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**ORIGINAL RESEARCH PAPER**

# HOW OBJECTIVELY MEASURED PHYSICAL ACTIVITY IS RELATED TO PSYCHOLOGICAL CONSTRUCTS: A PILOT STUDY AMONG ESTONIAN STUDENTS

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## Abstract

*The aim of this study was to explore the relationships between objectively measured physical activity and intrinsic motivation and the components of theory of planned behavior. Participants were 64 school students at age of 13 – 14 years from seven and eight grades in Estonia. An accelerometer was used to measure the moderate-to-vigorous physical activity twice during seven days with the interval of four weeks. In the first time of data collection, the intrinsic motivation, perceived behavioural control, attitudes, subjective norms, and intention toward physical activity in a leisure-time were measured. The path model was used to examine the relationships among the study variables. The model, in which the psychological constructs measured at the beginning of the study were entered to predict moderate-to-vigorous physical activity measured four week later, exhibited adequate fit to the data: $\chi^2 = 5.77$, $df = 5$; CFI = .985; RMSEA = .050. The path from intention to predict moderate-to-vigorous physical activity was significant ($\beta = .24$, $p < .01$). The model explained 6% of the variance in moderate-to-vigorous physical activity. By adding moderate-to-vigorous physical activity measured first time into the model increased the variance to be explained to 17%. Goodness of fit indices were also on acceptable level. The results confirmed that the components of the theory of planned behavior are indirectly and directly related also to objectively measure physical activity. The previous experience of physical*

*activity in leisure time e.g. past behavior must be considered for promotion the physical activity among adolescents.*

***Key Words**:* Moderate-to-vigorous physical activity, intrinsic motivation, Theory of planned behavior.

## Instruction

Physical activity (PA) has health benefits in children and adolescents. PA has positive effects on reducing overweight and obesity, cardiovascular diseases, cancer, osteoporosis, and depression (Janssen & LeBlanc, 2010). Despite this, data from more than 100 countries showed a prevalence of 80.3% of physical inactivity among adolescents (Hallal et al., 2012). There are a lot of research evidence based on self-determination theory (SDT; Deci &Ryan, 1985) and theory of planned behavior (TPB; Ajzen, 1991) showing how psychological variables are associated with PA. The links between psychological variables and PA were extensively established through self-reported recall questionnaire (see for review, Hagger & Chatzisarantis, 2015).

Most of the methods used in these studies are self-reported surveys. However, this method may be inaccurate due to unreliable memory recall, and it could be affected by social desirability (Adams et al., 2005). Compared with non-self-report measures (or "objective measures"), researchers showed that scores derived from self-report measures generally lacked reliability and validity (Prince et al., 2008). Therefore, the use of objective measures (e.g. pedometers, heart rate monitors, accelerometers) to assess PA and sedentary behaviours has become commonplace in recent studies. Several researchers (Dishman, Mciver, Dowda, Saunders, Pate, 2015; Wang, 2017) using SDT have found that autonomous motivation predicted positively objectively measured PA. Identified and intrinsic measures of autonomous motivation were the strongest predictors of PA (Dishman et al., 2015). An amount of the variance accounted by a single measure of relative autonomous motivation (RAI) for PA was modest (i.e., 3.5%; Wang, 2017).

The TPB posits that an individual's intention which represents also one's motivation and sense of a conscious decision to preform behaviour is directly influenced by three antecedents: attitudes, subjective norms, and perceived behavioural control (Ajzen, 1991; Hagger, Chatzisarantis, & Biddle, 2002). Researchers using the self-reported method have consistently showed the strong effect of attitude and perceived behavioural control on intention and on consequent behaviour including PA (Hagger et al., 2009; Hagger & Chatzisarantis, 2015). However, few studies have made an attempt to explore the relationships between the components of TPB and

objectively measured PA. The role of intention and attitude for prediction an objectively measured PA hase been established in obese adults and children with and without certain coordination disorders (Chevance et al., 2018; Kwan, Cairney, Hay, & Faught, 2013). The authors found that attitudes and subjective norms partially mediated the relationship between PA and motor impairment /coordination disorders.

In the present study we formulated three hypotheses. At first, we hypothesized that intrinsic motivation toward PA in leisure time will have an effect on the proximal determinants of intention and actual behaviour (objectively measured PA) from the TPB as hypothesized in the trans-contextual model (Hagger, et al., 2009). Secondly, we assumed that past PA behaviour has an increasing effect on actual PA behaviour four weeks later. Thirdly, the effects of the proposed model were assumed to hold regardless of the effect of past PA behaviour.

## Material and methods

*Participants and procedures*

Participants were 64 school students (17 boys and 47 girls) at age of 13-14 years from seven and eight grades in Estonia. The schools draw their students from an area characterized as 'middle-class' and matched the distribution of socioeconomic status levels. Students were taking physical education as a required course (two times a week, 45 – 50min per lesson). Consent for school pupils' participation in the study was obtained from parents and the school principals prior to data collection. Students were informed that they would be asked to complete a short questionnaire. They were told that participation was voluntary and they could choose to opt out if they desired. Students completed the questionnaires in gym within twenty minutes during the big break time.

In the first wave of data collection, the leisure-time moderate-to vigorous physical activity (LT1 MVPA) during the seven days was recorded and the PBC, attitudes, subjective norms, self-identity and intention components from the TPB and motivation in a leisure-time PA context were measured. Four weeks later, LT2 MVPA behavior was assessed. A four-week interest period was employed, because it represents a long-range prediction of behavior relative to the comparatively short-range effects previously studied using the TPB (Hagger et al., 2002).

*Measures*

Physical activity was measured using the Actigraph GT3X (ActiGraph LLC, Pensacola, FL). Each child wore an accelerometer on their waist during waking hours at least 10 hours for seven consecutive days except swimming and bathing activity. The data files were downloaded

using ActiLife software 6.13.3. The sampling interval (epoch) was set at 15 s. Accelerometer data were considered valid if over 600 min (10 hours) of recorded data per day at least four days out of seven were present. Zero counts of consecutive 60 min were classified as non-wear time. The PA intensity level in accelerometers was measured using Evenson, Catellier, Gill, Ondrak, & McMurray, (2008) cutoff points. The data of LT MVPA was evaluated as a percentage from the total recorded PA. The study was in accordance with the Declaration of Helsinki and approved by Research Ethics Committee of the University of Tartu (nr 268/M-6).

The theory of planned behaviour. Attitude, perceived behavioural control (PBC), subjective norms and intention subscales from the TPB questionnaire were used. Three items drawn from Courneya and McAuley (1994) were used to measure behavioural intentions (e.g., 'I intend to do active sports and/or vigorous physical activities in the next four weeks...') on seven-point Likert-type scales anchored by 'strongly disagree' (1) to 'strongly agree' (7). Attitudes were assessed in response to the following statement: 'Participating in active sports and/or vigorous physical activities during my leisure time in the next four weeks is...' Responses were measured on four seven-point semantic differential items with the following end points: bad-good, harmful-beneficial, unenjoyable-enjoyable. PBC was assessed through three items (e.g. 'I feel in complete control over whether I do active sports and/or vigorous physical activities in my leisure time in the next five weeks') measured on seven-point Likert-type scales ranging from 'no control' (1) to 'complete control' (7). Subjective norms were assessed by three items (e.g., 'People important to me think that I should do active sports and/ or vigorous physical activities during my leisure time in the next four weeks') on seven-point scales with 1 ('strongly disagree') to 7 ('strongly agree') endpoints.

Intrinsic motivation in a leisure-time PA context was assessed through the four-item intrinsic motivation subscale from the Behavioral Regulation in Exercise Questionnaire BREQ-2 **(**Markland, & Tobin 2004). An example item included: "I exercise because it is fun". Responses to each item were measured on seven point scales ranging from "very true" (7) to "not true at all" (1).

The TPB and SDT based questionnaires used in this study have been previously validated in different cultural contexts including Estonian sample (Hagger et al., 2007, 2009).

*Data analysis*

Prior to data analysis, a reliability coefficient for the scales was assessed. The value of ≥.70 was considered acceptable (Nunnally & Bernsterin, 1994). The mean scores of the scales were calculated summing

up the responses of each items and divided by the number in the corresponding scale. Relationships between study variables were examined using path analysis. The adequacy of the path model was estimated with multiple goodness-of-fit indices: the comparative fit index (CFI), non-normed fit index (NNFI), and the root mean square error of approximation (RMSEA). Acceptable fit of the hypothesized model with the data is supported if values exceed .90 for the CFI, and NNFI, and are equal to or less than .08 for the RMSEA (Hu & Bentler, 1999).

## Results

The reliability coefficients and descriptive statistics are presented in Table 1. All reliability coefficients exceeded the 0.70 criterion for acceptability (Nunnally & Bernsterin, 1994).

**Table 1**

Descriptive Statistics, internal consistency, and correlations between study variables

| | 1 | 2 | 3 | 4 | 5 | 6 | α | M | SD |
|---|---|---|---|---|---|---|---|---|---|
| 1.LT MVPA time 1 | | | | | | | | 6.75 | 2.38 |
| 2.LT MVPA time 2 | .38** | | | | | | | 1.42 | .70 |
| 3.Intrinsic motivation | .33* | .16 | | | | | .93 | 5.63 | 1.62 |
| 4.Intention | .28* | .24 | .48** | | | | .82 | 5.75 | 1.12 |
| 5.Attitude | .12 | .15 | .60** | .52** | | | .83 | 6.25 | .77 |
| 6.Perceived behavioural control | .07 | .20 | .37** | .63** | .61** | | .86 | 5.99 | .96 |
| 7.Subjective norm | .14 | .10 | .35** | .47** | .67** | .74** | .78 | 5.99 | .95 |

Note. LT MVPA = leisure-time moderate-to-vigorous physical activity. M = mean value of the LT MVPA is expressed as a percentage of the total recorded time. *P <.05; ** P< .01.

The path model presented in Figure 1. shows that intrinsic motivation toward leisure time physical activity was significantly related to the determinants of intention. From the determinants, attitude and perceived behavioural control were positively and subjective norms negatively related to intention which in turn predicted significantly LT MVPA. This model explained 6% of the variance in LT2 MVPA. Goodness of fit indices were on acceptable level: $\chi^2 = 5.77$, df= 5; NNFI = .984; CFI = 985; RMSEA = .050.

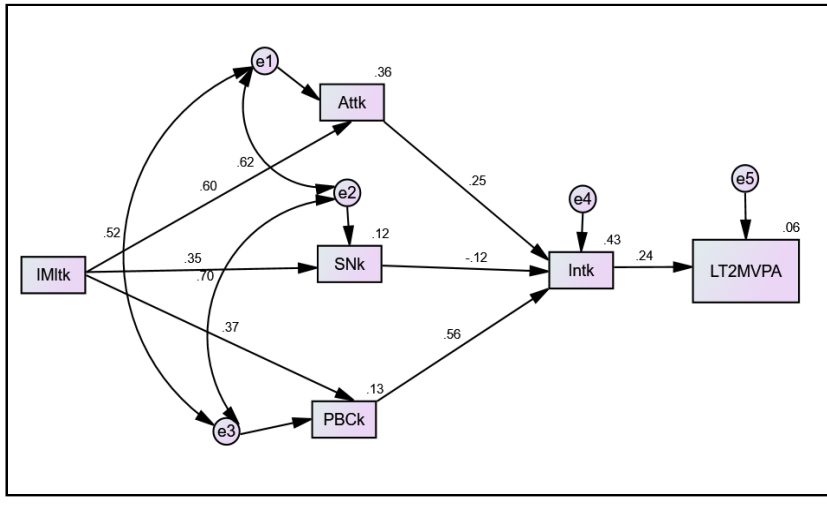


**Figure 1.** Path model predicting moderate-to-vigorous physical activity from intrinsic motivation and the components of theory of planned behaviour

Note. IMltk = mean value of the intrinsic motivation towards leisure-time physical activity; Attk = mean value of the attitude; SNk = mean value of the subjective norms; PBCk = mean value of the perceived behavioural control; Intk = mean value of the intention; and LT2MVPA = moderate-to-vigorous physical activity measured four weeks later; e1–e5 are error terms associated with each measured variable.

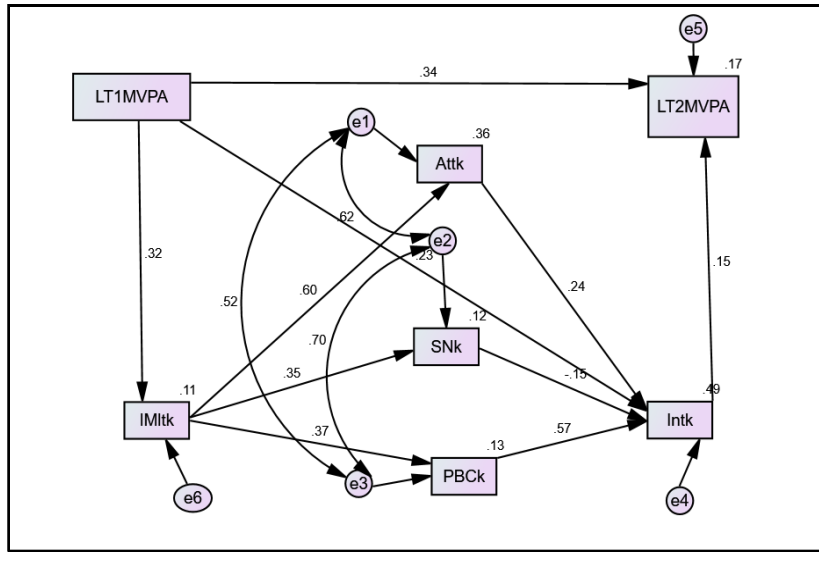


**Figure 2.** Path model predicting moderate-to-vigorous physical activity from the past experience of physical activity in leisure time, intrinsic motivation and the components of theory of planned behaviour

Note. IMltk = mean value of the intrinsic motivation towards leisure-time physical activity; Attk = mean value of the attitude; SNk = mean value of the subjective norms; PBCk = mean value of the perceived behavioural control; Intk = mean value of the intention; LT2MVPA = moderate-to-vigorous physical activity measured four weeks later and LT1MVPA = the past experience of moderate-to-vigorous physical activity; e1–e6 are error terms associated with each measured variable.

The inclusion of the past moderate-to-vigorous physical activity behaviour (LT1MVPA) into the model indicated that the relationships between intrinsic motivation and the determinants of intention and the latter with intention were hold, whereas the effect of intention on LT2MPVA turned out to be nonsignificant. Consequently, past behaviour attenuates the intention-behaviour relationship. In addition, the inclusion of past behaviour increased the explained variance in LT2MPVA from 6% to 17%. Goodness of fit indices were also on an acceptable level.

**Discussion**

The results of this study in generally confirm the findings of the research where the data were collected via self-reported measures (Hagger, et al., 2009; Hagger & Chatzisarantis, 2015). The first hypothesis that intrinsic motivation toward PA in leisure time has an effect on the proximal determinants of intention and objectively measured PA was confirmed. In both presented models with and without past PA behavior the negative relationship between subjective norm and intention was not significant. This is in line with the notion reported by several authors that subjective norms are not the most theoretically-relevant socially influential construct for understanding the behavior change (Courneya, Plotnikoff, Hotz & Birkett, 2000).

The model in which the past PA behaviour was included accounted for a greater amount of variance in PA than the model without the inclusion of the past PA behaviour. In total the model accounted for 17% of the variance in LT MVPA behaviour and supported the second hypothesis about an increasing effect of past behaviour. However, in several models of motivation for predicting self-reported PA (Hagger, et al., 2007, 2009; Hamilton & White, 2008), the total amount of the variance accounted for was higher than in the model, in which PA was objectively measured (Dishman et al., 2015; Kwan et al., 2013; Wang, 2017). It is noteworthy that the total amount of the variance in LT MVPA accounted for in the model presented in this study was higher than in above-mentioned studies.

The third hypothesis that the past LT MVPA will not attenuate the relationships between the components of the model was supported partially as the effect of intention on LT MVPA behaviour was no longer significant.
A unique contribution of this study is that an attempt was made to test the relationships between objectively measured PA and the psychological constructions from both, the self-determination theory and the theory of planned behaviour. The results of this study are important because identifying the determinants of objectively measured PA over time representing a crucial step in designing intervention programme in future.

These results should be interpreted with caution due to the sample size. The sample size was not large enough to segregate into meaningful groups for separate moderator analyses like gender or age.

## Conclusions

The intrinsic motivation toward PA in leisure time was related to intention via attitude and perceived behavioural control, and intention predicted objectively measured PA.

Past moderate-to-vigorous physical activity increased objective physical activity four week later.

The relationships between components of the proposed model to predict objective physical activity were similar to those previously reported in the trans-contextual model, where the physical activity was measured by self-reported data.

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