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Associations of subjective social status with accelerometer-based physical activity and sedentary time among adolescents

A running title:

Adolescents' subjective social status and physical activity

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Abstract

This study examined the associations of subjective social status (SSS) with physical activity (PA) and sedentary time (ST) among adolescents. The study population consisted of 420 Finnish adolescents aged 13 to 14 years. The adolescents reported their own SSS within their school (school SSS) and their family's social position within society (society SSS) based on the youth version of the Subjective Social Status Scale. Adolescents' moderate- to vigorous-intensity physical activity (MVPA) and ST were measured objectively by accelerometers and analyzed separately for the whole day and the school day. The associations between SSS and MVPA and ST outcomes were analyzed using multilevel modeling. School SSS was positively associated with whole-day MVPA and negatively associated with school-time ST. Society SSS was not significantly associated with objectively measured MVPA or ST. Both MVPA and ST are important behavioral determinants of health. As an important correlate of MVPA and ST, school SSS should be addressed by providers when discussing obesity risk and healthy behaviors with adolescents.

Key words:

Youth; accelerometry; health behaviour

The health benefits of physical activity (PA) are evident (Jansen & Leblanc, 2010). Previous research has demonstrated the beneficial effects of PA on obesity, musculoskeletal health, several cardio-metabolic risk factors and physical fitness (Janssen & Leblanc, 2010; Poitras et al., 2016; Santos et al., 2014; Strong et al., 2005). In addition, PA has been associated with academic achievement (Donnelly et al., 2016) and mental health (Poitras et al., 2016; Strong et al., 2005). Sedentary behaviour has been identified as a health risk factor in children and youth, independently of the benefits of moderate to vigorous intensity physical activity (MVPA) (Santos et al., 2014; Tremblay et al., 2011). Previous studies have indicated that excessive sedentary time (ST) is associated with unfavourable body composition, decreased fitness, lower self-esteem, lower prosocial behaviour (Tremblay et al., 2011) and increased risk of cardiovascular disease (Santos et al., 2014).

The current international PA guidelines for children and adolescents recommend at least one hour of MVPA per day (World Health Organization, 2010). A large proportion of adolescents are not physically active enough to experience health benefits (Hallal et al., 2012; Verloigne et al., 2012), and spend a lot of time sedentary (Pate, Mitchell, Byun, & Dowda, 2011). Also in Finland, despite good policies and programs to promote PA, overall levels of PA among youth are low (Inchley et al., 2016; Tammelin et al., 2016). Several interventions aim at increasing adolescents' PA (Hynynen et al., 2016; Kriemler et al., 2011). They are often implemented in schools to reach the majority of youths. These interventions can utilize research on factors related to adolescents' PA.

Several studies have identified socioeconomic status (SES) as an important correlate of PA (e.g. Stalsberg & Pedersen, 2010). However, for adolescents the influence of SES on levels of PA engagement and time spent sedentary is not clear (Sherar et al., 2016;

Pate et al., 2011; Stalsberg & Pedersen, 2010). The relationship between SES and PA/ST among children and adolescents has been researched with varying results. There are studies reporting positive, negative or no association between SES and PA and (mostly screen-based) ST (Sherar et al., 2016; Pate et al., 2011; Stalsberg & Pedersen, 2010). These studies have used different measures, especially for SES and PA, which makes explanations and interpretations of the findings complicated (Stalsberg & Pedersen, 2010).

In most studies, SES has been explored using objective measures of social status, such as parents' education and income. However, adolescents' subjective perceptions of social status are powerful predictors of their health and health behaviors independent of SES (Quon & McGrath, 2014). Subjective social status (SSS) can be defined as "an individual's perception of his or her place in the socioeconomic structure" (Singh-Manoux, Adler, & Marmot, 2003) and assessed among adolescents using the Subjective Social Status Scale-Youth Version (Goodman et al., 2001). This instrument has two dimensions: the adolescents' familial placement within society (society SSS) and adolescents' perceived social status within their school (school SSS) (Goodman et al., 2001).

Many studies over the last decade have reported associations between SSS and a variety of health outcomes in adolescents, including Finnish adolescents (Karvonen & Rahkonen, 2011). These associations were summarized and explored in a meta-analysis of 44 studies by Quon and McGrath (2014), who concluded that there is strong evidence of an association between SSS and adolescent health outcomes. Higher SSS was related to better self-reported health, better mental health, and better physical health (Quon & McGrath, 2014). In general, the associations are quite similar for school SSS and society SSS in respect to health outcomes (Quon & McGrath, 2014). Relationships between

adolescents' SSS and health behaviors have received less attention than those between SSS and health outcomes (Quon & McGrath, 2014; Sweeting & Hunt, 2015). However, evidence suggests that SSS is linked to unhealthy behaviors among youth, with recent research indicating school SSS has stronger associations with adolescents' unhealthy behaviors than society SSS (Quon & McGrath, 2014; Sweeting & Hunt, 2015).

To date, there has been limited research on the associations between SSS and self-reported PA levels (Frerichs, Huang, & Chen, 2014; Reitzel, Nguyen, Strong, Wetter, & McNeill, 2013). To our knowledge, the association between SSS and ST has not been researched and no earlier studies have reported the links between SSS and objectively measured MVPA or ST. However, the available evidence suggests SSS may be pertinent to adolescents' PA and ST. For example, studies report significant, positive associations between subjective perceptions of social status (perceived family wealth) and self-reported PA (Iversen & Holsen, 2008; Piko & Fitzpatrick, 2007) or physical inactivity (Janssen, Boyce, Simpson, & Pickett, 2006) among adolescents, although SSS was not directly measured in these studies. Several systematic reviews of factors related to adolescents' PA have been published and these reviews confirmed the existence of a variety of correlates of adolescents' PA, including social or cultural correlates such as family influence/support and friend support (Biddle, Atkin, Cavill, & Foster, 2011; Martins, Marques, Sarmento, & Carreiro, 2015; Van Der Horst, Paw, Twisk, & Van Mechelen, 2007). Studies have suggested that peer influence may be an even more important factor affecting adolescents' PA than parental support (Kirby, Levin, & Inchley, 2011), and the influence of peers can be either positive or negative (Martins et al., 2015). These factors all may relate to SSS and thereby suggest that SSS may also be a strong correlate of PA in adolescence, especially school SSS which represents adolescents' perceived social status within their school peer groups (Goodman, et al., 2001).

The purpose of this study is to examine the association of SSS with objectively measured MVPA and ST among adolescents. Based on earlier literature, we hypothesize that SSS, especially school SSS, is positively associated with MVPA and inversely associated with ST.

Methods

Participants and procedures

This study used cross-sectional data collected as part of a larger study related to the Finnish Schools on the Move program (Tammelin et al., 2016). Data for larger study were collected from fourth to seventh graders of nine schools in spring 2013. The current study included only students from grade 7 (lower secondary school), who came from eight cities, eight schools, and 42 school classes in different geographical parts of Finland. Five of the classes were sport classes in basic education, with four hours per week of physical education instead of two hours. Of the 875 students who were invited to participate in the study, 48% agreed to participate, with the current study population totaling 420 adolescents from the 7th grade (53.1% girls) with a mean age of 13.7 (*SD* = 0.4).

During a regular school day, students completed a questionnaire with measures of study variables and demographic items (e.g., sex, age, school, and class). Students also received accelerometers and instructions on how to use them, and their body weight and height were measured. Parents or guardians of 279 students (66%) also responded to a web-based questionnaire including questions on parental education and family income in order to provide background information on parental SES.

The study was approved by the Ethics Committee of the University of Jyväskylä. It followed the principles of the Declaration of Helsinki (World Medical Association, 2013) and Finnish legislation. Participation in the study was voluntary. Only adolescents with a fully completed consent form (certificate of consent signed by a parent or guardian and the adolescent) were included in the study.

Measures and variables

Accelerometer-based PA and ST

PA and ST were measured objectively by ActiGraph GT3X accelerometers with vertical axel. Students were instructed to wear the accelerometers on the right side of the hip during their waking hours for seven consecutive days. Students also completed diaries to report their school start and finish times for each measurement day. Accelerometer data was initially downloaded and converted to counts per 15-second epochs and exported to a text file by using Actilife software (version 6.11.7). Visual Basic Macro for Excel was used for data reduction. School-time and leisure time PA were separated by using student specific time filters derived from the diary data. If there was missing data on diary data, class-specific curriculum was used to approximate school hours (n=20). Non-wearing time was defined as a period of at least 30 minutes of consecutive zero counts (Domazet et al. 2016; Møller et al. 2014). Time spent in PA at different intensity levels during whole day and school-time were calculated. A cut-off value of 2,296 counts per minute (cpm) was used for MVPA, and an upper limit of 100 cpm was used for ST (Evenson et al, 2008). Whole-day MVPA and ST were calculated as weekdays and weekend days weighted averages (Whole-day MVPA, ST = [5 * average weekday MVPA, ST + 2 * average weekend day MVPA, ST] / 7) (Konstabel et al, 2014; Ortega et al, 2013). Whole-day MVPA and ST were expressed as minutes per day and ST was

additionally expressed as minutes per wear hour (with respect to total wearing time), respectively. School-time MVPA and ST were expressed as minutes per school-hour (with respect to daily school time). For whole-day MVPA and ST, at least 500 minutes of wearing time per day (e.g. Cooper et al., 2015) was required to represent a valid measurement day, and two valid weekdays and one weekend day were required for a valid measurement period (e.g. Syväoja et al, 2014; Verloigne et al, 2012). For school-time MVPA and ST, wearing time during school hours was required to be at least 80% of the school time (Haapala, et al., 2016; Morton et al., 2016), and two valid days were required for a valid measurement period.

Subjective social status

The youth version of the Subjective Social Status Scale (Goodman et al., 2001) was used to measure adolescents' SSS. This validated scale consists of two self-anchored 10-point ladder scales on which adolescents rank their families and themselves. The first ladder assesses society SSS: "Imagine that this ladder pictures how Finnish society is made up. At the top of the ladder are the people who are the best off – they have the most money, the most education, and the jobs that bring the most respect. At the bottom of the ladder are the people who are the worst off – they have the least money, little or no education, no job or jobs that no one wants or respects." The second ladder assesses school SSS: "Imagine that this ladder is a way of picturing your school. At the top of the ladder are the students in your school with the most respect, and most people wants to hang around with. At the bottom are the students who no one respects, and with whom no one wants to hang around with."

Parental socioeconomic status

Each parent or guardian reported their own and their spouse's or partner's highest educational level using a 5-point scale (from comprehensive school to higher academic degree). For analysis purposes, the scale was divided into three classes: 1) low (comprehensive school), 2) middle (vocational school or college), and 3) high (polytechnic or university). Each parent or guardian also reported the total combined household income before taxes for the past 12 months from all sources. Household income was divided into nine classes (from 1 = under 30,000 euros per year to 9 = over 100,000 euros per year).

Self-rated school performance

Adolescents' school performance in the prior year was self-reported and measured by the question "How would you rate your performance in the following subjects compared to your peers?" The subjects were as follows: mother tongue, English, other foreign languages, mathematics, biology/geography, physics/chemistry, religion/ethics, history, music, visual arts, crafts, and physical education. Students used a 5-point scale from 1 (very poor) to 5 (very well). The average of the 12 items was calculated.

Body mass index

Body height was measured with an accuracy of 0.1 cm (Charder HM 200P scale), and body weight was measured in light clothing using the scale of bioelectrical impedance analysis device (InBody 720, Biospace Co., Ltd). Body mass index (BMI, kg/m^2) was calculated by dividing the weight in kilograms by the square of height in meters.

Statistical analyses

The descriptive statistics were calculated using IBM SPSS Statistics (version 20.0). All further analyses were conducted using the Mplus statistical package (version 7.0) (Muthén & Muthén, 1998–2017). The differences between boys and girls in the study variables were tested via Student's *t*-test and Pearson's χ^2-test. The differences in the study variables between the students with parental-reported data and the students without parental-reported data were also tested. The associations among PA, ST, SSS (school SSS and society SSS), and potential confounding variables, including parental socioeconomic status (mother's education, father's education and household income), school performance, BMI, and sex were examined using sample correlations.

Because the data were clustered within schools and within classes, the final analyses were conducted using multilevel modeling. To study associations between SSS and PA outcome measures (whole-day/school-time MVPA and ST), a two-level regression model was applied. The classes were treated as primary sampling units (clusters). Intra-class correlation coefficients (ICC) were calculated for the study variables to evaluate the proportion of the total variance explained by the variation between classes. Two-level regression models were fitted separately for each PA outcome measure.

At the within-class level, each PA outcome measure was regressed on school SSS/society SSS and confounding factors including parental socioeconomic status, school performance, BMI, and sex. The confounding variables were chosen for final models based on the sample correlations. If the sample correlation between the explanatory variable and outcome variable seemed to differ between girls and boys, the corresponding interaction term was entered in the models as well. First, the association between school SSS/society SSS and the PA outcome measure was estimated as a random effect (i.e.,

the regression coefficient was allowed to vary across classes). If the variance of the regression coefficient was insignificant, the association was assumed to be similar across classes and was estimated as a fixed effect in further modeling. The variables of the between-class-level model were chosen based on the ICCs. In addition, the between-class-level model was controlled for belonging to a special sport class. Final model (both between- and within-class level model) for whole-day MVPA was adjusted for whole day ST and vice versa as well as the model for school-time MVPA was adjusted for school-time ST and vice versa.

Missing data on explanatory variables were handled by bringing them explicitly into the model (Muthén & Muthén, 1998–2017). The sample correlations and the parameters of the models were estimated using full-information maximum-likelihood estimation (FIML). FIML produces unbiased parameter estimates under the missing at random (MAR) assumption. Standard errors and test statistics robust to non-normality were used.

Results

The descriptive statistics of the study variables are presented in Table 1. Based on accelerometer measurements, boys had more MVPA and less ST than girls, both during the whole day and during school time. Boys perceived their school SSS and society SSS as higher compared with girls. Because the proportion of the low-educated parents was small, the low and middle categories were combined for further analyses.

Table 1. Descriptive statistics of the study variables.

Study variables	All (n=420)	Boys (n=197)	Girls (n=223)	*p*
Physical activity and sedentary time				
Whole-day MVPA (min/day)	n=306	n=127	n=179	
Mean (SD)	49.2 (22.3)	53.9 (24.9)	45.9 (19.7)	0.003
Whole-day ST (min/day)	n=306	n=127	n=179	
Mean (SD)	533.3 (65.8)	512.7 (67.8)	548 (60.4)	<0.001
Whole-day wear time (min/day)	n=306	n=127	n=179	
Mean (SD)	776.3 (58.0)	771.6 (55.7)	779.7 (59.6)	0.231
Whole-day ST (min/hour) [a]	n=306	n=127	n=179	
Mean (SD)	41.2 (3.8)	39.8 (4.3)	42.2 (3.2)	<0.001
School-time MVPA (min/school-hour)	n=376	n=168	n=208	
Mean (SD)	2.4 (1.3)	2.8 (1.5)	2.1 (0.9)	<0.001
School-time ST (min/school-hour)	n=376	n=168	n=208	
Mean (SD)	43.7 (4.1)	41.5 (4.2)	45.4 (2.9)	<0.001
Subjective social status (SSS)	n=409	n=191	n=218	
School SSS (range 1-10), Mean (SD)	6.7 (1.7)	7.1 (1.6)	6.3 (1.7)	<0.001
Society SSS (range 1-10), Mean (SD)	7.3 (1.5)	7.6 (1.4)	7.1 (1.7)	0.002
Parental socioeconomic status				
Mother's education	n=276	n=136	n=140	
Low	2.2%	2.2%	2.1%	
Middle	26.4%	23.5%	29.3%	
High	71.4%	74.3%	68.6%	0.555
Father's education	n=255	n=127	n=128	
Low	8.6%	6.3%	10.9%	
Middle	38.0%	38.6%	37.5%	
High	53.3%	55.1%	51.6%	0.415
Household income [b] (range 1-9)	n=275	n=137	n=138	
Mean (SD)	5.4 (2.5)	5.7 (2.5)	5.1 (2.5)	0.035
Self-rated school performance [c] (range 1-5)	n=395	n=187	n=208	
Mean (SD)	3.7 (0.4)	3.8 (0.4)	3.7 (0.5)	0.111
Body mass index	n=389	n=180	n=209	
Mean (SD)	19.7 (3.1)	19.6 (3.2)	19.9 (3.0)	0.381

MVPA=moderate to vigorous intensity physical activity.
ST=sedentary time.
Note. *p* for sex differences from Student's *t*-test or Pearson's χ^2-test.
[a] For the further analyses, whole-day ST was expressed as minutes per wear hour (min/hour) in order to take into account individual variability in the whole-day wear time.
[b] Parent's self-reported total household income before taxes for the past 12 months was categorised into nine classes from 1 = under 30,000 euros/year to 9 = over 100,000 euros/year.
[c] Adolescent's self-reported school performance. The following subjects were rated at 5-point scale from 1 = very poor to 5 = very well and the average of the 12 items was calculated: mother tongue, English, other foreign languages, mathematics, biology/geography, physics/chemistry, religion/ethics, history, music, visual arts, crafts, and physical education.

The students with information on parental SES (n = 279) were compared with the students who lacked parental-reported data (n = 141). The students with parental-reported data had a higher level of self-rated school performance than the students who lacked parental-reported data (mean = 3.78 vs. 3.65, p = 0.013). There were no differences in the levels of school SSS, society SSS, or MVPA and ST between the groups.

The correlation between society SSS and school SSS was 0.45 ($p < 0.001$). ICCs of school SSS and society SSS were insignificant and only 0.03 for both measures, indicating no considerable variation between different school classes in the SSS measures.

Sample correlations between explanatory variables and PA outcome measures, as well as ICCs of each of the four PA outcome measures, are presented in Table 2. School SSS was associated with all MVPA/ST measures. Associations of school SSS with whole-day MVPA and school-time MVPA were positive (r = 0.23, $p < 0.001$ and r = 0.13, p = 0.002, respectively), while associations of school SSS with whole-day ST and school-time ST were negative (r = -0.21, $p < 0.001$ and r = -0.23, $p < 0.001$, respectively). Society SSS had a negative association with whole-day ST (r = -0.13, p = 0.016). Significant ICCs were observed for whole-day MVPA (ICC = 0.17, p = 0.004), whole-day ST (ICC = 0.14, p = 0.001), and school-time ST (ICC = 0.14, p = 0.004), showing that variation between school classes explained 14% to 17% of the total variation of these measures.

Table 2. The sample correlation coefficients between the explanatory variables and accelerometer-based physical activity measures and intraclass correlation coefficients (ICCs) for these outcome variables.

	Physical activity outcome measures			
	Whole-day MVPA (min/day)	Whole-day ST (min/hour)	School-time MVPA (min/school-hour)	School-time ST (min/school-hour)
1 School SSS	0.23***	-0.21***	0.13**	-0.23***
2 Society SSS	0.07	-0.13*	0.02	-0.06
3 Mother's education (0=low or middle,1=high)	0.13	-0.07	-0.03	0.07
4 Father's education (0=low or middle, 1=high)	0.01	0.02	-0.02	0.04
5 Household income	-0.02	0.03	0.08	-0.03
6 School performance	0.08	-0.06	0.03	0.04
7 Body mass index	-0.06	0.06	-0.08	0.09
8 Sex (0=boy, 1=girl)	-0.18**	0.28***	-0.28***	0.48***
ICC	0.17**	0.14**	0.07	0.15**

SSS=subjective social status, MVPA=moderate to vigorous intensity physical activity, ST=sedentary time.

Note. *p<0.05, **p<0.01, ***p<0.001.

ICC, intraclass correlation coefficient reflecting the resemblance of the students within classes;

SSS, Subjective social status.

Each of the four PA outcome measures was regressed on school/society SSS and confounding variables. The within-class-level model was controlled for sex, BMI, mother's education, and school performance. Because there was a positive association between

school performance and school-time ST only among boys (for boys, $r = 0.29$, $p < 0.001$; for girls, $r = 0.10$, $p = 0.156$), the interaction term sex × school performance was entered in the models of school-time ST. First, the regression coefficient between school/society SSS and the PA outcome measure was allowed to vary across classes (Model 1; see Tables 3 and 4). No significant variances were detected in the association between school SSS and PA measures or between society SSS and PA measures.

Because ICCs of the explanatory variables were insignificant and low (ranging from 0.03 to 0.07), the associations were estimated only at the within-class level. Furthermore, all the associations were estimated as fixed effects and the models for MVPA were adjusted for ST and vice versa. (Model 2; see Tables 3 and 4). School SSS was positively associated with whole-day MVPA ($b = 0.11$, $p = 0.004$) and inversely associated with school-time ST ($b = -0.09$, $p < 0.001$) after controlling for confounding variables (see Table 3). However, the effect sizes of the associations can be considered small (Cohen, 1992). Society SSS was not associated with MVPA and ST during the whole day or during school time after controlling for confounding variables (see Table 4).

Table 3. The estimation results of the two-level regression models: the association of School SSS on physical activity outcome measures (n=420). The estimated variance of random slope (Model 1) and standardized regression coefficients of fixed effects (Model 2) are presented.

	Physical activity outcome measures			
	Whole-day MVPA (min/day)	Whole-day ST (min/hour)	School-time MVPA [4)] (min/school-hour)	School-time ST [4)] (min/school-hour)
Model 1	Estimate (*s.e*)			
BETWEEN CLASS LEVEL				
Variance of random slope	3.60 (3.95)	0.02 (0.02)	0.02 (0.05)	0.01 (0.04)
WITHIN CLASS LEVEL [1)]				
Model 2				
BETWEEN CLASS LEVEL [3)]				
Sport class	0.14 (0.72)	-0.68 (0.55)	0.30 (0.30)	-0.17 (0.21)
WITHIN CLASS LEVEL [2), 3)]				
School SSS	0.11 (0.04)**	0.00 (0.04)	-0.02 (0.04)	-0.09 (0.03)***
Mother's education (high)	0.08 (0.05)	0.05 (0.04)	0.01 (0.05)	0.06 (0.04)
School performance	0.03 (0.03)	0.01 (0.03)	0.04 (0.04)	0.16 (0.06)*
Body mass index	-0.03 (0.04)	-0.01 (0.04)	-0.02 (0.04)	0.01 (0.04)
Sex (0=boy, 1=girl)	0.03 (0.06)	0.15 (0.05)**	0.06 (0.06)	0.33 (0.04)***
Sex × School performance	-	-		-0.11 (0.05)*

Note. 1) Regression coefficient between School SSS and physical activity outcome measures was estimated as random slope and model was controlled for mother's education, school performance, body mass index, and sex. The model of school-time sedentary time was additionally adjusted for interaction sex × school performance.
2) All the associations were estimated as fixed effects.
3) The model for whole-day MVPA was additionally adjusted for whole-day sedentary time and vice versa, as well as the model for school-time MVPA was adjusted for school-time sedentary time and vice versa.
4) The level of school-time MVPA was higher and the level of school-time ST was lower for students who did not have diary data and whose school-time periods were determined by using class-specific curriculum (n=20) than for students having the diary data. Therefore, the model was refitted only for the student having the diary data. The results were similar.
*p<0.05, **p<0.01, ***p<0.001
s.e., standard error; SSS, Subjective social status.

Table 4. The estimation results of the two-level regression models: the association of Society SSS on physical activity outcome measures (n=420). The estimated variance of random slope (Model 1) and standardized regression coefficients of fixed effects (Model 2) are presented.

	Physical activity outcome measures			
	Whole-day MVPA (min/day)	Whole-day ST (min/hour)	School-time MVPA (min/school-hour)[4)]	School-time ST (min/school-hour)[4)]
Model 1	Estimate (*s.e.*)			
BETWEEN CLASS LEVEL				
Variance of random slope	4.82 (7.59)	0.05 (0.10)	0.01 (0.01)	0.02 (0.02)
WITHIN CLASS LEVEL [1)]				
Model 2				
BETWEEN CLASS LEVEL [3)]				
Sport class	0.04 (0.33)	-0.50 (0.38)	0.30 (0.30)	-0.16 (0.20)
WITHIN CLASS LEVEL [2), 3)]				
Society SSS	-0.03 (0.04)	-0.05 (0.04)	-0.03 (0.03)	-0.02 (0.03)
Mother's education (high)	0.08 (0.06)	0.05 (0.04)	0.01 (0.05)	0.06 (0.04)
School performance	0.02 (0.04)	0.01 (0.04)	0.05 (0.04)	0.08 (0.04)*
Body mass index	-0.03 (0.04)	-0.01 (0.04)	-0.02 (0.04)	0.02 (0.04)
Sex (0=boy, 1=girl)	0.01 (0.05)	0.15 (0.05)**	0.05 (0.06)	0.35 (0.04)***
Sex × School performance	-			-0.07 (0.03)*

Note. 1) Regression coefficient between Society SSS and physical activity outcome measures was estimated as random slope and model was controlled for mother's education, school performance, body mass index, and sex. The model of school-time sedentary time was additionally adjusted for interaction sex × school performance.
2) All the associations were estimated as fixed effects.
3) The model for whole-day MVPA was additionally adjusted for whole-day sedentary time and vice versa, as well as the model for school-time MVPA was adjusted for school-time sedentary time and vice versa.
4) The level of school-time MVPA was higher and the level of school-time ST was lower for students who did not have diary data and whose school-time periods were determined by using class-specific curriculum (n=20) than for students having the diary data. Therefore, the model was refitted only for the student having the diary data. The results were similar.
*p<0.05, **p<0.01, ***p<0.001
s.e., standard error; SSS, Subjective social status.

Discussion

This study demonstrated that adolescents' perceptions of social status in school, but not in society, were related to objectively measured MVPA and ST both of which are important and independent behavioral determinants of health. School SSS was positively

associated with whole-day MVPA but not with school-time MVPA. At the same time, school SSS was negatively associated with school-time ST.

The lack of association between school SSS and school-time MVPA may be due to the fact that school time PA for example during recess is probably light-intensity PA (e.g. walking and hanging up with friends) which in this study may be rather seen as lower ST than higher MVPA during school time.

The results of this study bolster findings from previous studies about the connection between adolescents' high SSS and good health or healthy behaviors (Quon & McGrath, 2014). School SSS has previously reported to have stronger associations with adolescents' smoking and drinking than society SSS (Sweeting & Hunt, 2015). According to these findings as well as the results of this study school SSS may have a more important meaning in adolescents' healthy and unhealthy behaviors than society SSS. In contrast to previous studies about SSS and self-reported PA among adults (Frerichs et al., 2014; Reitzel et al., 2013), the present study showed that society SSS was not associated with adolescents' objectively measured MVPA. The direct relationship between school SSS and daily MVPA as well as school-day ST in this study is in line with findings from studies demonstrating the significance of peers and social school context for adolescents' health behavior or well-being (Goodman et al., 2003; Sweeting & Hunt, 2014; Sweeting & Hunt, 2015). These immediate interaction processes have potentially greater relevance to youth, than macro-level status measures like society SSS, which may be more relevant to adults (Goodman et al., 2003; Sweeting & Hunt, 2015).

This study has some limitations worth noting. The study population was relatively small. The majority of the students came from higher SES families (71% of the mothers

were highly educated), which may limit generalizability of the findings. The data are cross-sectional and cannot be used to infer the direction of causality. Thus, school SSS should be used in future studies on the correlates of adolescents' daily MVPA, and the findings should be confirmed through longitudinal studies. The content of MVPA and ST was not assessed more closely. There are some activities that the accelerometer cannot measure (e.g. swimming) and ST may include various kind of sedentary behavior, such as "productive" (e.g. reading or doing homework) and screen time based (e.g. watching television, using social media, playing video games) activities. The association between school-SSS and whole-day ST may vary according to the type of sedentary behavior and perhaps for that reason, the association was not detected in this study.

Despite these limitations, these data provide interesting new information. This study was the first to examine the associations of SSS with adolescents' MVPA and ST measured by accelerometers. Although the associations of school SSS with school-time ST and whole day MVPA were statistically significant the effect sizes were relatively small. Future studies are needed to confirm these results and they could also examine the possible mechanisms behind the observed association between SSS and adolescents' MVPA with qualitative methods. For example, ethnographic methods in youth studies could disclose adolescents' own voices, which might help in understanding the association between SSS and health-related behaviors such as MVPA and ST.

These findings have important implications for health care provision for the youth, especially in relation to anticipatory guidance. The importance of school SSS in relation to daily MVPA among adolescents could be used in promoting adolescents' MVPA as well as decreasing ST during school day.

There is limited evidence on how to best promote PA and reduce sedentary behavior among adolescents in school-based interventions in the long term (Hynynen et al., 2015; Kriemler et al., 2011). The findings of this study highlight the importance of school-based SSS and peer relations as correlates of daily MVPA and school-day ST that should be taken into account in the promotion of MVPA and decreasing school-day ST among adolescents. The interventions should consider whether it is possible to create actions that adolescents could participate in despite the social hierarchies in school. To decrease ST in the school environment, it might be useful to include activities that affect every student's behavior especially during lessons, such as functional learning methods or developing common procedures in school society as well as learning environments to support reducing sitting during a school day. To increase MVPA, adolescents could be given more opportunities to take part in planning different kinds of activities in their own peer groups.

Conclusions

This cross-sectional study presents new findings on the relationship between SSS and objectively measured MVPA and ST among adolescents. Higher subjective social standing at school was positively associated with higher MVPA during the whole day and less ST during school hours, both of which are important behavioral determinants of health. Providers should attend to social hierarchies at school when promoting PA and decreasing ST among adolescents.

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