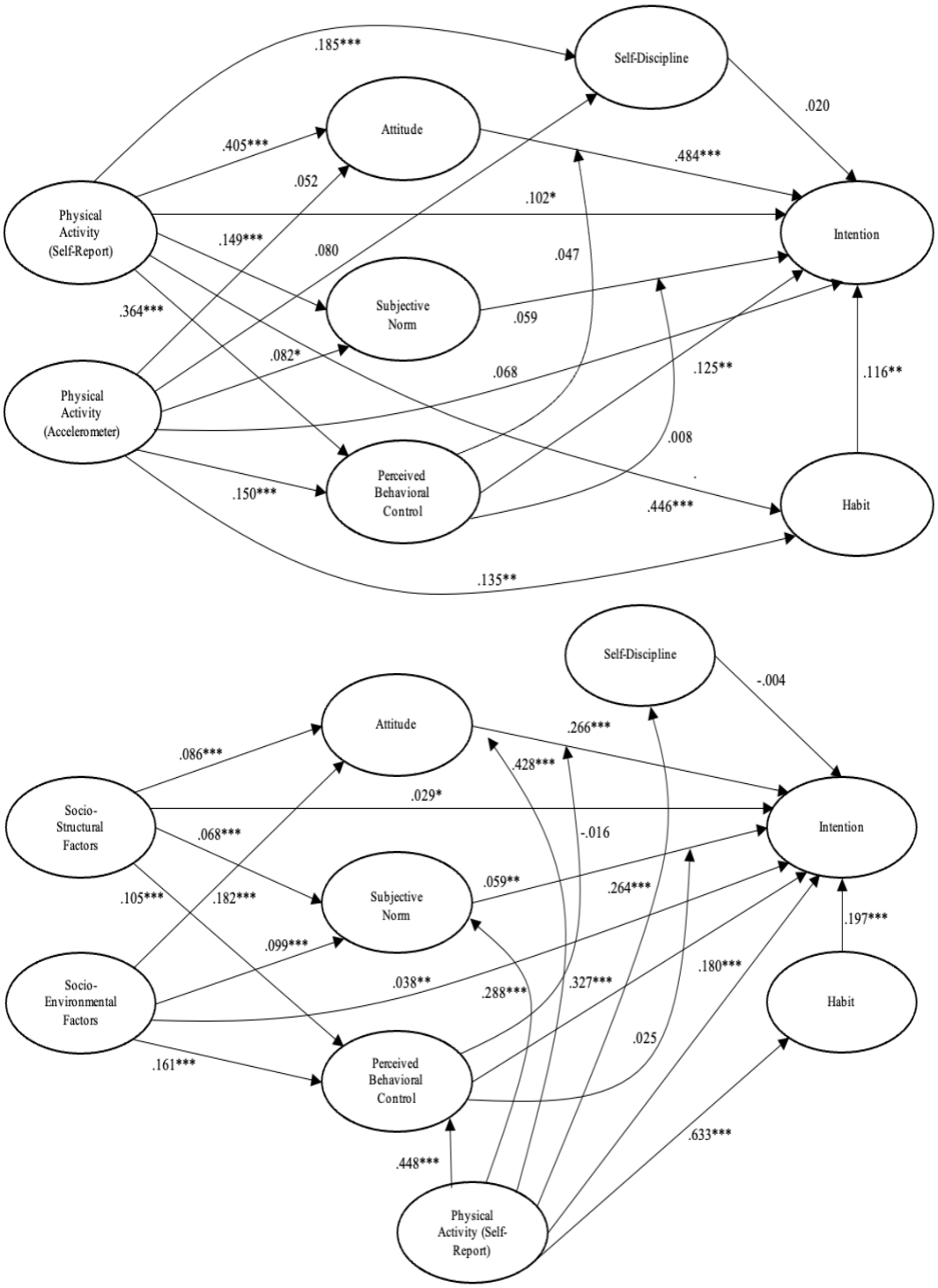

**Table 2**

*Factor Loadings, Reliability Estimates, Average Variances Extracted, and Descriptive Statistics for Model Variables*

| Construct | FL | CR | AVE | M | SD | Skew. | Kurt. |
|---|---|---|---|---|---|---|---|
| 2018 sample | | | | | | | |
| Self-reported PA behavior | | .880 | .786 | 5.991 | 1.073 | -1.017 | 0.253 |
| Item 1 | .887 | | | | | | |
| Item 2 | .887 | | | | | | |
| Self-discipline | | .811 | .420 | 2.899 | 0.523 | -0.077 | -0.321 |
| Item 1 | .620 | | | | | | |
| Item 2 | .747 | | | | | | |
| Item 3 | .688 | | | | | | |
| Item 4 | .650 | | | | | | |
| Item 5 | .618 | | | | | | |
| Item 6 | .547 | | | | | | |
| Habit | | .924 | .752 | 5.286 | 1.560 | -0.740 | -0.270 |
| Item 1 | .831 | | | | | | |
| Item 2 | .896 | | | | | | |
| Item 3 | .900 | | | | | | |
| Item 4 | .839 | | | | | | |
| Attitude | | .929 | .868 | 5.933 | 1.192 | -1.262 | 1.628 |
| Item 1 | .932 | | | | | | |
| Item 2 | .932 | | | | | | |
| 2020 sample | | | | | | | |
| Socio-structural factors | | .858 | .671 | 3.972 | 0.986 | -0.806 | -0.168 |
| Item 1 | .877 | | | | | | |
| Item 2 | .711 | | | | | | |
| Item 3 | .859 | | | | | | |
| Socio-environmental factors | | .905 | .826 | 4.497 | 0.818 | -1.869 | 3.289 |
| Item 1 | .909 | | | | | | |
| Item 2 | .909 | | | | | | |
| Self-reported PA behavior | | .919 | .851 | 4.448 | 1.696 | -0.021 | -0.686 |
| Item 1 | .922 | | | | | | |
| Item 2 | .922 | | | | | | |
| Self-discipline | | .856 | .500 | 2.483 | 0.562 | -0.005 | -0.185 |
| Item 1 | .689 | | | | | | |
| Item 2 | .788 | | | | | | |
| Item 3 | .725 | | | | | | |
| Item 4 | .738 | | | | | | |
| Item 5 | .708 | | | | | | |
| Item 6 | .575 | | | | | | |
| Habit | | .949 | .823 | 4.454 | 1.797 | -0.287 | -0.932 |
| Item 1 | .907 | | | | | | |
| Item 2 | .937 | | | | | | |
| Item 3 | .941 | | | | | | |
| Item 4 | .841 | | | | | | |
| Attitude | | .905 | .826 | 5.654 | 1.390 | -1.153 | 1.003 |
| Item 1 | .909 | | | | | | |
| Item 2 | .909 | | | | | | |

Note. FL = Factor loading of each item on designated factor, coefficients are combined loadings and cross-loadings (oblique-rotated) from partial least squares structural equation model; CR = Composite reliability coefficient from partial least squares structural equation model; AVE= Average variances extracted for factor from partial least squares structural equation model; M = Mean; SD = Standard deviation; Skew. = Skewness estimate; Kurt. = Kurtosis estimate.; PA = Physical activity.

**Table 3**

*Sample Characteristics and Descriptive Statistics for Study Variables*

| Variable | Statistics |
|---|---|
| 2018 sample | |
| Participants | 455 |
| Age, M years (SD) | 15.69 (1.69) |
| Gender, n (%) | |
| Female | 285 (62.6) |
| Male | 170 (37.4) |
| Grade level, n (%) | |
| Grade 5 | 203 (44.6) |
| Grade 7 | 127 (27.9) |
| Grade 9 | 125 (27.5) |
| Locality, n (%)[a] | |
| City center | 31 (6.8) |
| City, outside center | 249 (55.0) |
| Village center | 85 (18.8) |
| Village, outside center | 88 (19.4) |
| | |
| 2020 sample | |
| Participants | 3,878 |
| Age, M years (SD)[b] | 16.64 (0.72) |
| Gender, n (%)[c] | |
| Female | 2,161 (55.8) |
| Male | 1,694 (43.7) |
| Other | 20 (0.5) |
| Grade level, n (%)[d] | |
| Grade 1 | 1,902 (49.1) |
| Grade 2 | 1,454 (37.5) |
| Grade 3 | 494 (12.8) |
| Other | 23 (0.6) |
| Locality, n (%)[e] | |
| City center | 513 (13.3) |
| City, outside center | 1,802 (46.6) |
| Village or town | 1,009 (26.1) |
| Country, rural | 544 (14.1) |

Note. [a]Two participants did not report their locality; [b]Five participants did not report their age; [c]Three participants did not report their gender; [d]Five participants did not report their grade level; [e]Ten participants did not report their locality.

**Table 4**

*Items and Response Scales for Study Variables*

| Variable | Item(s)/measure | Scale/answer options |
|---|---|---|
| 2018 sample | | |
| Demographics | Date of birth | |
| | Gender | Boy, girl |
| | What grade are you in? | 1st, 3rd, 5th, 7th, 9th |
| | What kind of place do you live in now? | City center; city, outside center; village center; village, outside center |
| Attitude | Participating in active sports and/or vigorous physical activities during my leisure time in the next 5 weeks is… | 1 = unenjoyable, 7 = enjoyable<br>1 = useless, 7 = useful |
| Subjective norm | Most people who are important to me think I should do active sports and/or vigorous physical activities during my leisure time for the next 5 weeks | 1 = strongly disagree, 7 = strongly agree |
| Perceived behavioral control | I am confident I could do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks | 1 = strongly disagree, 7 = strongly agree |
| Self-discipline | Select the option that describes what kind of person you are usually. Everyone thinks about themselves in a different way so there are no right or wrong answers. Select one option from each row:<br>I often waste my time<br>I start tasks right away<br>I tend to postpone decisions<br>I like to get to work at once<br>I need a push to get started<br>I tend to carry out my plans | 1 = doesn't describe me at all, 4 = describes me very well |
| Intention | Circle the number that best describes your answer:<br>I intend to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks | 1 = strongly disagree, 7 = strongly agree |
| Habit | We would like to know what you think about doing sport and exercise. Choose the best option for each question:<br>Physical activity is something I do automatically<br>Physical activity is something I do without having to consciously remember<br>Physical activity is something I do without thinking<br>Physical activity is something I start doing before I realize I'm doing it | 1 = not true, 7 = absolutely true |
| Self-reported past behavior | Think about the last 7 days. On how many days have you exercised at least 60 minutes a day?<br>How much do you exercise during a regular week? | 0 = on 0 days, 7 = on 7 days<br>1 = not at all, 6 = seven hours or more per week |
| 2020 sample | | |
| Demographics | Date of birth | |
| | Gender | Boy, girl |
| | What grade are you in? | 1st, 2nd, 3rd |
| | What kind of place do you live in now? | City center; city, outside center; village or town; country, rural |

| | | |
|---|---|---|
| Socio-structural variables | To what extent do the following factors prevent you from doing sports and exercise:<br>In the proximity of my home there is not instruction of a type of sports that I found interesting<br>Doing sports/exercise is too expensive<br>In the proximity of my home there are not premises for exercising | 1 = very much, 5 = not at all |
| Socio-environmental variables | To what extent do the following factors prevent you from doing sports and exercise:<br>My friends no not do sports either<br>Appreciation towards exercise among my peers is low | 1 = very much, 5 = not at all |
| Attitude | Participating in active sports and/or vigorous physical activities during my leisure time in the next 5 weeks is…<br> | 1 = unenjoyable, 7 = enjoyable<br>1 = useless, 7 = useful |
| Subjective norm | Most people who are important to me think I should do active sports and/or vigorous physical activities during my leisure time for the next 5 weeks | 1 = strongly disagree, 7 = strongly agree |
| Perceived behavioral control | I am confident I could do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks | 1 = strongly disagree, 7 = strongly agree |
| Self-discipline | Select the option that describes what kind of person you are usually. Everyone thinks about themselves in a different way so there are no right or wrong answers. Select one option from each row:<br>I often waste my time<br>I start tasks right away<br>I tend to postpone decisions<br>I like to get to work at once<br>I need a push to get started<br>I tend to carry out my plans | 1 = doesn't describe me at all, 4 = describes me very well |
| Intention | Circle the number that best describes your answer:<br>I intend to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks | 1 = strongly disagree, 7 = strongly agree |
| Habit | We would like to know what you think about doing sport and exercise. Choose the best option for each question:<br>Physical activity is something I do automatically<br>Physical activity is something I do without having to consciously remember<br>Physical activity is something I do without thinking<br>Physical activity is something I start doing before I realize I'm doing it | 1 = not true, 7 = absolutely true |
| Self-reported past behavior | Think about the last 7 days. On how many days have you exercised at least 60 minutes a day?<br>How much do you exercise during a regular week? | 0 = on 0 days, 7 = on 7 days<br>1 = not at all, 6 = seven hours or more per week |

**Table 5**

*Latent Variable Correlations of the Integrated Structural Equation Model Variables for 2018 Sample*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Sex | — | | | | | | | | | | | | | |
| 2. Age | -.004 | — | | | | | | | | | | | | |
| 3. Weight | -.210*** | .662*** | — | | | | | | | | | | | |
| 4. Locale | .028 | .309*** | .241*** | — | | | | | | | | | | |
| 5. PB | -.080 | -.192*** | -.181*** | -.121* | — | | | | | | | | | |
| 6. PA | -.224*** | -.519*** | -.378*** | -.212*** | .373*** | — | | | | | | | | |
| 7. SD | .106* | -.197*** | -.121* | -.117* | .220*** | .163*** | — | | | | | | | |
| 8. Habit | .055 | -.050 | -.086 | -.094* | .482*** | .253*** | .288*** | — | | | | | | |
| 9. Intention | .122** | -.039 | -.042 | -.047 | .445*** | .201*** | .319*** | .535*** | — | | | | | |
| 10. Attitude | .125** | -.015 | -.031 | -.049 | .381*** | .144** | .323*** | .503*** | .749*** | — | | | | |
| 11. SN | .004 | .028 | .044 | -.087 | .156*** | .065 | .234*** | .282*** | .402*** | .478*** | — | | | |
| 12. PBC | .092* | -.054 | -.065 | -.083 | .394*** | .229*** | .337*** | .508*** | .649*** | .723*** | .386*** | — | | |
| 13. PBCxAtt. | -.166* | .097* | .098* | .021 | -.143** | -.077 | -.071 | -.237*** | -.381*** | -.553*** | -.205*** | -.551*** | — | |
| 14. PBCxSN | -.087 | .057 | .092 | .015 | -.053 | -.070 | -.090 | -.147** | -.208*** | -.291*** | -.092 | -.303*** | .491*** | — |

Note. PB = Self-reported past behavior; PA = Accelerometer past physical activity; SD = Self-discipline; Hab = Habit; Int = Intention; Att. = Attitudes; SN = Subjective norm; PBC = Perceived behavioral control.

***p < .001 **p < .01 *p < .05

**Table 6**

*Latent Variable Correlations of the Integrated Structural Equation Model Variables for 2020 Sample*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Sex | — | | | | | | | | | | | | | | |
| 2. Age | .003 | — | | | | | | | | | | | | | |
| 3. BMI | -.012 | .047** | — | | | | | | | | | | | | |
| 4. Locale | .007 | -.002 | .005 | — | | | | | | | | | | | |
| 5. PB | -.116*** | -.118*** | .008 | -.041* | — | | | | | | | | | | |
| 6. SSF | -.112*** | -.078*** | -.030 | -.203*** | .262*** | — | | | | | | | | | |
| 7. SEF | .082*** | -.038* | -.029 | -.014 | .218*** | .422*** | — | | | | | | | | |
| 8. SD | -.094*** | -.088*** | -.035* | .027 | .276*** | .146*** | .128*** | — | | | | | | | |
| 9. Habit | -.101*** | -.062*** | -.033* | .007 | .629*** | .274*** | .261*** | .331*** | — | | | | | | |
| 10. Intention | -.022 | -.014 | -.005 | -.000 | .619*** | .270*** | .316*** | .269*** | .669*** | — | | | | | |
| 11. Attitude | -.011 | -.006 | -.018 | .025 | .480*** | .266*** | .316*** | .271*** | .573*** | .711*** | — | | | | |
| 12. SN | -.043** | -.055*** | .012 | -.023 | .334*** | .188*** | .184*** | .164*** | .380*** | .480*** | .463*** | — | | | |
| 13. PBC | -.044** | -.008 | -.017 | -.001 | .509*** | .295*** | .308*** | .225*** | .545*** | .741*** | .665*** | .477*** | — | | |
| 14. PBCxAtt. | .023 | -.014 | .026 | -.014 | -.198*** | -.116*** | -.185*** | -.089*** | -.269*** | -.368*** | -.470*** | -.227*** | -.511*** | — | |
| 15. PBCxSN | -.002 | -.034* | .007 | -.017 | -.097*** | -.053** | -.115*** | -.027 | -.118*** | -.228*** | -.262*** | -.211*** | -.374*** | .528 | — |

Note. BMI = Body mass index; PB = Self-reported past behavior; SSF = Socio-structural factors; SEF = Socio-environmental factors; SD = Self-discipline; Att. = Attitude; SN = Subjective norm; PBC = Perceived behavioral control.

***p < .001 **p < .01 *p <.05

**Table 7**

*Absolute Parameter Estimate Differences and Variability Statistics from Multi-Group Analysis Comparing 2018 and 2020 Samples*

| Effect | β differences | SE |
|---|---|---|
| PB→SD | .057 | .048 |
| PB→Habit | .151*** | .047 |
| PB→Intention | .064 | .049 |
| PB→Attitude | .074 | .047 |
| PB→Subjective Norm | .158*** | .049 |
| PB→PBC | .104* | .047 |
| SD→Intention | .026 | .049 |
| Habit→Intention | .074 | .049 |
| Attitude→Intention | .187*** | .047 |
| SN→Intention | .003 | .049 |
| PBC→Intention | .196** | .049 |
| PBC x Attitude→Intention | .120** | .049 |
| PBC x Subjective Norm→Intention | .004 | .049 |

Note. β = Standardized path coefficient; SE = Standard error; PBC = Perceived behavioral control; PB = Past behavior (self-report); SD = Self-discipline.
***p < .001 **p < .01 *p < .05