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Stability and transitions in school-aged children's physical education need satisfaction profiles: A latent transition analysis

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ABSTRACT

This study examined stability and transitions of school-aged children's self-determination theory-based need satisfaction profiles in physical education (PE) over three years. Participants were 1121 (girls 573, boys 548) Finnish school children. The self-report data were assessed using identical procedures from 2017 to 2020. Three latent need satisfaction profiles were identified: Low, Mid, and High need satisfactions. Transitions mainly occurred between grade 5 and 6 in elementary school, after which the profile memberships remained relatively stable. The profile memberships were not school- or PE group dependent over time. These results indicate that school-based actions to achieve a positive impact on need satisfaction development could already be commenced in the early school years, as it may be more challenging to induce positive changes in student behaviours after children have transitioned to middle school.

Introduction

Achieving the benefits of physical education (PE), such as regular physical activity engagement, positive self-regard and improved coping skills and cognitive functioning, and higher academic performance (Finnish National Agency for Education, 2014; SHAPE America, 2013), are challenging if children show low motivation to engage in PE activities. The teacher-student interactions largely determine whether children experience these positive benefits. If they do, this may directly influence their motivation to engage physical activities in PE and beyond PE classes (Warburton, Wang, Bartholomew, Tuff & Bishop, 2020). Basic psychological need satisfactions (Deci & Ryan, 2000) are important determinants of autonomous motivation in PE classes (Vasconcellos et al., 2020). While need satisfactions (Vasconcellos et al., 2020; Warburton et al., 2020) have been widely studied, little is known about the stability of satisfaction profiles and transitions between them over time. This study examined this under-researched topic in the PE context over a three-year period.

The Self-determination Theory (SDT; Deci & Ryan, 2000; Ryan & Deci, 2017) offers a useful framework for investigating the processes of motivation. The Basic Psychological Need Theory (BPNT), which is grounded in the SDT, postulates the existence of three basic psychological needs: autonomy (the need to feel in control of one's behavior and goals), competence (the need to feel competent and have the capacities needed to accomplish goals), and social relatedness (the need to feel a sense of belonging and attachment to other people) (Deci & Ryan, 2000; Ryan & Deci, 2017). The satisfaction of basic psychological needs is universally essential for positive psychological well-being and functioning. In PE classes, children who feel that they are physically capable, socially connected with their peers, and provided with opportunities to make decisions on their PE activities may have a higher autonomous motivation to participate in PE activities (Wang & Chen, 2021). Although it has been suggested that the three need satisfactions are universal (Ryan & Deci, 2017), girls have shown lower competence need satisfaction than boys (Ferriz, Sicilia & Sáenz-Álvarez, 2013; Gråstén et al., 2019; 2020; Wang & Chen, 2021) but similar autonomy need satisfactions as boys (Gråstén & Watt, 2017; Wang & Chen, 2021), while the findings on the impact of gender on social relatedness need satisfaction have been conflicting (Ferriz et al., 2013; Gråstén & Watt, 2017; Xiang, Agbuga, Liu & Mcbride, 2017).

In turn, low levels of basic psychological need satisfactions are expected to inhibit motivation and their frustration to have even more harmful consequences. For example, in school PE classes, a student who fails to complete a given task but has a high level of need satisfactions and hence also of self-determination may be able to take actions to fix the problem, whereas a student who has a low level of need satisfactions

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may blame other factors, make excuses, or refuse to accept responsibility for the problem and, most importantly, remain unmotivated to rectify the situation. There is evidence that the intensity of feelings that differentiate need satisfactions and frustrations may be asymmetrical, as low need satisfaction is not always associated with need frustration, whereas need frustration is invariably associated with low need satisfaction (Vansteenkiste & Ryan, 2013). It is also possible that individuals experience the effects of need satisfaction and frustration simultaneously (Warburton et al., 2020).

The most topical approach in the SDT-based literature is to incorporate need satisfactions and frustrations into educational research (Chen et al., 2015; Ryan, Deci & Vansteenkiste, 2016; Warburton et al., 2020), since they may co-occur in learning settings (De Meyer et al., 2014; Haerens et al., 2013; L. 2015; Sun, Li & Shen, 2017; Wang, Morin, Ryan & Liu, 2016). The identification of need profiles may further current understanding of human behavior and functioning (Li et al., 2021). For instance, Warburton et al. (2020) recently examined the simultaneous associations of need satisfaction and frustration with motivation and well-being in high school PE students. Li et al. (2021) investigated the associations of need satisfaction and need frustration clusters with mindfulness, physical literacy, physical activity enjoyment, and physical activity in a sample of schoolchildren in the physical activity context. In addition to the cross-sectional research referenced above, a few similar studies have investigated need satisfaction profiles in high school PE students (Granero-Gallegos, Baena-Extremera, Pérez-Quero, Ortiz-Camacho & Bracho-Amador, 2012) and classroom (Earl, Taylor, Meijen & Passfield, 2019), however, without including frustrations as a variable. Other cross-sectional PE studies have examined motivational profiles derived from need satisfactions along with some other behavioural variables in high school students (Bechter, Dimmock, Howard, Whipp & Jackson, 2018; Huéscar Huéscar Hernández, Moreno-Murcia, Ruíz González & León González, 2019; Liu & Chung, 2018). In a recent systematic review, Vansteenkiste, Ryan and Soenens (2020) called for additional need satisfaction studies using person-person cantered analyses with samples of younger schoolchildren.

Hence, there are several reasons for investigating longitudinal changes in need satisfaction profiles from the elementary years onwards, as these have not to date been empirically studied in the PE or any other elementary educational domain Li et al., (2021); Vansteenkiste et al., (2020); Warburton et al., (2020). As previous cross-sectional research has revealed, school-aged children may represent different need profiles in PE classes. Person-oriented methods (i.e., identifying groups of individuals with similar features) are superior to variable-oriented methods (i.e., identifying processes found to a similar degree in all members of a group) in profiling qualitatively distinct groups (Laursen & Hoff, 2006). These methods allow for population heterogeneity in developmental differences between individuals (Ferguson, Moore & Hull, 2019). In addition to gender differences in need satisfactions, schools in Finland are free to decide whether girls and boys are taught using single-gender or coeducational groups (Finnish National Agency for Education, 2014). Therefore, it is important to consider the covariate effects of gender, PE group, and school, when examining need satisfaction profiles in the school PE context. This study extends previous PE research by using person-cantered latent transition analysis to examine stability and transitions in the need satisfaction profiles over time.

The need satisfaction profiles were explored over three years in the PE context, starting with the baseline assessments at grade 5. The aims were: 1) to identify the qualitatively distinct latent profiles of children with specific patterns of competence, autonomy, and relatedness need satisfactions in PE, 2) to examine the stability and transitions between profiles over time, and 3) the covariate effects of gender, PE group, and school over time. Based on previous research (Granero-Gallegos et al., 2012; Li et al., 2021; Warburton et al., 2020), we expected to find three need satisfaction profiles.

Methods

Participants

The total sample comprised 1121 (girls 573, boys 548) Finnish schoolchildren (M_{age} = 11.26 ± .32 years) representing approximately two percent of the total population of 61 062 fifth graders at baseline. The children were recruited from 35 randomly selected public schools in Southern (46% of students), Central (41%), Eastern (6%), and Northern Finland (7%) (Statistics Finland, 2019). The participating schools were typical of Finnish comprehensive schools (i.e., Finnish-speaking, dominant ethnicity white Finnish, approximately 300 to 500 students per school, and following the national core curriculum). All grade 5 students were invited by via direct contact with school principals. The children, drawn from a total of 67 classes, were taught by the same classroom teachers at T0 and T1. At T2 and T3 at the middle school level, the children were taught by specialist PE teachers. Participants engaged in a total of 90 min of PE per week. Although all students were given an equal opportunity to participate in the study, no children with special needs or disabilities volunteered.

Procedure

Data were collected using the same procedures at all measurement points (August-September) during 2017–2020 (T0-T3). Participants completed structured questionnaires in their classroom under the researchers' supervision. They were given information about the study protocols and their rights to withdraw their participation at any time without consequences. They were instructed to answer honestly and ask for help in case of unclear questions. The children's legal guardians were informed about the study protocol and written parental consents were obtained. The ethics committee of the local university approved the study.

Measures

Demographics. Gender was asked in the need satisfactions questionnaire. Gender identification (girl or boy) was prefaced with the stem: "*Using the given options, please select the one that describes you.*" PE group (e.g., 5A, 5B), school and date of birth were provided by the school secretaries.

Autonomy, competence, and relatedness need satisfactions. The three need satisfactions were assessed using the Finnish version of the Basic Psychological Needs in Physical Education Scale (BPN-PE; Vlachopoulos, Katartzi & Kontou, 2011). The item stem was "*In PE classes I feel that…*" The 12-item scale consisted of three 4-item subscales: competence need satisfaction (e.g., *I can do well even in the lessons considered difficult by most kids in my class*), relatedness need satisfaction (e.g., *my relationships with the other kids in my class are friendly*), and autonomy need satisfaction (e.g., *we do things in class that interest me*). All three subscales were measured on five-point response scales from *(1) totally disagree* to *(5) totally agree*. Individual mean scores were calculated for each subscale. Gråstén et al. (2019) reported acceptable validity for the scale ($\chi 2(50) = 106.59$, $p < .001$, *CFI* = 0.97, *TLI* = 0.96, *RMSEA* = 0.048, *SRMR* = 0.035) in a sample of Finnish school children.

Data analysis

First, the data were examined for normality of distributions, outliers, and missing values. Next, descriptive statistics of the study variables were analysed. The profile identification including the observations of the competence, autonomy, and relatedness needs satisfactions variables was examined using latent profile analysis. The stability, transitions, and covariate effects were analysed using latent transition analysis applying the five-step protocol outlined by

Table 1
Participants, means, standard deviations, and Cronbach alphas of the study variables at each time point.

Variable	Time	n	M	SD	α
Competence need satisfaction	T0	1121	3.43	.86	.84
	T1	991	3.38	.92	.89
	T2	895	3.30	.87	.90
	T3	819	3.29	.91	.91
Autonomy need satisfaction	T0	1121	2.99	.80	.70
	T1	991	2.82	.81	.76
	T2	895	2.87	.81	.77
	T3	819	2.86	.79	.76
Relatedness need satisfaction	T0	1121	3.73	.83	.79
	T1	991	3.64	.82	.80
	T2	895	3.57	.80	.83
	T3	819	3.52	.83	.84

Ryoo, Wang, Swearer, Hull and Shi (2018): 1) Cross-sectional data diagnosis and profile identification using latent profile analysis; 2) Testing longitudinal measurement invariance using latent transition analysis; 3) Defining latent profiles and testing differences between them; 4) Testing latent statuses for multiple-group latent transition analysis and transition probability invariance; and 5) Testing latent transition analysis with covariates.

Latent profiles of the competence, autonomy, and relatedness need satisfactions subscales were identified using the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), sample-size adjusted BIC (ABIC), Adjusted Lo-Mendell-Rubin likelihood ratio test (ALMR-LRT)· and entropy values (Muthén & Muthén, 2017). Lower AIC, BIC, and ABIC and higher entropy indicated the most reasonable model fit. The Adjusted Lo-Mendell-Rubin Ratio (ALMR-LRT) test compared the estimated model with an alternative model containing one latent group fewer than the current model. A statistically significant model supported retention of the estimated model. Comparison of the measurement invariance model (fixed to be equal over time) with a non-measurement invariance model (freely estimated) was implemented using the longitudinal measurement invariance test. The target was to achieve measurement invariance in defining the characteristics of latent statuses. Because of the large number of parameters and the developmental changes that occur over time in childhood, statistically significant invariance was expected, in which case the non-invariance model would be selected for the subsequent analyses. Next, to test transitions between latent profiles over time, the transition probabilities were fixed to be equal. Finally, the covariate effects of gender, PE group, and school on profile membership at each time point were tested. Descriptive statistics and missing value analysis were performed using SPSS 26.0 and latent transition analysis models performed using Mplus Version 8.4.

Results

Preliminary analyses

Graphical inspection revealed that the observed variables were normally distributed and that the standardized values (± 3.0) showed no significant outliers. The percentage of missing values was 16% (9 068 out of 56 016 values), as the proportion of participants with incomplete data increased over time (Table 1). The Missing Completely at Random (MCAR) test (χ^2 = 3774.38, *df* = 3659, *p* = .090) indicated that the data matrices with and without missing values were equal, and thus, no further data modification was required.

Descriptive statistics

Means, standard deviations (), and correlation coefficients (Table 2) were examined. The mean scores indicated that the need satisfactions declined over time. The correlation coefficients of the latent variables varied between weak and moderate. The strongest positive correlations at T2 were found between the competence and relatedness need satisfactions and between the autonomy and relatedness need satisfactions. The correlations between time points were strongest at the same measurement points for all the observed variables. For instance, competence need satisfaction at T0 had the strongest association with the autonomy and relatedness need satisfactions at T0, rather than with the competence, autonomy, or relatedness needs at T1, T2 or T3.

Latent profile analysis

Latent profile memberships based on competence, autonomy, and social relatedness need satisfactions over time were determined (Table 3). When the number of profiles was increased, the AIC, BIC, and ABIC indices decreased. The four-group solution revealed one profile with less than 5% of the participants at each time point. After considering all the indices, the three-profile solution (3–3–3–3) was deemed the most reasonable. Profile 1 was labelled "*Low need satisfaction*". The participants in this profile had significantly lower need competence, autonomy, and relatedness need satisfactions from T0 to T3 compared to the other two profiles. Profile 2 was named "*Mid need satisfaction*" and included most of the sample. These children had moderate need satisfaction scores compared those in the other two profiles. Profile 3 was labelled "*High need satisfaction*" and comprised the children with highest need satisfactions in the sample.

To avoid ambiguity when defining latent statuses, longitudinal measurement invariance was tested over time (Table 3). Specifically, the indices of a non-measurement invariance model (freely estimated) and the measurement invariance model (constrained to be equal over time) were compared. The freely estimated and constrained models differed, although the indices were almost equal. After considering all the indices, the freely estimated model was selected for the subsequent analysis. Distributions, means, and standard deviations for the latent profiles at each time point are presented in Table 4.

Stability of need satisfaction profile memberships

Regression analysis with repeated measures was conducted to test the stability of the need profile memberships over time. The model fit was acceptable ($\chi^2(2)$ = 4.72, *p* = .094, CFI = 0.99, TLI = 0.98, RMSEA = 0.035, 90% CI [.00, 0.07], SRMR = 0.014). The model revealed weak stability in cluster memberships between T0 and T1 (β = −0.05, SE = 0.03, *p* = .074, R^2 = 0.01) but moderate stability between T1 and T2 (β = 0.45, SE = 0.03, *p* < .001, R^2 = 0.20) and T2 and T3 (β = 0.42, SE = 0.03, *p* < .001, R^2 = 0.27). At both T0 and T1, 40% of the children were in the same cluster compared to 62% at T1 and T2 and 63% at T2 and T3. The percentages of children in the need cluster profiles and of those transitioning between them from T0 to T3 are presented in Fig. 1.

Table 2
Correlation coefficients of the observed variables at each time point.

	COM T0	COM T1	COM T2	COM T3	AUT T0	AUT T1	AUT T2	AUT T3	REL T0	REL T1	REL T2	REL T3
COM T0	1	−0.043	−0.008	.004	.479***	−0.050	.025	.000	.568***	−0.036	.035	−0.026
COM T1		1	.563***	.481***	−0.030	.472***	.289***	.240***	−0.078*	.523***	.354***	.253***
COM T2			1	.634***	.025	.323***	.517***	.330***	−0.020	.368***	.598***	.352***
COM T3				1	−0.059	.218***	.326***	.526***	−0.016	.334***	.410***	.578***
AUT T0					1	.040	.065	−0.056	.542***	.010	.039	−0.095**
AUT T1						1	.447***	.326***	−0.055	.529***	.308***	.194***
AUT T2							1	.505***	.013	.289***	.583***	.372***
AUT T3								1	−0.018	.262***	.371***	.561***
REL T0									1	−0.051	.012	−0.045
REL T1										1	.504***	.376***
REL T2											1	.530***
REL T3												1

Note. *** $p < .001$, ** $p < .01$, * $p < .05$. COM = competence need satisfaction, AUT = autonomy need satisfaction, REL = relatedness need satisfaction.

Table 3
The parameter estimates for the latent profile solutions within one to six groups.

	Parameters	AIC	BIC	ABIC	LT5%	LT1%	pLMR	Entropy
T0								
1-solution	6	8299	8329	8310	–	–	–	–
2-solution	10	7604	7654	7623	–	–	.000	.72
3-solution	**14**	**7429**	**7499**	**7454**	**–**	**–**	**.399**	**.70**
4-solution	18	7330	7421	7364	1	–	.000	.72
5-solution	22	7289	7399	7330	2	1	.009	.77
6-solution	26	7278	7409	7326	3	1	.231	.80
T1								
1-solution	6	7468	7497	7478	–	–	–	–
2-solution	10	6904	6953	6921	–	–	.000	.69
3-solution	**14**	**6758**	**6826**	**6782**	**–**	**–**	**.003**	**.74**
4-solution	18	6721	6810	6752	1	–	.008	.65
5-solution	22	6702	6810	6740	2	–	.283	.70
6-solution	26	6681	6809	6726	2	1	.343	.70
T2								
1-solution	6	6601	6630	6611	–	–	–	–
2-solution	10	6034	6082	6050	–	–	.000	.70
3-solution	**14**	**5817**	**5884**	**5840**	**–**	**–**	**.001**	**.75**
4-solution	18	5759	5845	5788	1	–	.005	.73
5-solution	22	5752	5858	5788	1	–	.339	.67
6-solution	26	5738	5863	5780	2	–	.075	.73
T3								
1-solution	6	6129	6157	6138	–	–	–	–
2-solution	10	5689	5737	5705	–	–	.041	.64
3-solution	**14**	**5440**	**5506**	**5461**	**–**	**–**	**.000**	**.77**
4-solution	18	5394	5478	5421	1	–	.011	.74
5-solution	22	5367	5470	5400	2	–	.044	.77
6-solution	26	5339	5461	5379	3	–	.382	.75
Model	G^2	AIC	BIC	Entropy	df	Diff. G^2	Diff. df	p
3–3–3–3(Free)Non	**−12 376**	**24 887**	**25 229**	**.72**	**68**	32	27	.000
3–3–3–3(Constrained)	−12 408	24 897	25,103	.72	41			

Notes. Bold indicates the most reasonable solution at each time point. AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, ABIC = Adjusted Bayesian Information Criterion, LT = less than, pLMR = p-value for Adjusted Lo-Mendell-Rubin Ratio Test, G^2 = likelihood ratio, df = degrees of freedom; Diff. G^2 = likelihood ratio difference, Diff. df = degrees of freedom difference.

Transition probabilities of need satisfaction profiles

Transition probability estimates and invariance over the four measurement points were tested (Table 5). To confirm the necessity of transition probabilities, the invariance was first examined. The free transition probability model (model 0) and the constrained model (model 1) were unequal. After considering all the indices, the freely estimated model with transition probabilities was tested. At T1 (Grade 6), the results revealed that the children in the Low need satisfaction profile at T0 (Grade 5) were the most likely to have transitioned to the Mid need satisfaction profile whereas the children in the Mid need satisfaction profile were the most likely to have transitioned to the High need satisfaction profile, and the children with highest need satisfaction most likely to have transitioned to the Mid need satisfaction profile. From Grade 6 onwards, the transition patterns were relatively stable, indicating that the Low, Mid, and High need satisfaction profiles remained almost the same from Grades 6 to 8.

Covariates of gender, class, and school

Gender, class, and school were included in the three-profile free transition probability model to examine their associations with the profile memberships at each measurement point (Table 6). In multinomial models, one profile stands for a reference group when regression coefficients are not provided for a given profile. At T0, a significant association between gender and status membership was detected in the Mid need sat-

Table 4
Means and standard deviations of the study variables by profiles and the distribution of statuses within girls and boys.

		Profile 1LowM (SD)	Profile 2MidM (SD)	Profile 3HighM (SD)
Competence need satisfaction	T0	2.29 (0.68)[2,3]	3.10 (0.57)[1,3]	4.13 (0.59)[1,2]
	T1	1.93 (0.69)[2,3]	2.96 (0.69)[1,3]	4.00 (0.65)[1,2]
	T2	1.90 (0.66)[2,3]	3.01 (0.62)[1,3]	4.00 (0.57)[1,2]
	T3	1.93 (0.79)[2,3]	3.11 (0.65)[1,3]	4.14 (0.58)[1,2]
Autonomy need satisfaction	T0	1.92 (0.55)[2,3]	2.75 (0.58)[1,3]	3.57 (0.63)[1,2]
	T1	1.72 (0.62)[2,3]	2.41 (0.59)[1,3]	3.38 (0.61)[1,2]
	T2	1.65 (0.48)[2,3]	2.59 (0.59)[1,3]	3.51 (0.57)[1,2]
	T3	1.54 (0.47)[2,3]	2.69 (0.51)[1,3]	3.67 (0.50)[1,2]
Relatedness need satisfaction	T0	2.27 (0.58)[2,3]	3.51 (0.52)[1,3]	4.41 (0.42)[1,2]
	T1	1.86 (0.52)[2,3]	3.28 (0.53)[1,3]	4.24 (0.46)[1,2]
	T2	2.04 (0.54)[2,3]	3.32 (0.49)[1,3]	4.24 (0.44)[1,2]
	T3	2.10 (0.72)[2,3]	3.37 (0.57)[1,3]	4.30 (0.46)[1,2]

Statuses by gender		Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
	T0	68	56	124	299	249	548	206	243	449
	T1	30	30	60	226	240	466	242	223	465
	T2	35	42	77	246	224	470	180	168	348
	T3	39	39	78	259	246	505	122	114	236

Note. The superscripts indicate the significant between-group mean differences at $p < .05$ level.

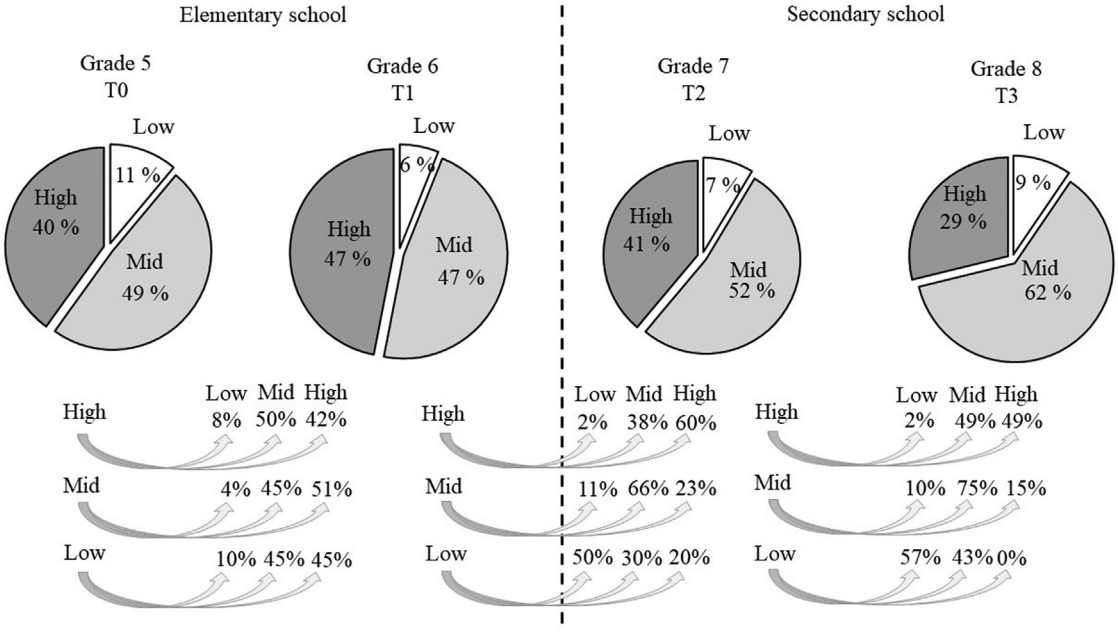

Fig. 1. The percentages of latent profile prevalence and transitions at each measurement point.

Table 5
Transition matrix estimates of need satisfaction profiles over three time points, and transition probability invariance.

τ T0-T1	LS1	LS2	LS3LS4	τ T1-T2	LS1	LS2	LS3LS4	τ T2-T3	LS1	LS2	LS3LS4
LS1	.097	**.501**	**.402**	LS1	**.702**	**.297**	.001	LS1	**.800**	**.200**	.000
LS2	.037	**.445**	**.519**	LS2	.112	**.770**	.118	LS2	.057	**.860**	.083
LS3	.102	**.499**	**.399**	LS3	.007	**.265**	**.729**	LS3	.000	**.278**	**.722**

Transition probability invariance	G^2	AIC	BIC	df	Diff. G^2	Diff. df	p
Model 0 (free)	−12 376	24 888	25 229	68			
Model 1 (constrained)	−12 488	25 097	25 398	60	112	8	.000

Notes. LS1 = Low need satisfaction; LS2 = Mid need satisfaction; LS3 = High need satisfaction, τ = Transition estimates, G^2 = likelihood ratio, AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, df = degrees of freedom, Diff. G^2 = likelihood ratio difference, Diff. df = degrees of freedom difference. Bold indicates the probability > 0.20.

Table 6
The covariate effects of gender, class, and school on the latent status prevalence at each time point.

status		LS3	LS2	LS1LS3
Intercept				
β0	T0	Ref	−0.78 (0.46)	**−1.51 (0.62)***
β1	T1	Ref	.14 (0.33)	**−2.21 (0.71)****
β2	T2	Ref	−0.99 (0.51)	**−3.67 (1.20)****
β3	T3	Ref	−1.15 (0.74)	**−28.66 (1.28)*****
Gender				
β4	T0	Ref	**.40 (0.17)***	.34 (0.22)
Odds		Ref	1.49 (0.25)	1.41 (0.31)
β5	T1	Ref	.01 (0.16)	.20 (0.32)
Odds		Ref	1.01 (0.16)	1.22 (0.38)
β6	T2	Ref	−0.09 (0.25)	−0.82 (0.45)
Odds		Ref	.91 (0.23)	.44 (0.20)**
β7	T3	Ref	.06 (0.32)	.09 (0.59)
Odds		Ref	1.07 (0.34)	1.10 (0.65)
Class				
β8	T0	Ref	.07 (0.04)	−0.01 (0.07)
Odds		Ref	1.07 (0.05)	.99 (0.07)
β9	T1	Ref	.00 (0.04)	.06 (0.08)
Odds		Ref	1.00 (0.04)	1.06 (0.08)
β10	T2	Ref	−0.03 (0.05)	.05 (0.11)
Odds		Ref	.97 (0.05)	1.06 (0.11)
β11	T3	Ref	.05 (0.08)	.03 (0.13)
Odds		Ref	1.05 (0.09)	1.03 (0.14)
School				
β12	T0	Ref	−0.11 (0.08)	.01 (0.13)
Odds		Ref	.90 (0.07)	1.01 (0.13)
β13	T1	Ref	−0.00 (0.07)	−0.09 (0.14)
Odds		Ref	1.00 (0.07)	.92 (0.13)
β14	T2	Ref	.06 (0.10)	−0.11 (0.19)
Odds		Ref	1.06 (0.10)	.90 (0.17)
β15	T3	Ref	−0.10 (0.14)	−0.09 (0.24)
Odds		Ref	.91 (0.13)	.91 (0.21)

Notes. β0-β15 are regression coefficients for logistic regression models; LS1 = Low Need Satisfaction, LS2 = Mid Need Satisfaction, LS3 = High Need Satisfaction (reference). Standard errors in parentheses; Ref = the profile stands for a reference in a multinomial model. Bold indicates significant covariate effects.

*** $p < .001$.

** $p < .01$.

* $p < .05$.

isfaction profile group: girls were more likely to have Mid compared to Low or High need satisfaction status. The covariates of class and school were not statistically significant at any time point, reflecting that latent profile membership was not dependent on school or PE group.

Discussion

A key objective of the Finnish National Core Curriculum is to provide positive PE experiences to all children regardless of their skill levels (Finnish National Agency for Education, 2014). Emphasizing the importance of positive motivational development, the present study investigated need satisfactions. Specifically, this study examined stability and transition probabilities in children's need satisfaction profiles in school PE. The key findings were: 1) three latent profiles were identified: Low, Mid, and High; 2) profile memberships were stable from Grade 6 onwards, as the between-profile transitions mainly occurred between Grades 5 and 6 in elementary school; and 3) while the profile memberships were not school- or class-dependent over time, girls were more likely to be in the Mid need satisfaction profile at baseline.

In this sample of Finnish school-aged children, we identified three need satisfaction profiles: Low, Mid, and High. This result was in line with the outcomes of previous cross-sectional studies in high school students that have excluded need frustrations and instead focused exclusively on the clustering of need satisfactions (Earl et al., 2019; Granero-Gallegos et al., 2012). In studies where frustrations have been included in the analysis, four qualitatively distinct latent profiles have typically been identified. For instance, Warburton et al. (2020) found four need profiles in a study combining relationships of need satisfactions and need frustrations in a sample of 274 English high school students. Similarly, Li et al. (2021) detected four need profiles in a sample of 844 Singaporean students. However, more important than the number of profiles is knowing how students are divided into different groups. In the current study, which is the first to examine the stability of need satisfaction profiles using longitudinal data, the potentially important implication was that the Low need satisfaction profile was the smallest (6– 11%) at each measurement point. Although frustrations were not assessed, the small proportion of children in the Low need profile resembled the findings reported by Warburton et al. (2020), who showed that children who reported at least moderate levels of need satisfactions did not experience need frustrations. This is an important finding, as it has been suggested that need satisfactions may enhance motivation even before need frustrations are experienced (Warburton et al., 2020). The current mean need satisfactions scores were relatively high throughout the study period and the proportions of girls and boys in the Low need satisfaction profile remained equal. Although from Grade 7 onwards, unlike in other school subjects, PE is taught to girls and boys separately in Finnish schools, with female teachers instructing girls and male teachers instructing boys (Heikinaro-Johansson, Palomäki & Kurppa, 2011), the PE classes appeared to satisfy the participants' psychological needs reasonably well. This was expected, despite the fact that PE enjoyment is not the same thing as need satisfactions, as Finnish school children usually self-report PE as an enjoyable and interesting school subject (Gråstén, Jaakkola, Liukkonen, Watt & Yli-Piipari, 2012; A. 2015). To minimize the proportion of children experiencing low need satisfactions, efforts should be made to ensure that all children, especially those with the lowest need satisfactions, have an equal opportunity to receive satisfying PE learning experiences. This could support their need satisfactions, which may anticipate higher autonomous motivation toward school PE (Vasconcellos et al., 2020) and physical activity outside school hours (Warburton et al., 2020).

The findings revealed that the profile memberships were stable from Grade 6 onwards, transitions between profiles mainly occurring between Grades 5 and 6. In particular, 90% of the children (as shown in Fig. 1) in the Low need satisfaction profile in Grade 5 had transitioned into the Mid and High need satisfaction profiles in Grade 6. In turn, the Mid and High need profile children remained (42– 45%) or transitioned (50%) only between these two highest need satisfaction profiles. It may be argued that the current self-reports do not measure need satisfactions as accurately as objective measures. However, in sport or PE activities perceived motivation may sometimes be more important than objective reality (Fox & Lindwall, 2014). Need satisfactions are not currently objectively measurable, and in any case they are individual truths. The present findings indicate that it may be more challenging to bring about positive changes in student behaviours if actions are not taken before the middle school years. From Grade 6 onwards, transitions between profiles, although not uncommon, were rarer than in elementary school, as most children's profiles remained unchanged. It is striking that none of the Low need profile children in Grade 7 had transitioned to the High need profile in Grade 8, an observation which reinforces the importance of early interventions to achieve positive development in need satisfactions.

Finally, keeping in mind that Finnish school PE is typically taught in gender-segregated groups from Grade 6 onwards, a significant difference in the profile membership probabilities of girls and boys was detected at baseline, where girls were more likely than boys to be in the Mid than Low or High need satisfaction profiles. Studies on need satisfaction differences between girls and boys at the variable level have reported conflicting mean scores. For example, in one study school-aged boys scored higher than girls on competence need satisfaction (Ferriz et al., 2013; Gråstén et al., 2019; 2020; Wang & Chen, 2021). Conflicting results have also been reported for relatedness needs satis-

factions (Ferriz et al., 2013; Gråstén & Watt, 2017; Gråstén et al., 2019; 2020; Xiang et al., 2017). Autonomy needs satisfactions have been usually found to be very similar in girls and boys (Gråstén & Watt, 2017; Gråstén et al., 2019; Wang & Chen, 2021), although exceptions favouring boys (Ferriz et al., 2013), apparently depending on sample characteristics, have also been reported. In the present study, the baseline gender difference is hard to explain as the profile memberships were not affected by school or PE group over time. Chen et al. (2015) suggested that the associations between psychological need satisfactions were not dependent on individual or cultural differences in how strongly people valued or desired need satisfactions. In this light, excluding the baseline finding on girls' Mid need profile membership at baseline, the mostly non-existent covariate effects of gender, class, and school followed the theoretical assumptions of the SDT, namely that need satisfactions are universal (Deci & Ryan, 2000; Ryan & Deci, 2017).

Research regarding enhancing needs in PE classes, especially in the case of the children reporting the lowest satisfactions, offers a basis for many potentially useful actions in PE teaching. Children could be instructed to give positive feedback to each other starting from the early school years, for example through hand gestures or using printed feedback cards to boost competence need satisfactions (Culp, 2013). Furthermore, clear guidelines and instructions enhancing open teacher-student communication and the provision of versatile social learning opportunities could be of great value for the positive development of social relatedness need satisfaction (Taylor & Ntoumanis, 2007). Families could take more responsibility in encouraging their children to be positive role models for each other and show good sportsmanship in accordance with the principles established with other children and teachers (Smith, Connolly & Pryseski, 2014).

For the children in the Low need satisfaction profile, with the lowest mean scores in the autonomy compared to competence and social relatedness need satisfactions, it would be essential to enhance their autonomy in PE classes. One important area for improvement in PE teaching is to involve children in the planning process of their PE classes. Finnish school PE has traditionally been very teacher-initiated since, based on the national curriculum (Finnish National Agency for Education, 2014), teachers are mainly responsible for the planning and implementation of their classes. It may be that the teacher-led method of PE teaching does not fully support the satisfactions of basic needs, especially in children with low need satisfactions. For instance, in the physical activity program with middle school students studied by Doolittle and Rukavina (2014), volleyball and table tennis classes were provided simply because students showed strong interest in these activities. There are many other useful strategies that could support positive autonomy need satisfactions in PE. Reeve (2009) recommended that teachers provide more detailed explanatory rationales on tasks, goals, and desired outcomes, rely less on controlling language to assist with motivational issues, give children enough time to learn, and consider children's negative expressions and reactions as a basis for improving learning tasks, demands, and teaching structures. Developing school PE in a more student-centered direction could thus be an effective way to tackle low need satisfactions in children, although for every single child to perceive PE classes as equally satisfying is clearly a utopian ambition.

Limitations and directions for future research

The strengths of this study were the large and nationally representative sample and long follow-up period used for the first time in basic psychological need studies. However, the study has its limitations. First, the data did not include need frustration scores, which could have provided deeper insights into psychological need development in school PE classes. Second, the data were collected in Finland, where compulsory school PE is a part of national curriculum. Thus, the participants could not opt out of PE classes. Although need satisfactions were not class- or school-dependent, it might have been beneficial also to have considered teacher-initiated pedagogy.

Future studies could examine the associations of teaching procedures with need satisfactions and frustrations with the aim of improving instructions, feedback, and cooperation procedures. In addition, need satisfactions, frustrations, and other behavioural outcomes such as objectively measured in-school PE and outside-school physical activity could be examined over longer follow-ups.

Conclusion

The need satisfaction profiles of a large sample of school-aged children were relatively stable. In school PE, it would be important that all children could experience psychologically satisfying PE classes that support their perceived need satisfactions of competence, autonomy, and social relatedness. Actions to promote positive need satisfaction development could be started already in the early school years, as it may be more challenging to induce positive changes in student behaviours after children have transitioned to middle school.

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Data availability

Due to the nature of this research, the participants of this study did not agree to their data being publicly shared, hence supporting data are not available.

Conflict of Interest

The authors declare no conflicts of interest. The results are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ajsep.2022.09.004.

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