Original Article

Predicting accelerometer-based physical activity in physical education and total physical activity: The Self-determination Theory approach

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ABSTRACT

The present study tested the motivational model of physical education (PE) including needs for competence, autonomy, social relatedness, intrinsic and extrinsic motivation, in-class moderate to vigorous physical activity (MVPA), and total MVPA. Participants were 490 (264 girls, 226 boys) Finnish elementary school students. The data were collected using accelerometers and questionnaires for a seven-day period during the fall semester 2017. The key findings were that 1) social relatedness associated with total MVPA via in-class MVPA in girls, whereas competence was linked to in-class MVPA through extrinsic motivation in boys, 2) competence was positively linked to extrinsic motivation in a similar way in both girls and boys, 3) social relatedness and in-class MVPA were positively associated with total MVPA in both girls and boys, 4) competence, autonomy, and relatedness were positively linked to intrinsic motivation in girls when only competence and autonomy were related to intrinsic motivation in boys, and 5) in-class MVPA contributed 36% of total weekly MVPA minutes in the present sample. Although the indirect relationships between study variables did not fully support the existing PE motivational model, the direct associations showed that needs

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of competence, autonomy, relatedness could be promoted in PE classes to support intrinsic motivation, and total MVPA. **Keywords:** Psychological needs; Exercise motivation; School; Structural equation modelling.

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INTRODUCTION

Technological advances of modern society have contributed to a lifestyle that has changed children's physical activity behaviour from that of 20 years ago (Institute of Medicine, 2013). Many children are not participating in sufficient physical activity to maintain good health and well-being, as based on the recent international comparison only 30% of children and youth meet the current guidelines of daily 60 minutes of moderate to vigorous physical activity (MVPA) (Tremblay et al., 2016). Since school-aged students spend almost half of their waking hours in compulsory education, school physical education (PE) has been suggested to be one of the most cost-effective venues to increase children's MVPA engagement (Bassett et al., 2013; McKenzie & Lounsbery, 2009). Existing evidence indicates that positive motivational experiences children gain from PE may play the central role when they adopt patterns of regular physical activity (Nupponen et al., 2010; Vanttaja et al., 2017). The present study utilized the motivational model of PE (Vallerand & Lalande, 2011) grounded in the Self-determination Theory (SDT; Deci & Ryan, 2000, 2008) to examine the associations among students' motivational experiences, in-class MVPA, and total MVPA.

School PE is defined as the planned and progressive learning that takes place in school curriculum timetabled time and which is delivered to all students and involves both "learning to move" (i.e. becoming more physically competent) and "moving to learn" (i.e. learning through movement) elements (Harris, 2015). The amount of MVPA during PE classes depends on many factors, such as student skill level (Fairclough & Stratton, 2006), lesson theme (Slingerland, 2014), gender (Slingerland, 2014), lesson context (Mersh & Fairclough, 2010), resources (Levin et al., 2001), teacher specialization (Sallis et al., 1997), and class size (McKenzie & Marshall, 2000). Therefore, a few previous studies reported in the PE context showed that there is a large variation in the amount of objective MVPA that PE classes contributes to total MVPA, ranging from 8% based on accelerometer scores (Dale, Corbin, & Dale, 2000) to 34% obtained using fitness trackers (Gråstén et al., 2015). For instance, previous findings in the sample of Finnish middle school students revealed that girls met up to 26% and boys 34% of their weekly objectively measured MVPA for two 45-minute PE classes (Gråstén et al., 2015). However, motivational experiences in school PE and its contributions to actual in-class MVPA and overall MVPA is largely unknown (Ntoumanis & Standage, 2009; Vanttaja et al., 2017).

SDT (Deci & Ryan, 2000) addresses the relationships between social context and motivation. For example, SDT can be used to illuminate the relationships between intrinsic and extrinsic motivation in PE, in-class MVPA, and overall MVPA. *Intrinsic motivation* represents the situations when a student is motivated to engage in an activity because it is personally rewarding, i.e. finding the activity interesting or enjoyable without external contingencies (Deci & Ryan, 2008). Previous PE research has indicated that intrinsic motivation is linked with higher activity levels in PE classes (Gråstén & Watt, 2017; Lonsdale et al., 2009) and daily self-reported MVPA (Gråstén & Watt, 2017; Kalaja, 2012). *Extrinsic motivation* occurs when the student is motivated to perform a behaviour or engage in an activity to earn a reward, i.e. participating in PE activities to get higher grades or to win awards (Deci & Ryan, 2008). Extrinsic motivation has been shown to trigger negative behavioral outcomes, such as low physical activity in PE classes (Gao, 2012; Gao, Podlog, & Huang, 2013).

The development of intrinsic and extrinsic motivation is specified using the concept of basic psychological needs, namely competence, autonomy and social relatedness (Deci & Ryan, 2008). *Competence* refers to beliefs about the ability to be successful in an achievement domain (Deci & Ryan, 2008). Previous findings have consistently showed that physical competence is positively linked with intrinsic motivation (Deci & Ryan, 2000; Gråstén & Watt, 2017; Standage, Duda & Ntoumanis, 2005) and self-reported MVPA (Cox, Smith, & Williams, 2008; Yli-Piipari, 2011). *Autonomy* is a need to self-determine behavior and to achieve consistency

between the particular activity and sense of self-control (Deci & Ryan, 2008). Previous studies grounded in SDT have provided evidence that higher perception of autonomy is associated with higher intrinsic motivation and MVPA levels during PE classes (Lonsdale et al., 2009) and self-reported total MVPA (Chatzisarantis & Hagger, 2009; Gråstén & Watt, 2017). *Social relatedness* is the need to feel connected and to perceive acceptance from other students (Deci & Ryan, 2008). Past studies have shown that PE classes that support perceptions of social relatedness predicted self-reported MVPA participation (Cox, Smith, & Williams, 2008; Standage, Duda, & Ntoumanis, 2005; Taylor et al., 2010). Previous PE studies have also found competence to be the strongest predictor of intrinsic motivation compared to autonomy and relatedness (Standage, Duda, & Ntoumanis, 2005; Taylor et al., 2010). Applied to a PE context, when a student feels physically competent, experiences freedom to make choices or influence on PE activities, and has a pleasant and supportive learning environment created by the teacher and peers, she or he will likely to be more intrinsically motivated in PE, leading them toward being more physically active (Slingerland, 2014; Weiss,Corbin, & Pangrazi, 2000).

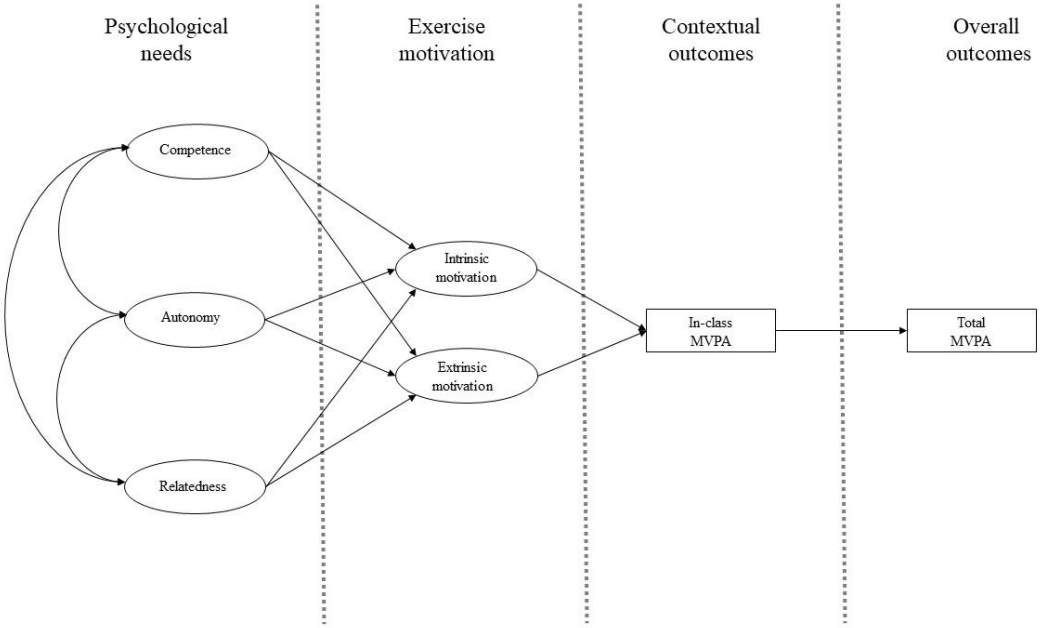

Figure 1. The theorized motivational model of PE including accelerometer-based in-class and total MVPA

An evident limitation in respect to past research in the field is that only a limited number of studies (e.g. Dale, Corbin, & Dale, 2000; Gråstén et al., 2015) examined the amount of objectively measured MVPA that PE classes contributes to total MVPA. Although an impressive body of studies investigating PE motivation and its relations with overall MVPA have been reported, past studies have exclusively relied on self-reports (e.g. Cox, Williams, & Smith, 2007; Fairclough et al., 2012; Gråstén & Watt, 2017; Haerens et al., 2010; Slingerland, 2014; Taylor et al., 2010; Yli-Piipari, 2011). Considering this, a lack of research examining the motivational processes underlying actual in-class MVPA behaviour and its contributions to overall MVPA warrants further studies. Previously, boys have been shown to be more physically active (Tremblay et al., 2016) and to score higher than girls on physical competence (Fairclough, 2003), autonomy (Soini et al., 2007), and intrinsic motivation (Yli-Piipari, 2011), whereas girls have been reported to show higher social relatedness than boys (Gråstén & Watt, 2017). On this basis, to examine gender differences in the motivational processes, the present study adopted a multi-group analysis through structural equation modelling providing parameter estimates and interpretation of parameters to both groups (Hu & Bentler,

1999). The present study extended previous findings by examining the motivational model of PE including psychological needs, motivation, objective in-class MVPA, and total MVPA (Fig. 1).

The key aim was to test the motivational model of PE including needs of competence, autonomy, relatedness, intrinsic and extrinsic motivation, objective in-class MVPA, and total MVPA in school-aged girls and boys. A presumption of the present model was that competence, autonomy, and relatedness would be positively linked with overall MVPA (Cox, Smith, & Williams, 2008; Taylor et al., 2010; Yli-Piipari, 2011) through intrinsic motivation (Lonsdale et al., 2009; Standage, Duda & Ntoumanis, 2005; Vallerand & Lalande, 2011) and in-class MVPA (Gråstén & Watt, 2017; Lonsdale et al., 2009), whereas extrinsic motivation was expected to have negative links to both MVPA scores (Gao, 2012; Gao, Podlog, & Huang, 2013). The second aim was to analyse potential differences between girls and boys in competence, autonomy, relatedness, intrinsic and extrinsic motivation, in-class MVPA and total MVPA. Finally, the contribution of in-class MVPA to total weekly MVPA minutes was determined.

METHODS

Participants

A total sample comprised 490 (264 girls, 226 boys) elementary school children aged between 10- to 12-years (M = 11.25 ± .31 years). Children were recruited from 35 public schools across Finland. All Grade 5 students were invited to participate through the direct contact with the school principals. All students who returned signed guardian consents were permitted to participate in the study. Participants were ineligible if they had a medical condition or physical injuries as informed by parents before the commencement of the study. Participation was voluntary and no extra credit was awarded for the participation. Study approval was also obtained from the ethics committee of the local university.

Measures

Basic Psychological Needs

The Finnish version of the Basic Psychological Needs in Physical Education Scale (BPN-PE; Vlachopoulos et al., 2011a) was used to assess the satisfaction of competence, autonomy, and social relatedness in PE. The scale consisted of 12 items referring three subscales: competence (e.g. *I am able to do well even in the lessons considered difficult by most kids in my class*), relatedness (e.g. *My relationships with the other kids in my class are friendly*), and autonomy (e.g. *We do things in class that interest me*). The scale had an item stem "*Generally in PE class I feel?*" All subscales were measured on five-point scales from *(1) totally disagree* to *(5) totally agree*. Vlachopoulos et al. (2011a) reported that the scale had an acceptable model fit in the sample of Greek elementary school students.

Intrinsic and Extrinsic Motivation

Contextual intrinsic motivation was measured using the Perceived Locus of Causality in Physical Education Scale (PLOC-R; Vlachopoulos et al., 2011b) which was modified for the Finnish school context. The measure consists of two subscales, comprising intrinsic motivation (e.g. *I enjoy learning new skills*) and extrinsic motivation (e.g. *In this way I will not get a low grade*). The scale comprised fourteen items and had the item stem "*I take part in PE, because*?" Each item was rated on a five-point Likert-scale ranging from *strongly disagree (1)* to *strongly agree (5)*. Previously, the confirmatory factor analysis results supported the acceptable construct validity of the scale in a sample of Greek elementary school students (Vlachopoulos et al., 2011b).

In-class and Total MVPA

In-class and total MVPA were measured using triaxial Actigraph GT3X+ accelerometers. Total MVPA was collected across a period of seven days and in-class MVPA was separated from the total MVPA minutes. Students participated in two PE classes (2 x 45 minutes) during the measurement period following the local curriculum. The activity monitors were light, small, easy to use, and were worn on the right waist. The devices collected the data at fifteen-second intervals and summarized minutes spent in MVPA. Only daytime activity (7:00 to 23:00) was included into the analyses apart from engaging in water-based activities. Total MVPA minutes were considered valid if a child had at least three days including one weekend day with at least 500 minutes of activity recorded per day, following the protocol adopted in the earlier studies of Bergh et al. (2011) and Gråstén and Watt (2016). Periods of 30 minutes of consecutive zero counts were defined as non-wearing time (Heil, Brage, & Rothney, 2012). The lower threshold for moderate-intensity was 2296 counts per minute (Evenson et al., 2008). The current device has previously been calibrated for young people in laboratory and free-living conditions (Martinez-Gomez et al., 2012).

Procedure

The objective MVPA data collection was completed across seven weeks, starting in August and continuing until October 2017. Students concurrently responded to the online questionnaires under the supervision of the teachers in the computer labs. Students were encouraged to answer honestly and assured that their responses were confidential. Children were advised to ask help if needed and they were told that their involvement was optional, and they could terminate their participation at any time without any consequences. Children represented 67 study groups taught by classroom teachers. All teachers were specialized in elementary school education with previous PE teaching experience. All classes focused primarily on developing functional movement skills, i.e. running, jumping, and throwing in different forms of activities (Finnish National Agency for Education, 2014).

Data Analysis

Prior main analyses, normal distribution, outliers, and missing values were detected. Study variables were approximately normally distributed and did not contain significant outliers based on the standardized values (± 3.00) (Tabachnick & Fidell, 2012). A total of 3.7% missing values in study variables were detected, as 96 students did not provide fully completed questionnaires. Missing completely at random (MCAR) test (χ^2 = 26.570, *df* = 24, *p* = .325) showed that data with and without missing information were similar, and therefore missing values were expected to be missing completely at random (Little & Rubin, 2002).

Correlation coefficients, means, standard deviations, and Cronbach alphas were determined for each variable. The equality of means between girls and boys were tested using the Wald's test of parameter equality, as a goodness of test is that it only requires the estimation of one model (Williams, 2015). Since this was the first study using the Finnish versions of the BPN-PE and PLOC-R scales, related confirmatory factor analyses were provided to test the factor stuctures of the scales. To test the associations between needs for competence, autonomy, relatedness, intrinsic and extrinsic motivation, in-class MVPA and total MVPA, a path model was implemented. Indirect effects between basic psychological needs and total MVPA variables were tested by setting intrinsic and extrinsic motivation and in-class MVPA as mediators into the model. Gender differences in loadings between variables were examined using two-group tests following the protocol of Muthén and Muthén (2013), in which two nested models can be tested by setting the parameters to be equal.

Chi-square test (χ2) was used as a test of the models' overall goodness-of-fit to the data. A non-significant difference between observed and theoretical distribution had an acceptable fit to the data (Hu & Bentler,

1999). To determine the appropriateness of the model the standardized root mean square residual (SRMR) and the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker-Lewis index (TLI) were examined (Hu & Bentler, 1999). A value of .05 or less for SRMR indicate excellent and .08 or less an acceptable magnitude of a varying quantity, and a value of .08 or less for the RMSEA indicate an acceptable fit of the model. The CFI and TLI indices greater than .95 are indicative for an excellent model fit. The MCAR -test for missing values was performed using SPSS Version 22.0 and path models using Mplus Version 8.0.

RESULTS

Descriptive Statistics

First, the correlation coefficients, means, standard deviations, and Cronbach alphas of the study variables were examined (Table 1). The correlations between variables ranged from weak to strong. The strongest positive correlation was found between competence and relatedness in both girls and boys. The Cronbach alphas of the scales were acceptable in both groups. Mean scores indicated that perceptions of competence, relatedness, and intrinsic motivation were relatively high. A series of Wald's tests revealed that boys had higher mean scores in competence ($p < .001$), relatedness ($p < .01$), intrinsic motivation ($p < .01$), in-class MVPA ($p < .05$), and total MVPA ($p < .001$) when compared to girls. Children's in-class MVPA ranged from 0.25 to 68.75 minutes per weekly PE classes in both girls and boys, whereas girls' total MVPA varied between 15.51 and 127.89 minutes and boys' total MVPA between 19.35 and 150.18 minutes per week. In-class MVPA contributed approximately 36% of total weekly MVPA minutes in both girls and boys.

Table 1. Correlations, means, standard deviations, and Cronbach alphas of the study variables

	1	2	3	4	5	6	7	M (SD)	α
1Competence	-	.45***	.53***	.44***	.30***	.07	.23***	3.34 (.88)	.86
2 Autonomy	.50***	-	.61***	.61***	.09	.07	.07	2.96 (.82)	.73
3 Relatedness	.62***	.52***	-	.53***	.15*	.19**	.23***	3.63 (.84)	.80
4 Intrinsic motivation	.50***	.54***	.46***	-	.17**	.03	.13	3.81 (.88)	.78
5 Extrinsic motivation	.26***	.08	.07	.14*	-	.03	.02	2.67 (.63)	.74
6 In-class MVPA	.05	-.04	.09	.03	-.15*	-	.21***	19.90 (13.01)	-
7 Total MVPA	.12	.50	.17*	-.02	-.06	.27***	-	55.11 (20.64)	-
M (SD)	3.64 (.81)	3.08 (.78)	3.84 (.73)	4.05 (.80)	2.74 (.74)	22.64 (14.57)	64.49 (23.65)		
α	.81	.66	.78	.74	.77	-	-		

Note 1. Correlations, means, standard deviations, and Cronbach alphas for girls (n = 264) are presented above and for boys (n = 226) below the diagonal.
*Note 2. ***p < .001, **p < .01, *p < .05.*

Confirmatory Factor Analysis

Confirmatory factor analyses were conducted to test the factor stuctures of the Finnish versions of the BPN-PE and PLOC-R scales. The construct validity of the the BPN-PE scale ($\chi^2(50) = 106.59$, $p < .001$, $CFI = .97$, $TLI = .96$, $RMSEA = .048$, $SRMR = .035$) was confirmed. However, the fit indices revealed a poor factor structure for the PLOC-R scale ($\chi^2(139) = 476.91$, $p < .001$, $CFI = .85$, $TLI = .82$, $RMSEA = .071$, $SRMR =$

.063). Based on the modification indices, the residual variances of the individual items "*Because it is important to me to do well in PE*" and "*Because it is important to me to be good in the sports we practice in PE*", "*Because I would feel bad about myself if I didn't*" and "*Because it would bother me if I didn't*", and finally "*Because I would feel bad if the teacher thought that I am not good at PE*" and "*Because in this way I will not get a low grade*" were allowed to correlate. The modified model had the acceptable factor structure ($\chi^2(135) = 299.85$, $p < .001$, *CFI* = .93, *TLI* = .91, *RMSEA* = .050, *SRMR* = .056). In addition, Cronbach alphas of both intrinsic and extrinsic subscales were acceptale (Table 1). Based on this, the present scales provided reliable results for the path model development.

The Motivational Model of Physical Education

First, to examine the associations between need for competence, autonomy, relatedness, intrinsic and extrinsic motivation, in-class and total MVPA participation, both girls and boys were included in the same model. The theorized model revealed an excellent model fit ($\chi^2(1) = 2.57$, $p = .109$, *CFI* = .99, *TLI* = .92, *RMSEA* = .057, *90% CI* [.00, .15], *SRMR* = .011). The standardized model results showed direct paths between competence → intrinsic motivation ($\beta = .19$, $p < .001$), autonomy → intrinsic motivation ($\beta = .39$, $p < .001$), social relatedness → intrinsic motivation ($\beta = .18$, $p < .001$), competence → extrinsic motivation ($\beta = .33$, $p < .001$), in-class MVPA → relatedness ($\beta = .21$, $p < .001$), in-class MVPA → total MVPA ($\beta = .21$, $p < .001$), competence → total MVPA ($\beta = .19$, $p < .001$), autonomy → total MVPA ($\beta = -.16$, $p < .05$), and relatedness → total MVPA ($\beta = .17$, $p < .01$). An indirect path from relatedness to total MVPA via in-class MVPA was detected ($\beta = .04$, $p < .01$).

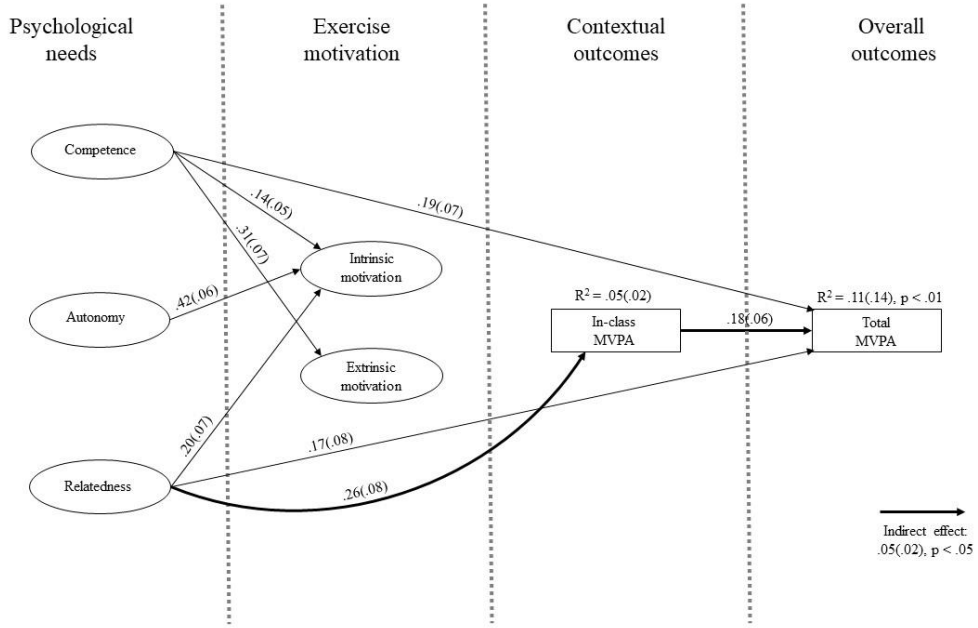

Figure 2. The standardized parameter estimates of the motivational model for girls (n = 264)

To find gender differences in associations between competence, autonomy, relatedness, intrinsic and extrinsic motivation, in-class and total MVPA participation, the model was separately tested in girls and boys. The model showed an excellent model fit for the data of girls ($\chi^2(1) = 1.803$, $p = .179$, *CFI* = .99, *TLI* = .93, *RMSEA* = .055, *90% CI* [.00, .19], *SRMR* = .012) (Fig. 2). The standardized results showed direct paths between competence → intrinsic motivation, autonomy → intrinsic motivation, social relatedness → intrinsic

motivation, competence → extrinsic motivation, in-class MVPA → relatedness, in-class MVPA → total MVPA, competence → total MVPA, and relatedness → total MVPA. An indirect path between relatedness and total MVPA through in-class MVPA was found. Squared multiple correlations revealed that the model explained 5% of the variability of in-class MVPA and 11% of total MVPA in girls. The model including boys only showed an excellent model fit ($\chi^2(1) = 1.803$, $p = .179$, *CFI* = .99, *TLI* = .93, *RMSEA* = .055, *90% CI* [.00, .19], *SRMR* = .012) (Fig. 3). The standardized parameter estimates revealed direct paths between competence → intrinsic motivation, autonomy → intrinsic motivation, competence → extrinsic motivation, in-class MVPA → extrinsic motivation, in-class MVPA → total MVPA, and relatedness → total MVPA. An indirect path between competence and in-class MVPA through extrinsic motivation was discovered. Squared multiple correlations revealed that the model explained 5% of the variability of in-class MVPA and 12% of total MVPA in boys.

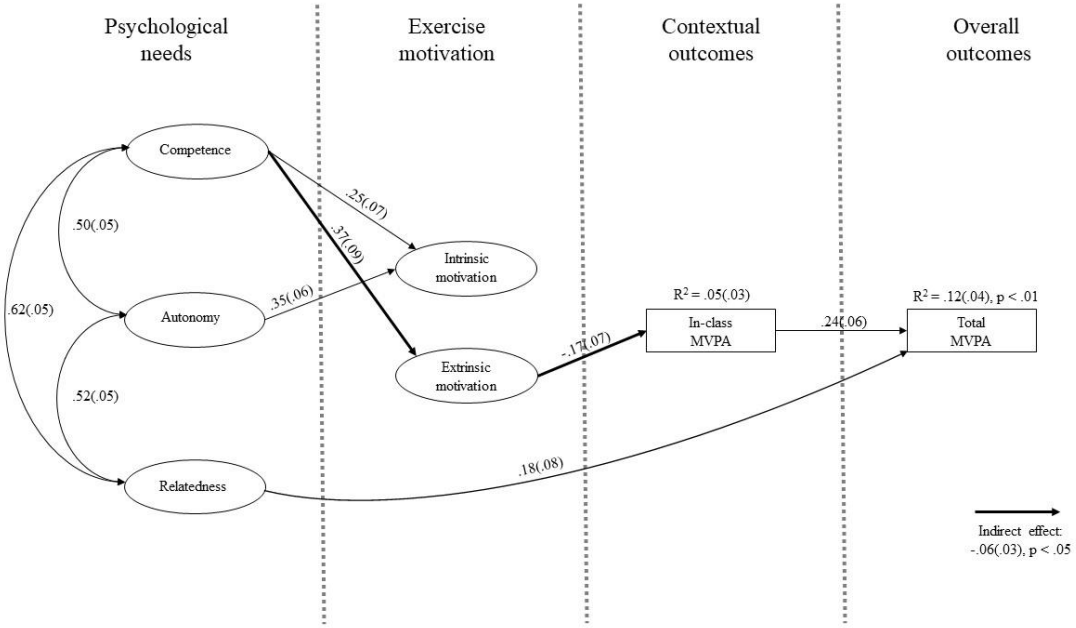

Figure 3. The standardized parameter estimates of the motivational model for boys (n = 226)

Finally, to test the statistical significance of the gender differences in associations between competence, autonomy, relatedness, intrinsic and extrinsic motivation, in-class and total MVPA participation, a multi-group model including girls and boys was implemented. The model revealed an excellent model fit ($\chi^2(2) = 2.53$, $p = .282$, *CFI* = .99, *TLI* = .97, *RMSEA* = .033, *90% CI* [.00, .14], *SRMR* = .011). Next, the loadings of paths were fixed to be equal in both girls and boys. A series of two-group tests showed a difference between girls and boys in the loading of direct path between extrinsic motivation and in-class MVPA ($\chi^2(1) = 4.16$, $p < .05$).

DISCUSSION

The aim of the present study was to test the motivational model of PE including needs for competence, autonomy, relatedness, intrinsic and extrinsic motivation, in-class MVPA, and total MVPA. The key findings were that 1) social relatedness associated with total MVPA via in-class MVPA in girls, whereas competence was linked to in-class MVPA through extrinsic motivation in boys, 2) competence was positively linked to extrinsic motivation in a similar way in both girls and boys, 3) social relatedness and in-class MVPA were

positively associated with total MVPA in both girls and boys, 4) competence, autonomy, and relatedness were positively linked to intrinsic motivation in girls, when only competence and autonomy were related to intrinsic motivation in boys, and 5) in-class MVPA contributed 36% of total weekly MVPA minutes in the present sample.

This study was the first to examine the motivational model of PE including needs, motivation, objective MVPA scores in the same model. The findings partly supported the existing model of Vallerand and Lalande (2011), as social relatedness and total MVPA was associated via in-class MVPA in girls, whereas competence was linked with in-class MVPA through extrinsic motivation in boys. Similarly, a study of Gråstén and Watt (2017), with an exception that in-class MVPA was not directly measured in their setting, revealed indirect links between competence, intrinsic motivation, and PE performance in girls, not in boys. These results indicated that girls and boys might perceive PE classes in a different way. However, it was unforeseen that psychological needs unrelated with objective MVPA scores through intrinsic motivation in neither girls nor boys. Perhaps, the use of measurement protocol in the current study (Bergh et al., 2011) could explain, at least partly, the non-materialized indirect associations. The MVPA minutes for each student were recorded across a seven-day period and total MVPA scores were considered valid if a student had at least three days of light to vigorous activity. It is possible that daily or weekly variation in MVPA behaviour can provide unstable results. In contrast, most past studies reporting the positive relationships between intrinsic motivation and MVPA variables (e.g. Gråstén & Watt, 2017; Haerens et al., 2010; Taylor et al., 2010; Yli-Piipari, 2011) used self-reports, which are often targeted to measure "typical" MVPA behaviour over accurate MVPA minutes across a specific timeframe. The accuracy of the current objective measurement instrument may provide a plausible explanation in respect to the differences between past and current findings. Despite that, the indirect path found in girls warrants the use of pedagogical methods to increase perceptions of social relatedness in PE teaching. For instance, children could be given opportunities to lead warm-ups, embrace different roles, such as coach, referee, captain, and scorer, or select tactics and team strategies when applicable (Wallhead & Ntoumanis, 2004). In sum, having a peer with whom to be physically active could lead children to persist at greater physical activity over the long term (Ryan & Deci, 2017). In turn, an unexpected finding of the negative indirect path between need for competence and in-class MVPA via extrinsic motivation in boys may indicate excessive competition among boys in PE classes. Boys tend to be more competitive than girls are, as Lauriola et al. (2004) found some evidence that girls participated in sport activities more for friendship and boys more for competitive motives and the satisfaction of winning. Adapted to PE classes, this behaviour can be problematic, especially among boys with lower perceptions of physical competence. To control the negative effects of extrinsic motivation and competition in PE classes, school PE could be most effective if the key objective is increasing intrinsic motivation (Lonsdale et al., 2009) through competence, autonomy, and relatedness.

Second, an unexpected finding was that need for competence had a positive and weak link to extrinsic motivation in a similar way in girls and boys. In other words, the higher need for physical competence, the higher perceptions of extrinsic motivation in PE. Previous PE studies have found need for competence to be the strongest predictor of intrinsic motivation compared to autonomy and relatedness (Standage, Duda, & Ntoumanis, 2005; Taylor et al., 2010). Similar evidence has not been reported in respect to extrinsic motivation. According to SDT, extrinsically motivated student in PE classes engages in an activity, for example, to win a competition (Deci & Ryan, 2008). PE teachers can provide competitive situations that can foster or discourage students to experience long-lasting positive learning outcomes (Layne, 2014). These competitions in school PE are not limited to training physical skills, they also have potential to contribute positively or negatively to children's affective, cognitive, and social development (Bailey et al., 2009; Harris, 2015). However, appropriate competitive situations, for example winning as a team, are also needed for

positive learning outcomes, if the students are taught the prerequisite skills needed to participate in these situations (Siedentop & Tannehill, 2000). If teaching in PE classes focuses on effort and active participation over personal skills and qualities (Deci & Ryan, 2008), a diversity of students with high or low physical competence have opportunities to learn desired short-term (e.g. particular physical skill) and long-term goals (e.g. physically active lifestyle), regardless of extrinsic motivation. Therefore, it would be firmly important to enhance physical competence across PE classes. For instance, children could be provided opportunities to practice movement skills using small group over individual activities, opportunities to take the ownership of the activities by giving responsibility for setting up equipment and dictating the progression through activities and maximizing the active participation over waiting for their turn during specific activities (Gråstén et al., 2017).

Third, as SDT proposes, the results showed that the need for social relatedness associated with total MVPA in both girls and boys. Similarly, according to the previous study of Cox, Williams, and Smith (2007), students who experienced positive relatedness when engaged in PE activities, were also more physically active on their leisure time. To support perceptions of social relatedness across actual PE lessons, students could be given opportunities to fulfil their roles in their teams to develop content knowledge and refine performance within peer teaching instructional tasks (Wallhead, Garn, & Vidoni, 2013).

Fourth, all psychological needs, competence, autonomy, and relatedness were positively linked with intrinsic motivation in the model of girls. The present links followed the motivational model of Vallerand and Lalande (2011), in which the development of intrinsic motivation is specified through basic psychological needs (Deci & Ryan, 2008). However, social relatedness was not connected to intrinsic motivation in the boys' group. Similarly, Gråstén and Watt (2017) found that girls and boys differ regarding their perceptions of social relatedness in the PE context. The present and previous findings may indicate that girls perceived the social aspect of PE classes more important than boys did. This is interesting, especially when one of the main assumptions of SDT is the universality of its psychological constructs and motivational processes across cultures, developmental periods, and for this study, gender (Deci & Ryan, 2000). In Finland, girls and boys are often taught in gender specific groups, as schools are free to determine how to group students (Ministry of Education and Culture, 2012). However, this literature remains unclear, no studies with respect to the motivational differences in PE classes between girls and boys taught in single sex groups or mixed group have been reported. PE teachers could provide activities with reasonable skill levels and challenges to support perceptions of physical competence, multiple choices and freedom to choose activities from a range of activities to promote perceptions of autonomy, and opportunities to interact and socialize with other participants to support perceptions of social relatedness (Deci & Ryan, 2000; 2008).

Finally, following past studies in the field (Fairclough & Stratton, 2006; Gråstén et al., 2015), an expected finding was that in-class MVPA related with total MVPA in both girls and boys. Specifically, in-class MVPA contributed 36% of total MVPA on the weekly basis in the present sample. These findings showed the importance of school PE classes toward total MVPA minutes. However, relatively low overall MVPA minutes across the current sample were concerning. Because regular PE classes are not restricted to training physical skills (Bailey et al., 2009), it is clear that school PE cannot provide unlimited contribution to the total MVPA minutes (Gråstén & Watt, 2016). The present results indicated small MVPA minutes outside PE classes and during leisure time, as most children did not receive sufficient MVPA on the daily basis. This is expected to change in coming years, as more than 80% of Finnish comprehensive schools (all schools in the current sample) are involved in the Finnish Schools on the Move Program (2016). Specifically, this is a national action plan aiming to establish a physically active culture in Finnish comprehensive schools. For example, the actions include active transportation to school, supervised games, access to fitness facilities and sport

equipment during recess breaks, minimizing sedentary time, and maximizing the efficient time in PE classes. Some actions on the national level to increase physical activity among elementary students during school days have already been done. It must be recognized that even children meeting the physical activity guidelines can still be inactive for many hours per day, e.g. after-school and weekends (Metcalf et al., 2012). Second, if children accumulate increased in-school activities, it is possible that they reduce their active play or participation in unorganized activities during leisure time (Tammelin, Laine, & Turpeinen, 2013). Therefore, parents could be advised to support their children to be more physically active, for instance, in terms of transportation to school and leisure activities, walking or biking with children. As parents are often important role models to their children, families could be encouraged to spend more time playing together, for example after-school and weekends (Gråstén, 2017).

Limitations and future studies

To date, no studies incorporating SDT-based psychological needs, intrinsic and extrinsic motivation, objective in-class MVPA, and total MVPA have been reported. Therefore, the use of accelerometer-based scores was the key strength of the study. Despite, the findings presented are not free of a set of limitations. First, the study was implemented using the cross-sectional study design, and therefore, the associations identified should not be interpreted as cause-and-effect relationships. In addition, the motivational variables were measured using self-reports, when the truthfulness and accuracy of self-reported measures may be compromised. Some behaviours may be difficult to recall or so sensitive that participants are reluctant to provide exact details. Finally, several measurement periods for objective MVPA scores over fall, winter, and spring seasons would have been beneficial, although the current measurements followed existing seven-day protocols. Future studies could assess the seasonal variation between psychological needs, motivation, and MVPA scores to standardize the measurement practices as accurately as possible. As this study focused on elementary school children, the presented model could be studied among larger samples of children and youth at different ages. Finally, longitudinal studies following motivational variables over prolonged periods and studies examining PE experiences among single-sex and mixed groups could have a great value to develop school PE classes to support children's PE motivation and physical activity behaviour.

CONCLUSIONS

The current findings partly supported the presented PE motivational model. Although the indirect relationships between psychological needs, motivation, and MVPA variables did not fully materialize as expected, the direct associations added into the growing body of SDT-based studies in the school PE context that basic psychological needs could be firmly promoted in PE classes to support intrinsic motivation and actual MVPA. To do this, PE teachers could provide activities with reasonable skill levels and challenges to support perceptions of physical competence, freedom to choose activities from a range of activities to promote perceptions of autonomy, and opportunities to interact and socialize with other participants to support perceptions of social relatedness.

A cause of concern arising from these results was the insufficient MVPA minutes on the daily basis across the current sample of children. Although the participation schools are involved in the national action plan, overall objective MVPA minutes were very small, especially among less active students. Therefore, raising awareness about risks related to insufficient MVPA and inactive lifestyle among parents and families is essential to enhance children's health and well-being. In addition to valuable actions taken in schools, parents could be encouraged to firmly support their children to be more physically active in terms of leisure time activities.

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COMPETING INTERESTS

The authors declare no competing interests.

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