

Research article

Parental socioeconomic status, adolescents' screen time and sports participation through externalizing and internalizing characteristics



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ABSTRACT

The socioeconomic status of parents is reportedly closely related to the digital screen usage and physical inactivity levels of children and adolescents. Internalizing and externalizing behavior characteristics may be linked to these associations and explain them. The purpose of the present study was to investigate the effects of parents' socioeconomic status (SES) on youths' total screen time along with physical inactivity through internalizing and externalizing behavior characteristics. Thus, we examined associations between parents' socioeconomic status (using scores based on several indicators) and adolescents' total digital screen exposure and physical inactivity level, together with the potentially predicting role of the adolescents' internalizing and externalizing behavior. For this, we assessed the internalizing and externalizing problem characteristics, total screen time exposure, physical inactivity level and parental socioeconomic status of a large cohort sample of Finnish adolescents (the Northern Birth Cohort, 1986 comprised 2899 males and 3059 females). The present study includes data collected in two phases, in 1985–1986 and 2000–2001. Path modeling suggests that a low SES of parents was directly associated with adolescents' physical inactivity level, while externalizing characteristics were a significant and additional contributing factor in adolescents' level of screen exposure in both genders. Gender moderated the relationship between adolescents' internalizing and externalizing characteristics and physical inactivity levels. The results also suggest that parents' socioeconomic status constitutes a risk factor in relation to media screen exposure only in female adolescents. Implications of the findings are discussed.

1. Introduction

Socioeconomic status (SES, which commonly refers to educational level, social class, and/or income) has direct or indirect associations with various health indicators (e.g., morbidity, mortality and self-reported health) (Huisman et al., 2013; Society, 2003). It has been proposed that variations in SES are the fundamental basis of health inequalities and, further, the links between SES and health have been explained by social causation (i.e., socially based structural factors such as behavioral or working environment factors) and health choices (i.e., healthy individuals tend to advance in their careers) (Dahl, 1996). However, according to the latest evidence, the implications of SES for health are strongly attributable to an individual's lifestyle (Simandan, 2018; Wang and Geng, 2019), and thus lifestyle choices may mediate the associations

between SES and health (Wang and Geng, 2019). Thus, educational level has been known to influence health through associations with human resources, psychosocial capabilities, expedient health care and lifestyle, living conditions and choices (Hayward et al., 2015).

Parents' SES also reportedly influences children's and adolescents' digital screen use patterns in several ways. A finding of particular interest here is that highly engaged screen use is more likely among children with low parental SES than among children with higher SES backgrounds (Cameron et al., 2015). It may be that parental education level seems to play a role in shaping social and physical characteristics of the home environment, which may be related to capabilities and skills related to fostering healthy lifestyles (Glymour et al., 2014). For instance, mothers' educational status may be positively correlated with their supervision of their children's screen use behaviors (Mantziki et al., 2015). Tandon et al.

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(2014) also found that both physical and social aspects of home environments, including availability of devices with screens and avoidance of physical activity, are positively related to children's exposure to screens.

Parents' low education and/or job skills are among the most important risk factors for children's internalizing (emotional) and externalizing (behavioral) problems (Lanza et al., 2010; Kochanska et al., 2013). Internalizing problems are characterized by symptoms associated with withdrawal, which may include depression, anxiety and somatization (e.g., Deković et al., 2004; Przybylski, 2014). Externalizing problems refer to behavioral problems such as impulsiveness, rule-breaking and aggressiveness (e.g., Achenbach et al., 2002; Przybylski, 2014).

Several studies have shown that internalizing and externalizing problems typically start at the beginning of adolescence (Costello et al., 2003; Zahn-Waxler et al., 2008). Moreover, girls are reportedly more likely to present internalizing problems whereas boys have higher risks for externalizing tendencies (Rescorla et al., 2007; Zahn-Waxler et al., 2008).

In terms of the influences of parental education and job skills level on the risk of internalizing and externalizing problems in young people, these may be at least partly because the paucity undermines adults' psychological and economic resources and ability to provide supportive, consistent parenting practices, including provision of adequate time, control and attention to children (Klebanov et al., 2006). Thus, it impairs the ability to form responsive parent-child relationships, and hence children's willingness to cooperate actively with their parents and follow parental rules (Kochanska, 2002; Thompson, 2008). Other factors that influence development of young people's behavioral problems have also been identified, including cognitive deficits (Burchinal et al., 2006), parents' mental health problems, families' stressful life situations (Burt et al., 2004) and marital conflicts (Conger et al., 1994).

In the past decade, young people have spent increasing amounts of their free time playing video games, watching television or using the internet (Ofcom, 2019). Media use may have varying purposes and significance for adolescents, for instance opportunities for entertainment, coping with stressful situations, autonomy and intimacy, homework and identity processes (Coyne et al., 2013). Use of electronic media devices and related applications appears to be particularly high in the period between adolescence and emerging adulthood (Common Sense Media, 2015). This coincides with a critical period, around the beginning of middle school (at ca. 13 years in Finland), when contextual and developmental transitions may generally increase adolescents' risks for behavioral problems (Bierman et al., 1992). Cell phone-based activities have become particularly strongly embedded elements of being an adolescent (Lenhart, 2015; Männikkö et al., 2018). Usually late adolescence is characterized by increased use of texting and social media use, while levels of television viewing and video gaming remain quite stable (Coyne et al., 2018). Generally boys favor screen-based activities, such as playing video games, while girls are more engaged with mobile devices (Mullan, 2018; Ofcom, 2019).

Internalizing and externalizing behaviors in young people have received increasing attention in research on screen use patterns (Stiglic and Viner, 2019; Przybylski, 2014). Much research on health implications has focused on the extent of young people's screen time and associated effects. According to a recent review, screen use is correlated to an array of adverse psychosocial impacts for adolescents, including hyperactivity/inattention problems, lower quality of life and increased internalizing problems (Suchert et al., 2015). Higher levels of video game playing and television viewing have also been associated with social behavioral problems (Carson et al., 2016). Similarly, a meta-analysis detected strong to moderate effects of screen/sedentary time (especially related to television viewing) on depression symptoms and psychological distress among school-aged children and adolescents, respectively (Asare, 2016). Another meta-analysis of reviews also found evidence of positive connections between screen exposure and both obesity and depressive symptoms (Stiglic and Viner, 2019). However, Stiglic & Viner (2019) found little evidence of associations between

excessive screen exposure and anxiety, hyperactivity or inattention tendencies, or reductions in self-esteem, psychosocial health and educational attainments. On the contrary, screen-based interventions (particularly using cell phones) can reportedly be effectively used to supplement social support and diminish externalizing behaviors (Burraston et al., 2014). In summary, available evidence suggests there are positive cross-sectional associations between adolescents' screen time and both externalizing (Suchert et al., 2015) and internalizing problems (Hoare et al., 2016; Stiglic and Viner, 2019). However, these outcomes are somewhat inconclusive where the putative associations have not been sufficiently tested in longitudinal studies (Hoare et al., 2016; Suchert et al., 2015). Still, in these studies the internalizing and externalizing factors have been mostly considered as consequences of accumulated screen time (i.e., cross-sectional associations) while in some cases it may be that those symptoms (e.g., depression Houghton et al., 2018); and attention, hyperactivity and conduct disorder symptoms (George et al., 2018) have been seen as precursors of youths' higher screen time.

Besides socio-demographic and internalizing or behavioral factors, young people's screen behavior might be associated with health through the lens of the displacement hypothesis, according to which time used on screen-based activities (as an indicator of sedentary behavior) can displace more beneficial activities such as, for instance, physical activity (Ferguson, 2017; Melkevik et al., 2010). Although some studies support this view concerning the effects of screen behavior and their influence on individuals' inactivity (Cox et al., 2012; Tandon et al., 2012), diminished time with screens does not inevitably promote more physically active behaviors. Furthermore, studies have shown physical activity involvement to be beneficial for youths' emotional and behavioral development (Jamnik and DiLalla, 2019; Poitras et al., 2016). Of these two constructs, internalizing factors have received more attention (Biddle et al., 2019). For instance, it has been shown that young people were less shy, anxious and withdrawn if they engaged in organized physical activity (Brière et al., 2019). Consequently, the latest reviews have highlighted the importance of exercise, including at least 60 min each day in moderate-to vigorous-intensity physical activity (MVPA) in relation to various health indicators (psychosocial, physical and cognitive) among young people (Carson et al., 2016; Poitras et al., 2016).

Because several studies have shown that excessive use of digital media by young people may be related to psychosocial instability and other adverse health effects (American Academy of Pediatrics, 1999; Nunez-Smith et al., 2008), the American Academy of Pediatrics (AAP) recommended that screen time (other than video-chatting) should be avoided for children until they are at least 18 months old, and limited to a maximum of an hour a day between 18 months and 5 years (Council on Communications and Media, 2016; Media, 2011). More recently, the World Health Organization (2019) published new health guidelines for children, including recommendations that sedentary screen time should be close to zero for infants less than one year old, and at most an hour per day for children aged two to four. In Finland (and many other countries) there are no formal recommendations for under school-age children. However, a maximum of around two hours of daily screen time has been typically endorsed for school-aged children (7–18 year-olds) (Ministry of Education and Young Finland Association, 2008). A recent empirical investigation found that the average daily screen time for Finnish preschool children aged 3–6 years was approximately one hour 40 min, and higher among children with low parental education levels, according to diaries kept by parents (Lehto et al., 2018). Moreover, another recent Finnish survey found that approximately 55 % of children and adolescents (aged 9–15 years) exceeded the daily screen time threshold of two hours at least five days per week (Kokko et al., 2019).

When studying digital media use patterns and their potentially adverse effects on individuals, qualitative and/or quantitative measures can be used. Quantitative variables of digital screen use, such as amounts of time and frequencies of specific forms of digital screen use, are

commonly determined through self-reports or objective measurements (Arundell et al., 2016; Stiglic and Viner, 2019). Such measurements commonly include information on use of various digital devices and applications by children and/or adolescents after school. Even if nowadays young people participate in a wide spectrum of online activities, for instance by using mobile screen devices, recent reviews of screen use impacts on health have highlighted that previous studies have been predominantly based on screen activities such as television viewing and gaming (Arundell et al., 2016; Stiglic and Viner, 2019).

Qualitative aspects of digital screen use often include individuals' problematic (dependency-like) behavior patterns related to digital screen use (Sigerson et al., 2017; Sim et al., 2012), which is also characterized by co-occurrence of functional impairments. In this kind of situation, screen use patterns may resemble behavior linked to substance addiction, including common symptoms such as, for instance, withdrawal and tolerance (Sigerson et al., 2017). Previous studies have identified four common kinds of problematic behavior patterns linked to use of digital technology (including the internet, video gaming, smartphones and social networking sites), which correlate with three common risk factors: depression, anxiety and loneliness (Sigerson et al., 2017).

In summary, there is inconsistent evidence concerning associations between screen use and various psychosocial health indicators. Moreover, relationships between adolescents' screen time and parents' SES require further attention. Many previous studies have considered direct associations between screen-based sedentary behavior and classical SES variables, including educational level, occupation and income (Tandon et al., 2012), but potentially mediating indicators have been rarely investigated. Previous studies have also largely neglected paths through which internalizing and externalizing behavioral problems may influence total screen time (Stiglic and Viner, 2019). Knowledge of these paths could help in the formulation of effective interventions to curb young peoples' excessive screen time and ameliorate the development of associated problems. Thus, in the study reported here, a multivariate approach was applied to assess the relationships between parental SES, internalizing and externalizing characteristics and adolescents' screen time, along with physical inactivity in adolescence. In particular, the aim is to study the contributing roles of parental SES and adolescents' internalizing and externalizing characteristics in predicting the extent to which an adolescent uses time on screens, and how screen exposure may further exacerbate their physical inactivity. Gender differences were also investigated because these factors have been reported to vary among males and females. Drawing on previous literature, the following hypotheses are formulated:

It is expected that parents' low SES positively predicts adolescents' internalizing and externalizing characteristics and a higher level of screen time, along with physical inactivity (H1). Further, it is hypothesized that adolescents' internalizing and externalizing characteristics positively predict the extent of screen time along with physical inactivity (in this case concerning only internalizing characteristics) (H2). Next, adolescents' higher level of screen time would positively predict physical inactivity (H3). Additionally, the present study considers the conjoint longitudinal connections between parents' SES in both childhood and adolescence.

2. Methods

2.1. Sample and procedure

Data were derived from two waves (baseline and second follow-up) of the Northern Finland Birth Cohort 1986 study (NFBC, 1986), in which there was originally a representative sample of 9432 participants (4865 males and 4567 females). Details of the design and methods of the original study have been described elsewhere (e.g., Hartikainen-Sorri and Rantakallio, 1993; Miettunen et al., 2014). Baseline, first follow-up and second follow-up data were collected in 1985/1986 (T1, at subjects' birth), 1993/1994 (T2, when subjects were 7–8 years old) and

2000/2001 (T3, when subjects were 15–16 years old), respectively. Data on all indicators used in the analyses presented here were collected in face-to-face interviews (at baseline, on the parents' socioeconomic characteristics) and paper-and-pencil questionnaires (administered to subjects and their teachers during follow-ups). Only respondents for whom full information was available on parental SES at baseline (T1), and emotional and behavioral characteristics with information on screen time during the second follow-up (T3) were included in the final analyses. This resulted in a final sample of 5950 participants, including 2893 adolescent males and 3057 adolescent females. The Ethical Committee of the Northern Ostrobothnia Hospital District in Oulu, Finland, approved the study. Written informed consent was obtained from both the children and their parents. Participation was voluntary.

2.2. Measures

Data used in this study included information collected at baseline (at the time of the subjects' birth, when their mothers visited a maternity health center), on the subjects' sex (coded as 1 for male and 2 for female), and socioeconomic status of both parents (or guardians) in terms of educational level, occupational status and employment status. Data on the socioeconomic indicators were also drawn from information gathered when the children were 15/16 years old, in the third wave (T3, in adolescence) in 2000 and 2001. The data were used to generate summed values of SES indicators by manually recoding the original data for socioeconomic terms into categorical variables, then summing as follows. SES at birth included two items for both parents (or guardians): education level and occupational status. Low educational level (no higher than compulsory school) and unskilled worker (employment status out of work) were coded 1, while all other options were coded 0. SES at adolescence included four items for both parents (or guardians). Less than 9 years of compulsory school, no basic vocational education, no other vocational qualifications and employment status out of work were all coded 1, while all other options were coded 0. The SES in childhood and adolescence scores were then separately summed to obtain overall scores ranging from 0 to 4 and 0 to 8, respectively.

Internalizing and externalizing problem subscales were selected from the Youth Self Report (YSR) instrument (Achenbach, 1991; Achenbach and Resorta, 2001) to assess these constructs. The internalizing and externalizing subscales include three (30 items referring to anxious-depressed, withdrawn-depressed and somatic complaints) and two (29 items that corresponded to rule-breaking and aggressive behaviors) subscales, respectively, each rated on a 3-point Likert scale (0 = not true, 1 = somewhat true, or 2 = very true). Higher scores indicate more internalizing or externalizing problems. In a previous analysis of data pertaining to the same sample, focusing on links with substance abuse, Cronbach's alpha values for these scales of 0.87 and 0.86, respectively, were obtained (Miettunen et al., 2014).

Screen time was estimated using two items asking respondents how many hours per day they spent, on average, watching television and playing video games or other computer-based screen activities. The responses were summed to form a measure of total screen time (more strictly, total screen use or exposure time) used as a unidimensional scale.

Participants' physical activity was measured using two items that asked how much they participated in brisk physical activity (in moderate- to vigorous-intensity) outside school hours, and did they belong to a sports club (Kantomaa et al., 2008). The response options for the first item were not at all, approximately half an hour a week, approximately one hour a week, two to three hours a week, four to six hours a week and at least seven hours a week. The response alternatives for the latter item were no; yes, but I do not attend the training sessions; and yes, and I attend the training sessions. The data were used to generate summed values of physical inactivity indicators by manually recoding the original data for physical activity terms into categorical variables, then summing as follows. The physical inactivity variable included two items, where physical activity level was no more than 1 h a week and no participation

in a sports club (and included training sessions) were coded 1, while all other options were coded 0. The overall physical inactivity scores ranging from 0 to 2.

2.3. Statistical analysis

Initial numbers of participants in the study were 9432 in 1986 and 7039 in 2000/2001. However, to meet requirements of the statistical procedures, only participants for whom there was no missing data (n = 5958) were included in the analysis presented here. Distributions of total variables deviated substantially from normality, with univariate skewness (SK) and univariate kurtosis (KU) values ranging from .057 to 5.183 and -.742 to 67.115, respectively. Thus, a multiple paths model was created using a bootstrapping procedure with 1000 resampling, which enables assessment of models' overall fit in such cases (Preacher et al., 2007). Means and standard deviations of the summed measures of SES, internalizing and externalizing problems, total daily screen time and inactivity level, were subjected to independent t-tests to detect possible between-gender differences.

Longitudinal associations between SES at birth and adolescence, internalizing and externalizing problems, screen time and physical inactivity were assessed by mediation analysis. For this, three types of correlations (longitudinal, cross-sectional and synchronous associations at follow-up) between variables measured on two occasions (baseline and second follow-up) were computed. The resulting paths model (Figure 1) was tested using all data. Gender was included in the model as a control variable, but is not presented in the figure for the sake of clarity. All presented regression weights are standardized.

Finally, we examined whether correlations between study variables were moderated by the subjects' gender, by multigroup comparison. The chi-square difference test ($\Delta\chi^2$) across the two groups (males and females) was investigated by comparing an unconstrained model to a model with equal structural loadings across genders. Then, the chi-square difference was tested separately for each path (i.e., path loading [coefficients] was set equal across both genders). Finally, invariances for each path were compared using the difference in chi-square statistics, where values in both higher than .01 indicate no significant difference between the models (Cheung and Rensvold, 2002).

To evaluate whether the models represented the data adequately, criteria presented by Hu and Bentler (1999) were applied. Their goodness of fit was evaluated using the Comparative Fit Index (CFI), Tucker-Lewis Fit index (TLI), and Root Mean Square Error of Approximation (RMSEA). Models were considered acceptable if their CFI and TLI values were greater than 0.9, and their RMSEA value was below 0.08 (Hu and Bentler, 1999). In these tests the threshold of statistical significance was set at .01. All analyses were conducted using IBM SPSS Statistics 22 and Amos 20.0 software packages.

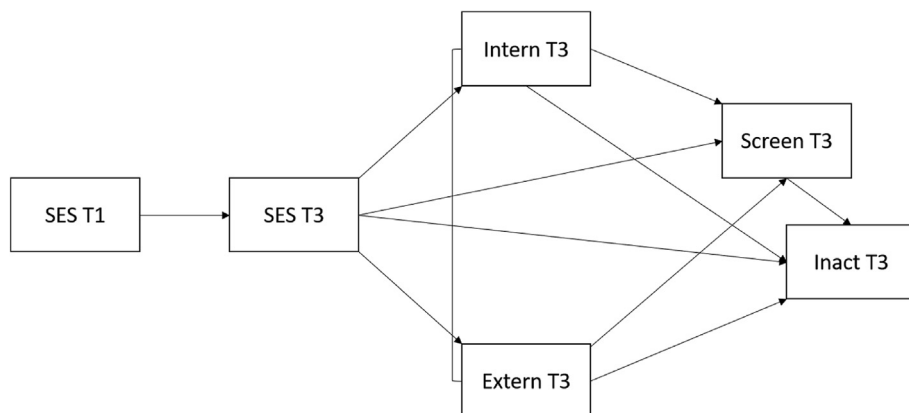


Figure 1. Assumed pathways for the domains between socioeconomic status (SES) indicators, total amount of digital screen use and physical inactivity. Note: SES T1, SES T3, Intern T3, Extern T3, Screen T3 and Inact T3 respectively refer to: parents' socioeconomic status in childhood (T1, baseline); parents' socioeconomic status in adolescence (T3, second follow-up); level of internalizing behavior problems at T3; level of externalizing behavior problems at T3; total screen time at T3 and level of physical inactivity at T3. See text for definitions and derivations.

3. Results

3.1. General characteristics

Mean values of the summed SES, internalizing problems, externalizing problems, total screen time and physical inactivity variables are presented in Table 1. On average, the adolescents were exposed to screens for 3.79 h a day. There were significant gender differences among the total screen time ($t(5112) = 19.39, p < .001$), physical inactivity level ($t(5891) = -6.35, p < .001$) and internalizing ($t(5601) = -32.45, p < .001$), and externalizing ($t(5948) = -11.09, p < .001$) problem scores. In the following sections SES in childhood and SES in adolescence refer to parental socioeconomic status at T1 and T3, as previously defined.

3.2. Evaluation of models

3.2.1. Total sample

The goodness of fit tests indicated that the model adequately fits the data ($\chi^2(4) = 35.964$; CFI = .993; RMSEA = .037; TLI = .965). Low SES in childhood was associated with low SES in adolescence ($\beta = .476, p < .001$), accounting for 22.6% of the variance in SES level. SES in adolescence was not significantly associated with levels of either internalizing problems ($\beta = .024, ns$) or externalizing problems ($\beta = .025, ns$). Moreover, it was not correlated positively with total screen time in adolescence ($\beta = .019, ns$). In addition, the adolescents' level of externalizing problems was significantly positively associated ($\beta = .118, p < .001$) with their total daily screen time. Lower SES ($\beta = .106, p < .001$) and a higher level of internalizing problems ($\beta = .079, p < .001$) in adolescence were positively related to the level of physical inactivity. The adolescent's level of screen time was also positively related to the level of physical inactivity among the total sample ($\beta = .044, p < .001$). Furthermore, levels of internalizing and externalizing problems correlated strongly and positively with each other ($\beta = .474, p < .001$). The path model accounted for 7.5% and 2.7% of the variance in total screen time and physical inactivity levels respectively.

In terms of control, adolescents' gender (boys = 0, girls = 1) was related positively to adolescents' levels of internalizing ($\beta = .385, p < .001$) and externalizing ($\beta = .142, p < .001$) problems, screen time ($\beta = -.264, p < .001$) and physical inactivity ($\beta = .062, p < .001$).

3.2.2. For boys and girls

As significant gender differences were found among many variables, the model fit was checked for both female and male. The index values obtained show that the path model had an acceptable goodness of fit for both genders (Table 3). Because the chi-square difference between the two gender models was significant ($\chi^2(10) = 44.858, p < .001$), the analysis was run to test for effects of gender on the considered variables.

Table 1. Mean (M) and standard deviation (SD) of SES T1 (socioeconomic status in childhood, at baseline), SES T3 (socioeconomic status in adolescence), internalizing problems (at T3), externalizing problems (at T3), total screen time (at T3) and physical inactivity (at T3) for male, female and the whole sample. See text for definitions and derivations.

Scale	Whole sample (N = 5958)	Male (N = 2899)	Female (N = 3059)
SES T1	M = .70 SD = .81	M = .70 SD = .82	M = .70 SD = .81
SES T3	M = .95 SD = 1.25	M = .96 SD = 1.29	M = .95 SD = 1.22
Internalizing problems	M = 9.10 SD = 6.79	M = 6.41 SD = 5.21	M = 11.64 SD = 7.12
Externalizing problems	M = 9.86 SD = 6.41	M = 8.93 SD = 6.05	M = 10.76 SD = 6.61
Total screen time	M = 3.79 SD = 2.94	M = 4.53 SD = 3.33	M = 3.09 SD = 2.29
Physical inactivity	M = .94 SD = .66	M = 0.89 SD = 0.67	M = 1.00 SD = .64

There was a significant and positive path between low SES in childhood and low SES in adolescence ($\beta = .442, p < .001$ for female and $\beta = .510, p < .001$ for male). Level of externalizing problems was significantly positively related to total daily screen time for both genders ($\beta = .129, p < .001$ and $.119, p < .001$ for female and male, respectively). Gender comparison also showed that among female low SES in adolescence had a significant and positive influence on total amount of screen time ($\beta = .059, p < .001$) while there was no significant connection among boys. The tested paths model explained the higher variance in total screen time among females (2.3%) compared to males (1.3%). Furthermore, low SES in adolescents was directly and positively related to their level of physical inactivity for both genders ($\beta = .094, p < .001$ and $.116, p < .001$ for female and male, respectively). The level of internalizing problems in adolescence was significantly and positively related to the level of physical inactivity only for males ($\beta = .115, p < .001$). The level of externalizing problems ($\beta = .056, p = .007$) and screen time ($\beta = .058, p = .001$) among females was positively related to their level of physical inactivity in adolescence. The tested paths model explained the higher variance in physical inactivity levels among males (2.5%) compared to females (2.2%).

All pathways were constrained with equal coefficients for girls and boys to determine the statistical significance of the observed gender differences in specific pathways (Table 2). This analysis detected three significant between-gender difference in the pathways (between low SES in childhood and low SES in adolescence; level of internalizing problems and physical inactivity in adolescence and level of externalizing problems and physical inactivity in adolescence). Low SES in childhood predicted low SES in adolescence more strongly for boys than girls. Gender

comparison also showed that low SES in adolescence had stronger effects on girls than boys in terms of total screen time. Moreover, the level of externalizing problems had also stronger effects on girls than boys in relation to the level of physical inactivity, whereas the level of internalizing problems contributed more to physical inactivity tendencies among boys than girls.

4. Discussion

The purpose of this study was to examine associations between parents' SES and screen exposure, and with physical inactivity, via internalizing and externalizing behavior characteristics of Finnish adolescents participating in a large cohort study. The present study showed that parents' lower socioeconomic status predicted significant direct risk of later adverse socioeconomic status among both genders. The results also revealed and partly supported the hypothesis 1 that parents' low socioeconomic status constitutes a direct risk factor in relation to physical inactivity in both genders. Furthermore, as hypothesized in hypothesis 2, the results showed that adolescents' level of externalizing problems was significantly and positively correlated with total daily screen time cross-sectionally in both genders. Additionally, a sufficiently high level of externalizing problem behavior characteristics could restrain female adolescents' vigorous participation in sports. However, we found a strong and significant positive association between internalizing problems and the adolescents' level of physical inactivity, especially among the male participants. Findings also showed that a higher level of screen time may contribute more to physical inactivity among female adolescents and thus hypothesis 3 was partly supported.

Table 2. Effects of pathways on screen time, by gender.

Path	Total		Female		Male		Path weight difference $\Delta\gamma^2 (1, N = 5958)$
	Effect ^a	P	Effect ^a	P	Effect ^a	P	
SES at birth (T1) - > SES in adolescence	.476	< .001	.442	< .001	.510	< .001	14.70, p < .001
SES in adolescence (T3) - > internalizing (T3)	.024	.046	.040	.028	.008	.677	2.37, p = .123
SES in adolescence (T3) - > externalizing (T3)	.025	.052	.035	.050	.014	.453	.919, p = .338
SES in adolescence (T3) - > level of screen time (T3)	.019	.136	.059	< .001	-.008	.662	5.107, p = .024
Internalizing (T3) - > level of screen time (T3)	.003	.831	.018	.384	-.009	.654	.618, p = .432
Externalizing (T3) - > level of screen time (T3)	.118	< .001	.129	< .001	.119	< .001	2.379, p = .123
SES in adolescence (T3) - > level of physical inactivity (T3)	.106	< .001	.094	< .001	.116	< .001	.758, p = .384
Internalizing (T3) - > level of physical inactivity (T3)	.079	< .001	.040	.048	.115	< .001	11.97, p = .001
Externalizing (T3) - > level of physical inactivity (T3)	.007	.619	.056	.007	-.050	.018	12.65, p < .001
Level of screen time (T3) - > level of physical inactivity (T3)	.044	< .001	.058	.001	.035	.055	2.051, p = .152

Note. ^a Standardized regression coefficients; significant results are in boldface; $\Delta R^2 = .195$ for SES in adolescence among females; $\Delta R^2 = .023$ for total screen time among females; $\Delta R^2 = .022$ for physical inactivity among females; $\Delta R^2 = .260$ for SES in adolescence among males; $\Delta R^2 = .013$ for total screen time among males; $\Delta R^2 = .025$ for physical inactivity among males.

Table 3. Results of tests of fits of the mediation models for the whole sample, girls and boys.

Index	χ^2 /p-value	CFI	RMSEA	TLI
Total mediation model	35.964/< .001	.993	.037	.965
Mediation model: group men/women	38.221/< .001	.991	.025	.966

Note. CFI, comparative fit index; RMSEA, root mean square error of approximation; TLI, Tucker-Lewis Index.

Adjusting for internalizing and externalizing factors allowed evaluation of the relations between adolescents' screen time and parental SES. Low parental SES may have made some contribution to female subjects' higher screen exposure, contrary to hypothesis 1 there were weak indications of a direct but non-significant effect among male participants, but this could be at least partly attributed to confounding effects of externalizing and internalizing problems in the cross-sectional observations. Low parental SES contributed more strongly (but not significantly) to externalizing and internalizing behavior problems in the female adolescents than in the males. In line with our hypotheses, the longitudinal analysis also detected significant associations between low parental SES in childhood and low parental SES in adolescence.

As expected (H1), we found a significant and direct positive association between parents' low socioeconomic status and adolescents' physical inactivity. Consequently, in our sample, lower socioeconomic status was only significantly and positively related to female (not male) adolescents' daily screen time. This reflects consistency with a recent study that found youth with higher parental income (as one of the strongest demographic factors) favored participation in both self-organized and organized sports, which can supposedly be explained by parents' support of such activities (Wiium and Säfvenbom, 2019). That said, our findings also support the view that the influence of SES level on health is strongly related to behavior choices (Wang and Geng, 2019), for instance concerning physical activity and/or screen media use patterns.

The positive association between the adolescents' level of externalizing behavior problems (comprised of rule-breaking and aggressive tendencies which can be characterized by impulsive behavior) and total screen time we detected is line with our hypothesis (H2) and partly consistent with the findings of recent reviews (Carson et al., 2016; Nikkelen et al., 2014; Suchert et al., 2015). For instance, a review by Carson et al. (2016) reported a longitudinal relationship between higher exposure to screen time (general screen time, television viewing and video gaming) and disadvantageous changes in behavior (i.e., a pattern of violent and disruptive behavior) (Carson et al., 2016). The authors also noted that those interrelations were the most consistent as regards television viewing and gaming. Consequently, a meta-analysis by Nikkelen et al. (2014) summarized the previous evidence on the associations between screen media use and ADHD-related behaviors (i.e., hyperactivity, attention impairments and impulsivity) in young people. Nikkelen et al. reported that there were few studies that solely (i.e., most of the studies used combined measures) concentrated either on hyperactivity, attention impairments or impulsivity where attention problems yielded a moderate positive correlation, and impulsivity a small, but significant positive connection to total media use. Furthermore, only one study assessed hyperactivity. The authors did not find an effect of media type (i.e., television viewing versus gaming) on the strength of the screen-ADHD-related connections but the effect sizes were higher for boys than for girls, as was the case for cross-sectional studies compared to longitudinal studies. Another review also revealed a strong positive relationship between accumulated screen time and higher levels of hyperactivity/inattention problems in children and adolescents (Suchert et al., 2015). Authors of these reviews highlighted the limitations of previous studies, including heterogeneity of screen-based indicators, the majority of studies being based on a cross-sectional approach, and lack of examination of specific explanatory mechanisms that could explain these interrelations (Nikkelen et al., 2014; Suchert et al., 2015).

To date, there is a paucity of research on mechanisms linking youths' externalizing behavior problems and health-risk choices such as higher levels of screen use (or physical inactivity, as also found among female adolescents in present study). One possibility is that certain problem behaviors (e.g., addictive and rule-breaking behaviors) may be related to an individual's decreased level of self-control (Keane et al., 1993; Tittle et al., 2003), which may also be regarded as a predictor of antisocial behavior (social maladaptation; Cecil et al., 2012). Individuals with impaired self-control (i.e., impaired capacity to control cognition, emotion and behaviors) are characterized as risk-taking, impulsive, insensitive, less verbal and more short-sighted (Gottfredson and Hirschi, 1990) and therefore such individuals fail to inhibit urges toward different screen activities. It has been also shown that mother-child interaction involving elevated levels of maternal negative affect may be related to decreased levels of inhibitory control in preschoolers (van Dijk et al., 2017). It has been further argued that a negative environment reduces children's ability to take advice and learn from it, which impairs internalizing cognitive processes (e.g., inhibitory control) resulting in further increases in hyperactivity/impulsive behavioral problems. Two longitudinal studies have supported this hypothesis, indicating that children's executive functioning (i.e., cognitive self-regulation of thought, action and emotion) is mediated by the association between early parenting and externalizing behavior (Sulik et al., 2015; van Dijk et al., 2017). In the present study girls showed significantly higher rates of internalizing symptoms than boys, as previously reported (Garber, 2006; Perrino et al., 2019).

In contrast to externalizing behavior and our hypothesis (H2), we found that internalizing behavior problems did not directly contribute to our participants' screen time. For example, it is possible that elevated symptoms of depression may trigger desire to spend time without screens. Discrepancies in this respect with previous findings could be also due to differences in methodologies and measures of specific types of screen-based activities (Maras et al., 2015) or difficulties in distinguishing and delimiting screen time from sedentary behaviors that are not screen-based (Stiglic and Viner, 2019), or only intermittently screen-based. While there is reportedly moderate evidence of a relationship between excessive screen exposure and depression symptoms in youth (Asare, 2016; Ferguson, 2017; Stiglic and Viner, 2019), links between other general internalizing behavior symptoms (e.g., anxiety) and excessive screen time are less clear (Stiglic and Viner, 2019). Ferguson (2017) recently found associations between negative outcomes (depression, delinquency and reduced grades) and total screen time among youths, but only in cases of high screen use (over six hours daily). Some authors have also found that total screen or technology use accounts for minimal variance in symptoms of depression in youth (Ferguson, 2017; Orben and Przybylski, 2019). It should also be noted that the cross-sectional nature of most previous evidence prohibits assessments of the causality of these associations.

In contrast, a recent comprehensive evaluation of reviews concluded there is no clear evidence of a positive relationship between excessive screen time and either certain externalizing problems (including hyperactivity and inattention) and internalizing problems, such as anxiety, low self-esteem and poor psychosocial health (Stiglic and Viner, 2019). However, Stiglic & Viner concluded that there is moderately strong evidence of a relationship between excessive screen time and depressive symptoms. Similarly, a recent meta-analysis of correlations between total screen exposure and mental health outcomes (Asare, 2016) found that

screen-based sedentary behavior is a weak but significant predictor of adverse mental health outcomes including anxiety, depression, low self-esteem, psychological distress and low quality of life. Asare also concluded that the health indicator most strongly influenced by this behavior is depression.

As expected (H2), the current study revealed that male adolescents' internalizing characteristics were associated with a heightened risk of physical inactivity, which is consistent with previous evidence (Jamnik and DiLalla, 2019; Kantomaa et al., 2008). A study by Kantomaa et al. (2008) reported interrelations between physical inactivity and emotional (e.g. anxious/depressed symptoms in boys; withdrawn/depressed symptoms in boys and girls) and behavioral (e.g. social and attention problems in girls and boys) problems, based on the same cohort sample used in current study. In their paper they also made some arguments for how physical activity can promote mental health. Correspondingly, one possible explanation for this is that internalizing problems may be related to an increased risk of physical health symptoms (weight problems, somatic complaints, respiratory diseases and health behavior choices; Aarons et al., 2008; Biebl et al., 2011; Jamnik and DiLalla, 2019; Kantomaa et al., 2008; Nelson et al., 2013) and may induce young people to participate further in certain alternative activities that adversely impact their health.

In the current study, higher levels of screen-based activities such as video gaming, computer use and television viewing restrained (H3 was supported) adolescents' (especially females') vigorous sport participation (sports club participation and vigorous exercise); similarly previous studies have also revealed that self-organized exercise in youths (Sandercocock Ogunleye and Voss, 2012) or sports club participation (Mäkelä et al., 2016) may reduce the time used on screen-based activities. This finding may mean these behaviors to a great extent displace one another, but a group of interacting contextual and psychosocial mechanisms—mentioned in this section—are known to be involved. However, the cross-sectional nature of the above-mentioned interrelations limits us in drawing robust conclusions about causality. Studying tracking patterns of sport participation and screen time would be an important area for future research.

Effects of screen activities on youth may also depend, at least partly, on their nature. For instance, time devoted to mobile device-based activities may increase opportunities for displacing face-to-face socialization, thereby reducing real life social interaction and raising probabilities of anxiety symptoms (Billieux et al., 2015), whereas excessive overall screen time may promote depressive symptoms (Stiglic and Viner, 2019). Moreover, internet-based activities may increase youths' risks for cyber-bullying, and thus depression and anxiety symptoms (Kowalski and Limber, 2013). In addition, Maras et al. (2015) recently found connections between time spent playing digital games and symptoms of depression and anxiety among youths. They also found that time spent using computers was related to symptoms of depression, but not anxiety symptoms. It is also worth noting that there are a number of other factors that may influence screen use patterns and their importance, including, for instance, relationship state (in a relationship versus single), occupation (active versus out of work) and important life events (e.g. shifts in relationship status) (Billieux et al., 2015).

Effects of gender have also been reported. For example, men are more likely to become highly immersed in online gaming and gambling, while women have stronger tendencies to become problematically engaged with social media, online shopping and texting (Ferguson et al., 2011; Kuss et al., 2014; Maraz et al., 2015; Van Deursen, Bolle, Hegner and Kommers, 2015). One recent study supporting our findings detected a positive association between internalizing symptoms and subsequent screen-based sedentary behavior among girls (who also tended to use such technology-based activities such as cell phone use, emailing and texting), but not boys (Perrino et al., 2019). However, most previous studies have addressed implications of screen time based largely on television viewing time, and few have comprehensively assessed screen

activities, including computer use, gaming and mobile screen use. Thus, implications of these activities warrant further attention.

It should be noted that other indicators that we did not examine reportedly have mediating effects on children's and/or adolescents' screen time, including family structure (Quarmby et al., 2011), parent-child interactions (Zhao et al., 2018) and attachment to parents and peers (Richards et al., 2010). In addition, migrant status of children may increase susceptibility to high screen exposure (Iguacel et al., 2018; Puder et al., 2013). However, although these demographic, psychological, social and behavioral factors have been identified as potential determinants of youths' excessive screen exposure, their effects have not been examined in detailed prospective studies.

Two limitations of this study should be noted. First, the analysis of relationships between screen time and the adolescents' behavior (externalizing and internalizing along with physical inactivity characteristics) was based on cross-sectional observation, which prevents assessment of their causality. Thus, directions of the associations should be verified in further longitudinal research. Second, no empirical data on screen time derived from observation of exposure to specific devices with screens and specific types of screen activities were available. For example, lack of data on mobile based screen activities has been highlighted also in the recent review of reviews (Stiglic and Viner, 2019). Such data could have substantially affected the results as different screen activities might have different effects on youths' emotional health. Thus, more refined examination of specific types of screen exposure may illuminate relationships between specific activities and either emotional or behavioral problems.

Nevertheless, this study contributes to the evidence base by providing an in-depth examination of associations between parental SES and adolescents' total screen time along with sports participation through externalizing and internalizing characteristics. The current findings suggest that parents' low SES can lead to greater physical inactivity among adolescents. Parents' lower socioeconomic status can also contribute later to adverse socioeconomic status. Moreover, the results show a clear link between a higher level of externalizing problem characteristics and screen use among adolescents, indicating that externalizing characteristics could mediate the relationship between low parental SES and higher screen exposure. Gender moderated the relationship between adolescents' internalizing and externalizing characteristics and physical inactivity levels. The results may help to clarify some interrelations of risky behaviors and facilitate formulation of health education programs. They show that when evaluating individuals' level of engagement in screen activities, it may be useful to consider their sports engagement as well as specific types of emotional and behavioral problems they have. The findings also indicate that future studies should: utilize longitudinal and experimental designs, use both subjective and objective measures of screen use, and include comprehensive analysis of individuals' full range of leisure time activities surrounding digital screen use in characterization of screen and leisure time behaviors.

Declarations

Author contribution statement

N. Männikkö: Conceived and designed the analysis; Analyzed and interpreted the data; Contributed analysis tools or data; Wrote the paper.

H. Ruotsalainen, M. Kääriäinen: Conceived and designed the experiments; Wrote the paper.

J. Miettunen: Contributed analysis data.; Conceived and designed the experiments; Wrote the paper.

K. Marttila-Tornio: Contributed analysis data.

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The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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