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ORIGINAL ARTICLE

Computer use, sleep duration and health symptoms: a cross-sectional study of 15-year olds in three countries

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Abstract
Objectives This study investigated whether computer use is associated with health symptoms through sleep duration among 15-year olds in Finland, France and Denmark.
Methods We used data from the WHO cross-national Health Behaviour in School-aged Children study collected in Finland, France and Denmark in 2010, including data on 5,402 adolescents (mean age 15.61 (SD 0.37), girls 53 %). Symptoms assessed included feeling low, irritability/bad temper, nervousness, headache, stomachache, backache, and feeling dizzy. We used structural equation modeling to explore the mediating effect of sleep duration on the association between computer use and symptom load.
Results Adolescents slept approximately 8 h a night and computer use was approximately 2 h a day. Computer use was associated with shorter sleep duration and higher symptom load. Sleep duration partly mediated the association between computer use and symptom load, but the

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indirect effects of sleep duration were quite modest in all countries.

Conclusions Sleep duration may be a potential underlying mechanism behind the association between computer use and health symptoms.

Keywords Adolescent · Computer use · Sleep duration · Symptoms · Survey

Introduction

Electronic media use forms an important part of life for today's children and adolescents. In the US, studies report that media exposure among school-aged children and adolescents is nearly 8 h a day, even when taking multitasking into account (Rideout et al. 2010). From 2004 to 2009, total media exposure in a typical day among US adolescents increased over 2 h (Rideout et al. 2010), yet the recommendation for total media use itself is only 1–2 h of quality programming per day (American Academy of Pediatrics Committee on Public Education 2001).

Previous studies indicate that frequent electronic media use, computer use or TV viewing is associated with mental (Mentzoni et al. 2011) and somatic symptoms (Alexander and Currie 2004), socio-emotional problems (Russ et al. 2009), and tiredness (Van den Bulck 2004). Many cross-sectional studies have also reported an association between excessive electronic media use and later bedtime (Van den Bulck 2004), shorter sleep duration (Li et al. 2010), and sleep disturbances (Owens et al. 1999).

Various mechanisms may explain the association between media exposure and sleep. Electronic media use may simply delay bedtime and reduce the amount of sleep one gets during the 24-h cycle due to the obligation to wake up early for school in the morning. Also, the bright light of the screen may suppress melatonin secretion, phase-delay the biological clock, and increase mental and physiological arousal (Cajochen et al. 2011; Higuchi et al. 2005), which in turn may make falling asleep more difficult. It is also possible that media, not turned off during the night, may awaken adolescents, at different moments of nights, reducing total sleep time. Because sleep is essential for mental and somatic health as well as daily functioning (Curcio et al. 2006; Roberts et al. 2009a, b; Wolk et al. 2005) and because it seems that adolescents are sleeping less than recommended (Leger et al. 2012), it is important to study factors which potentially threaten to get sufficient amount of sleep. One mechanism behind the association between electronic media use and health may be that electronic media use reduces or impairs sleep.

Whether the effect of electronic media on sleep and health varies by gender remains unclear. Boys and girls differ in how they use electronic media; boys are usually more frequent users and play more, whereas girls are more engaged in communication activities (Ohannessian 2009). Boys and girls also differ in their sleep habits. Girls report longer sleep duration (Westerlund et al. 2009). Girls' earlier onset of puberty may explain gender differences in sleep during adolescence. Physiological changes during puberty may also influence the sleep–wake cycle, thereby delaying circadian phase. The physiological need for sleep may also increase during puberty (Carskadon 2011). In addition, girls usually experience more health problems than boys do, a phenomenon evident in many countries (Currie et al. 2012).

Only few studies have previously examined whether sleep mediates the association between electronic media use and health. Punamäki et al. (2007) found among Finnish adolescents that sleep habits and tiredness partly mediated the association between intensive use of information technology and poor perceived health. (Punamäki et al. 2007). Barlett et al. (2012) reported in a 13-month follow-up study that sleep (time 2) partially mediated the associations between media exposure (time 1) and attention problems, physical aggression, and body mass index (time 3). They suggest that sleep may be a general mediating mechanism between media exposure and health outcomes (Barlett et al. 2012). To our knowledge, no study exists which specifically focus on sleep duration as mediator between computer use and health symptoms. Because daily electronic media use is increasing, examining the associations between electronic media use and health and investigating the underlying mechanisms is becoming increasingly important.

This study aims to explore the association between computer use and psychological and somatic symptom load among 15-year olds adolescents and to investigate whether sleep duration mediates this association. We used comparative data from representative samples of adolescents from three countries. We hypothesize that computer use is associated with shorter sleep duration (Li et al. 2010), and more symptoms (Alexander and Currie 2004; Mentzoni et al. 2011). We also hypothesize that shorter sleep duration is associated with more symptoms (Roberts et al. 2009a, b), and short sleep duration partly mediates the association between computer use and health symptoms (Punamäki et al. 2007; Barlett et al. 2012).

Methods

We drew Finnish, French and Danish data from the international WHO (World Health Organization) collaborative study Health Behaviour of School-aged Children (HBSC) from 2010. The survey instrument used in the HBSC study is an internationally standardized questionnaire developed by the international research network. The questionnaires were administered in school classes, and the students answered the questionnaire anonymously (Roberts et al. 2009a, b).

The sampling of nationally representative populations within age groups of 11-, 13- and 15-year olds was based on the HBSC study protocol. In Finland, schools were selected by cluster sampling from school registers, taking into account the size of schools and regions. One class was then selected randomly from each school. In France, the sampling method was also school-based cluster sampling that took into account the size of the schools; then, two classes were randomly chosen from each selected school. In Denmark, schools were randomly selected from a complete school register using simple random sampling, and all relevant classes from these schools were included.

This study comprises total of 5,402 adolescents (mean age 15.61 years (SD 0.37, girls 53 %) from Finland ($n = 2{,}110$), France ($n = 1{,}906$) and Denmark ($n = 1{,}386$). The national research teams reported the following response rates among 15-year olds: Finland, 96 %; France, 77–80 %; and Denmark, 86 % (among the full sample of 11-, 13-, and 15-year olds). Because the sampling varied somewhat between the countries, counting equivalent response rates is difficult. The Norwegian Social Science Data Services (NSD) cleaned the data. The criteria for excluding cases were pupils deviating with more than ± 6 months from the mean age in each age group and/or missing more than 25 % of the answers to selected key questions. Total sample size was 5402 from Finland, France and Denmark. In our analyses, we also excluded adolescents missing values for any of the following variables: computer use, sleep duration, psychological or somatic symptom load, and Family Affluence Scale; thus 5,025 adolescents were remained in our analyses.

The HBSC study was approved at national levels, and each country confirmed its respective legal requirements. Pupil participation was voluntary in all countries and based on informed consent. In Finland, ethics approval came from the National Board of Education and the Trade Union of Education. In addition, in Finland, schools' headmasters independently decided whether to participate in the study or not. In France, the Ministry of Education and the French National Commission of Computer Science and Freedom approved the study protocol. In Denmark, no formal agency exists to handle ethical approval of questionnaire-based survey studies in the general population. Therefore, the research team approached the school director, the board of parents, and the board of pupils in each participating school for approval.

We assessed computer use on school days with the question: "How many hours a day do you usually use a computer for chatting, surfing the internet, emailing or doing your homework?" Response categories were "not at all", "half an hour", "1 hour", "2 hours", "3 hours", "4 hours", "5 hours", "6 hours" and "7 hours or more". Computer use on school days served as a continuous variable.

We calculated sleep duration from pupils' reports of bedtimes and wake-up times on school days. Bedtimes were asked as follows: "When do you usually go to bed if the next morning is a school day?" Answering alternatives for bedtimes on school nights ranged in half an hour intervals from "at latest 9 pm" to "2 am or later". We assessed wake-up times with the question: "When do you usually wake-up on school mornings?" Response categories ranged in half an hour intervals from "5 am at the latest" to "8 am or later". We then calculated sleep duration using the following formula: 24 − bedtime + wake-up time.

We measured psychological and somatic symptom load with the HBSC Symptom Check List (HBSC-SCL), which asks the following question: "How often have you had the following symptoms during the past 6 months?" We included three psychological symptoms (feeling low, irritability or bad temper, feeling nervous; Chronbach's alpha total 0.76; girls 0.75; boys 0.75) and four somatic symptoms (headache, stomachache, backache, and feeling dizzy; Chronbach's alpha total 0.64; girls 0.64; boys 0.62). The response categories were: (5) almost daily, (4) more often than weekly, (3) weekly, (2) monthly, and (1) seldom or never. For each student, we added the responses as a simple index of symptom load; the range for psychological symptoms was 3–15, and for somatic symptoms, 4–20. We used these two indices as quasi-quantitative measures in the correlational analyses.

The Family Affluence Scale (FAS II), which is an indicator of socioeconomic position, served as a covariate in the models. FAS II is the sum variable of four items: whether the student has his/her own bedroom, the number of cars in the family, the number of family holidays, and the number of computers in the family. The FAS II score ranges from 0 to 7, where 7 is meaning the most affluent position (Currie et al. 2008).

Statistical analysis

Descriptive statistics appear as means and standard deviations. We tested differences in computer use, sleep duration, and symptom load between genders within countries using the Mann–Whitney *U* test and differences within genders between countries with the Kruskall–Wallis test. We calculated Spearman's rank correlation coefficients for computer use, sleep duration, and psychological and somatic symptom load. We performed descriptive statistics and correlation analyses with Predictive Analytics SoftWare (PASW) Statistics version 18.0 for Windows (Chicago: IL).

To examine associations between computer use, and psychological and somatic symptom load and the mediating role of sleep duration, we used SPSS AMOS 18 to apply structural equation modeling (Arbuckle 2006). First, the measurement model, which is equivalent to a confirmatory factor analysis with somatic and psychological symptoms, was examined before testing the structural mediation model. Because the variables were non-normally distributed, we chose an asymptotically distribution-free (ADF) method to examine both the measurement model and the mediation model.

To evaluate whether the measurement model and the mediation models fit the data, we explored several model fit indices including the Normed Fit Index (NFI), Goodness-of-Fit Index (GFI), Comparative Fit Index (CFI), Root Mean Square Error Approximation (RMSEA), Root Mean Square Residual (RMR), and χ^2 test. To obtain adequate fit, the following recommended cut-off values are reported, NFI $\geq$ 0.90, CFI $\geq$ 0.95, RMSEA $\leq$ 0.08, and RMR $\leq$ 0.08. In this study, we followed these cut-off values. A non-significant p value in the χ^2 test means that the model-implied covariance matrix is equivalent to the empirical covariance matrix. The χ^2 test is very sensitive to large sample sizes and a non-significant p value is unlikely with large sample sizes (Schermelleh-Engel et al. 2003).

Based on the results of the measurement model, we formulated two latent variables: *psychological symptom load* and *somatic symptom load*. The measurement model achieved adequate fit in all six different groups. Factor loadings varied from 0.338 to 0.821 and correlations between the latent variables varied from 0.586 to 0.740. The mediation model included this measurement model.

The mediation models were made separately for boys and girls and separately for each country across six groups. From the mediation model, standardized direct effects of computer use on symptom load, standardized indirect effects, and standardized total effects (direct + indirect effects) are reported as regression coefficients with their standard errors, 95 % CI, and p values. We performed bootstrapping (500 bootstrap resamples) to estimate the CI and p values. Indirect effects describe the proportion of the association between the independent and the outcome variable, which goes through the mediator variable. We also applied terms as direct effects, indirect effects and total effects later in the text.

Results

Table 1 shows that computer use did not differ between boys and girls in Denmark and Finland, whereas in France the mean computer use time was higher among girls than boys. In Finland, girls slept less than boys and in Denmark boys slept less than girls. In all countries, psychological and somatic symptom loads were higher among girls than boys. Danish girls used computers more, slept less, and reported lower symptom loads than did girls in Finland and France. The boys differed from each other in their computer use, sleep duration and symptom load; French and Finnish boys, however, showed no differences in either psychological or somatic symptom load. In all countries, increasing computer use was associated with shorter sleep duration and higher somatic symptom load. With the exception of boys in France and Denmark, high computer use was also associated with higher psychological symptom load. Decreasing sleep duration was associated with higher psychological and somatic symptom load in all groups, except among Danish boys. Among Danish boys,

Table 1 Computer use [mean (SD)], sleep duration [mean (SD)] and psychological and somatic symptom load among 15-year olds by gender and country, Health Behaviour in School-aged Children study collected in Finland, France and Denmark in 2010, 15-year olds

	Finland			France			Denmark				
	Boys (n = 622)	Girls (n = 668)	p value[a]	Boys (n = 960)	Girls (n = 1,079)	p value[a]	Boys (n = 797)	Girls (n = 889)	p value[a]	p value[b]	p value[b]
Computer use (hh:mm/day)	2:12 (1:39)	2:06 (1:32)	0.776	1:42 (1:45)	2:06 (1:50)	<0.001	2:30 (1:52)	2:18 (1:34)	0.398	<0.001	<0.001
Sleep duration (hh:mm/day)	8:06 (0:55)	7:54 (0:56)	<0.001	7:54 (1:06)	7:48 (1:06)	0.128	7:30 (0:53)	7:42 (0:53)	0.001	<0.001	<0.001
Psychological symptom load, range 3–15 (3 = good, 15 = poor)	6.1 (2.52)	7.6 (2.90)	<0.001	6.3 (2.93)	7.7 (2.95)	<0.001	5.4 (2.22)	6.3 (2.52)	<0.001	<0.001	<0.001
Somatic symptom load, range 4–20 (4 = good, 20 = poor)	7.5 (2.72)	9.0 (3.23)	<0.001	7.4 (3.00)	8.9 (3.18)	<0.001	6.6 (2.80)	7.3 (2.82)	<0.001	<0.001	<0.001

[a] p value between genders in each country (Mann–Whitney)

[b] p value within boys between countries (Kruskall–Wallis)

[c] p value within girls between countries (Kruskall–Wallis)

Table 2 Spearman's rank correlation coefficients between somatic and psychological symptoms, sleep duration, computer use among 15-year olds by gender and country, Health Behaviour in School-aged Children study collected in Finland, France and Denmark in 2010

	1. Somatic symptoms	2. Psychological symptoms	3. Sleep duration	4. Computer use
Finland (n = 960, boys; n = 1,079, girls)				
1 Somatic symptom load (range 4–20, → high)		*0.509***	*−0.184***	*0.135***
2 Psychological symptom load (range 3–15, → high)	0.493**		*−0.211***	*0.199***
3 Sleep duration school nights (h/night, → longer)	−0.168**	−0.136**		*−0.249***
4 Computer use school days (h/day, → many hours)	0.139**	0.146**	−0.290**	
France (n = 797, boys; n = 899, girls)				
1 Somatic symptom load (range 4–20, → high)		*0.418***	*−0.140***	*0.150***
2 Psychological symptom load (range 3–15, → high)	0.459**		*−0.185***	*0.157***
3 Sleep duration (h/night, → longer)	−0.150**	−0.177**		*−0.189***
4 Computer use school days (h/day, → many hours)	0.088*	0.048	−0.155**	
Denmark (n = 622, boys; n = 668, girls)				
1 Somatic symptom load (range 4–20, → high)		*0.390***	*−0.183***	*0.127***
2 Psychological symptom load (range 3–15, → high)	0.436**		*−0.183***	*0.116***
3 Sleep duration (h/night) (h/night, → longer)	−0.171**	0.073		*−0.253***
4 Computer use school days (h/day, → many hours)	0.112**	0.063	−0.258**	

Values for boys appear under the diagonal; values for girls appear above the diagonal with italics

** Correlation is significant 0.01 (2-tailed)

* Correlation is significant 0.05 (2-tailed)

the shorter the sleep duration the higher somatic symptom load was, but sleep duration did not correlate with psychological symptom load (Table 2).

According to most fit indices, the structural equation models achieved adequate fit in all six groups. Computer use was associated with shorter sleep duration and shorter sleep duration was associated with higher psychological and somatic symptom load in all groups. The model explained more of the variance in psychological symptom load (r^2) among girls than boys, and the associations between computer use and symptom load were somewhat stronger among girls than among boys (Figs. 1, 2, 3). Direct effects of computer use on psychological and somatic symptom loads were significant in most groups, even when sleep duration was included in the models. Except among boys in Denmark and France, computer use was not directly related to psychological symptom load, and among French boys it was unrelated to somatic symptom load. Indirect effects of computer use on psychological and somatic symptom loads through sleep duration were quite modest, but significant in all groups except among Danish boys where computer use was not indirectly related to psychological symptom load through sleep duration (Table 3).

Discussion

The present study of adolescents in Finland, France and Denmark shows that frequent computer use was associated with shorter sleep duration and higher psychological and somatic symptom loads. These results are in line with previous results (Alexander and Currie 2004; Li et al. 2010; Mentzoni et al. 2011) as well as our hypotheses. Also, shorter sleep duration was associated with higher symptom load, as it was hypothesized. According to previous results (Barlett et al. 2012; Punamäki et al. 2007), it was also hypothesized that sleep duration mediates the association between computer use and symptoms. Sleep duration partly mediated the association between computer use and psychological and somatic symptom loads. The indirect effects through sleep duration were, however, quite modest. Computer use was also directly associated with symptom load when sleep duration was included in the model. Thus, mediation was only partial. We observed the same kind of mediation pattern in all groups except among Danish and French boys. Among French boys, computer use was related to psychological and somatic symptom loads only through sleep duration, and among Danish boys, computer use associated with somatic symptom load only through sleep duration.

Punamäki et al. (2007) and Barlett et al. (2012) have reported similar kind of results that sleep mediated the association between electronic media use and health. Punamäki et al. (2007) found that intensive information and technology use, including computer use and mobile phone use, were associated with poor perceived health, including poor health status, musculoskeletal symptoms, and health complaints among 12- to 18-year olds. The

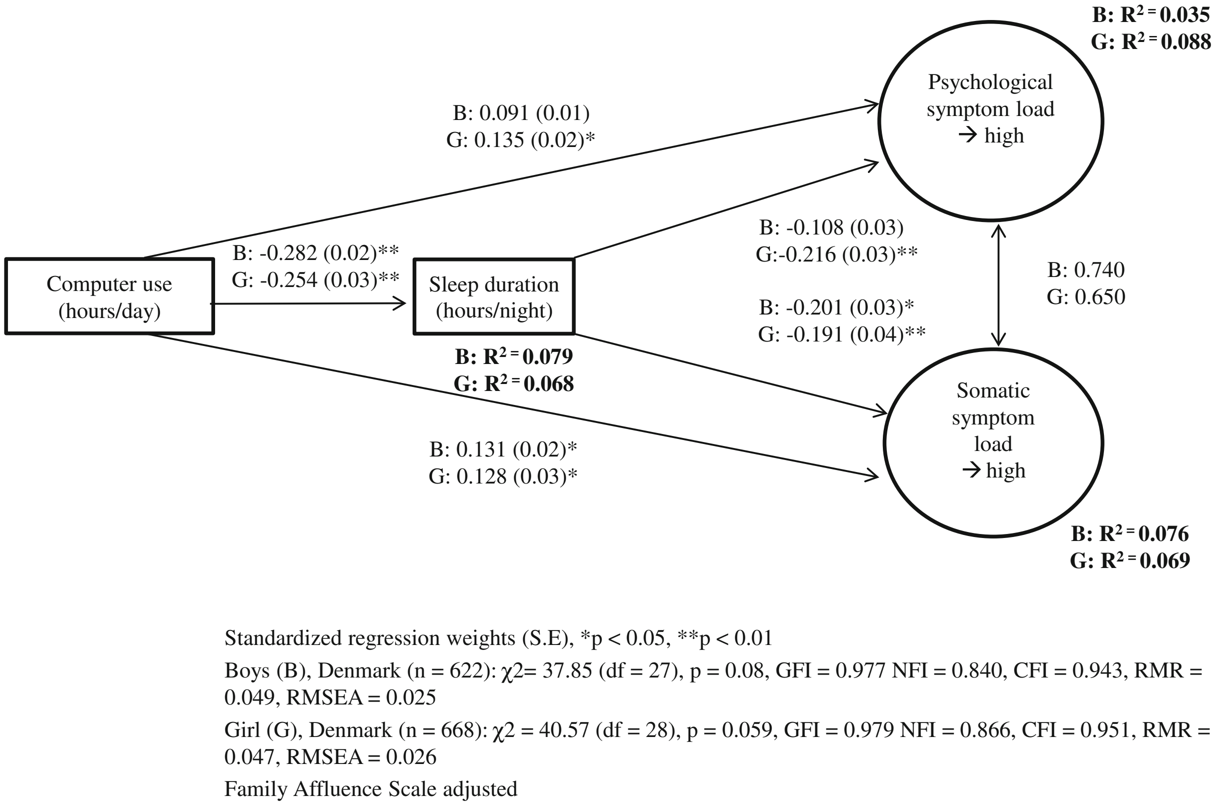
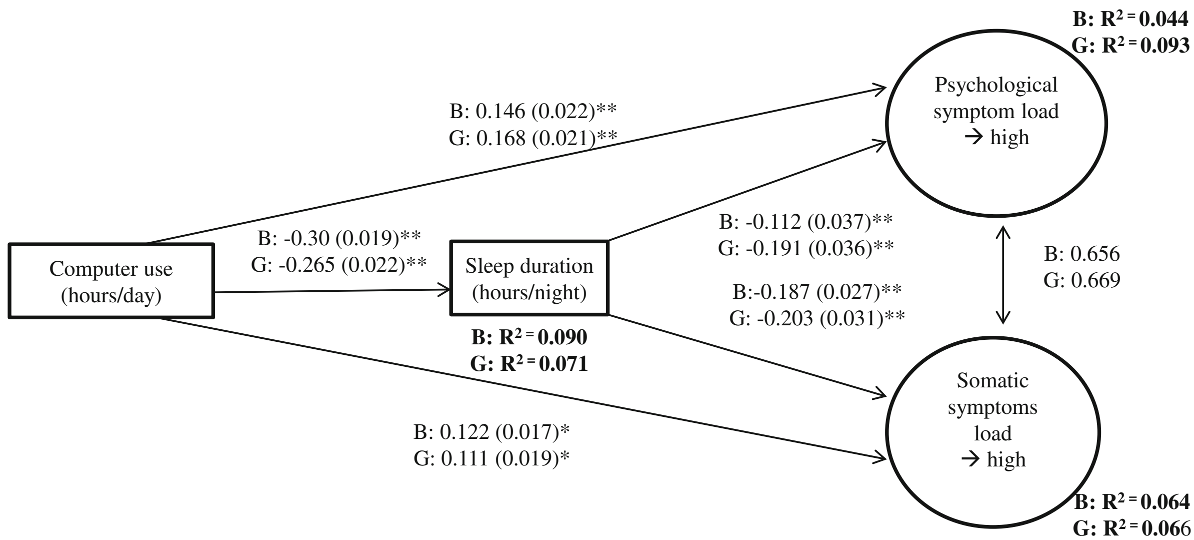


Fig. 1 Associations between computer use, sleep duration, and psychological and somatic symptoms among 15-year olds in Denmark, Health Behaviour in School-aged Children study, year 2010

association was mediated through impaired sleep habits; sleeping hours and regularity of bedtimes, and waking-time tiredness. Frequent computer use was associated with poorer health, particularly among boys, as was intensive mobile phone use among girls. In our study, we did not statistically test gender differences, but the model explained more of the variance in psychological symptom load among girls than among boys, and the associations between computer use and symptom load were somewhat stronger among girls than among boys. Barlett et al. (2012) reported that among school-aged children (mean age 9.6), baseline screen time was associated with baseline short sleep duration which, in turn, was associated with short sleep duration 7 months later, which was associated with higher body mass index, teacher-reported attention problems, and physical aggression 13 months later.

Strengths of this study include large random samples of pupils in three countries with high response rates and essentially comparative measurements. Our research question was novel, particularly focusing on short sleep duration as mediator between computer use and health symptoms. We also examined boys and girls separately, and found small differences between genders. As the associations were quite similar, especially among girls, in each country, it strengthens the hypothesis that computer use affects sleep duration and health symptoms, and not the other way round.

Of course, certain limitations should be considered in interpreting these findings. The cross-sectional design of the study makes it impossible to draw causal conclusions from the analyses, whereas the statistical method applied is generally based on the idea understanding that the pathways are causal. Although we have selected computer use as the determinant and somatic and psychological symptom load as the outcome measures, the causal pathway may potentially be opposite (i.e. adolescents with high symptom loads may react in an introverted way and use computers more than adolescents with low symptom loads). Furthermore, we are uncertain whether short sleep duration is an outcome of computer use and a determinant of symptom load. We neither can exclude the possibility that adolescents with difficulty falling asleep use computers more than other adolescents do nor can exclude the possibility that short sleep duration is a result of high symptom load. Such circumstances would compromise our model. A common idea in this area of research, however, is that high computer use and short sleep duration are causally related to health problems such as psychological and somatic symptoms



Standardised regression weights (S.E), *p < 0.05, **p < 0.01

Boys (B), Finland (n = 960): $\chi 2$ = 45.59 (df = 28), p = 0.019, GFI = 0.982 NFI = 0.910, CFI = 0.962, RMR = 0.044, RMSEA = 0.026

Girl (G), Finland (n = 1079): $\chi 2$= 42.45 (df = 28), p = 0.039, GFI = 0.990 NFI = 0.934, CFI = 0.976, RMR = 0.029, RMSEA = 0.022

Family Affluence Scale adjusted

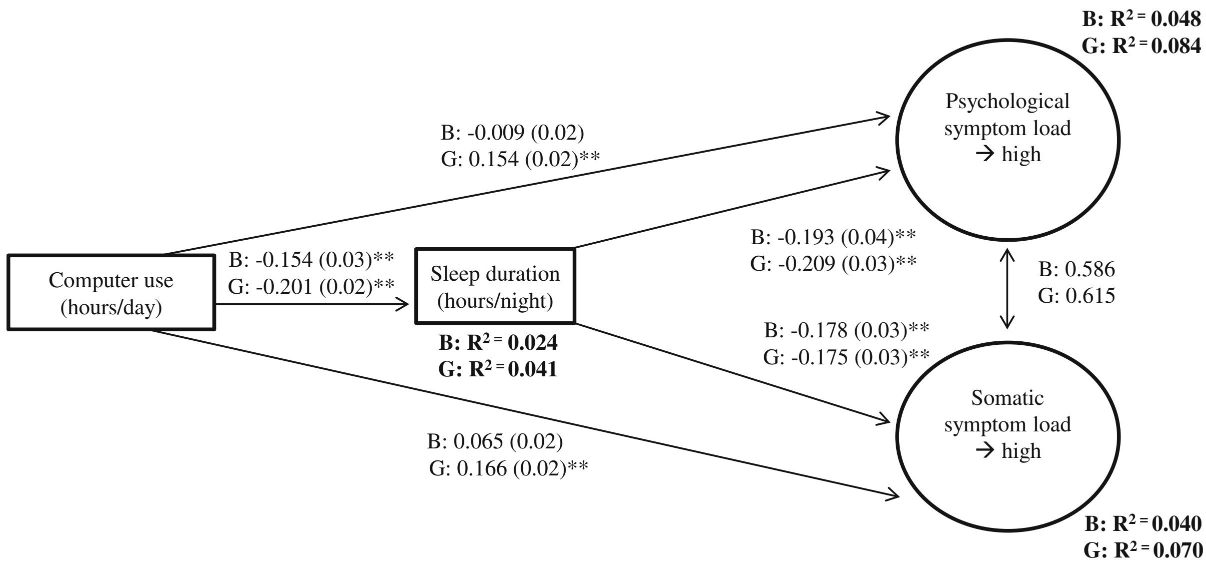
Fig. 2 Associations between computer use, sleep duration, and psychological and somatic symptoms among 15-year olds in Finland, Health Behaviour in School-aged Children study, year 2010

(Alexander and Currie 2004; Mentzoni et al. 2011; Russ et al. 2009; Van den Bulck 2004). Further, several of the researchers who have published in this area suggest that excessive electronic media use leads to less sleep (Higuchi et al. 2005; Li et al. 2010; Owens et al. 1999; Van den Bulck 2004). Consequently, the use of structural equation modeling, which enabled us to examine indirect effects and how well this specific structure explains the variance of the latent variables, was empirically justified.

A limitation is that the proportion of those with school repetitions varies between countries. The proportion of adolescents who have repeated the class was small in Finland and in Denmark (0–1 %), but it was much more common in France (38 %). It is possible that health symptoms are more common among those who repeated the class. Because they have been excluded there might be a selection bias regarding the French data. The response rate varied between the countries. However, the response rate was relatively high also in the French data, 77–80 %, therefore, we do not think this is a big selection bias problem.

Another potential limitation is the measurements of the applied variables. Although computer use was measured with a fairly simple and straight-forward question, the measurement was sufficiently reliable and valid (Schmitz et al. 2004). The question regarding computer use did not distinguished doing homework from other uses which can be seen as a weakness because doing homework may be linked to school grade which might be linked with psychological symptom load. The fact that most mobile phones these days have access to internet and a wide variety of portable devices further complicates the accurate measurement of computer use. Sleep duration measured with self-reported bedtimes and wake-up times seems to be a valid measure of sleep when reference methods among adolescents have been sleep diaries and actigraphy (Wolfson et al. 2003). Several studies have confirmed the validity of the HBSC-SCL. Ravens-Sieberer et al. (2006) used item response theory and concluded that the seven items applied formed a valid scale. Haugland and Wold (2001) reported high test–retest reliability of the items and qualitative analyses showed acceptable reliability. In previous confirmatory factor analyses, Hetland et al. (2002) demonstrated that the HBSC-SCL reflects two correlated sub-factors: psychological and somatic symptoms (Hetland et al. 2002).

Finally, unmeasured confounding factors may represent potential limitation of the study. Other factors may also contribute to explanations of the association between electronic media use, sleep, and symptom load among young people. In this study, we examined the possible mediating effect of sleep duration because that computer use may



Standardized regression weights (S.E), *$p < 0.05$, **$p < 0.01$

Boys (B), France (n = 797): $\chi 2 = 57.17$ (df = 28), p=0.001, GFI = 0.970 NFI = 0.838, CFI = 0.905, RMR = 0.069, RMSEA = 0.036

Girl (G), France (n = 899): $\chi 2 = 42.34$ (df = 28), p = 0.040, GFI = 0.988 NFI = 0.911, CFI = 0.967, RMR = 0.042, RMSEA = 0.024

Family Affluence Scale adjusted

Fig. 3 Associations between computer use, sleep duration, and psychological and somatic symptoms among 15-year olds in France, Health Behaviour in School-aged Children study, year 2010

plausibly reduce sleep duration, and reduced sleep duration may lead to more health problems. This relationship is surely complex, and many other possible mediating or explaining factors exist such as lack of physical activity, and sedentary lifestyle, which is related to somatic (overweight) (Kautiainen et al. 2005) and mental health (Penedo and Dahn 2005) as well as sleep (Nixon et al. 2009). Stress at school may impair sleep, reduce sleep efficiency, impair sleep quality and reduce sleep duration (Kim and Dimsdale 2007). In addition, social factors may explain the associations between computer use, sleep, and perceived symptoms such as loneliness (Amichai-Hamburger and Ben-Artzi 2003), bullying (Gini and Pozzoli 2009) or problems with family functioning (Adam et al. 2007). Socioeconomic differences in health and health behaviors are broadly reported; the lower the parents' socioeconomic status the poorer the adolescent's health (Hanson and Chen 2007). Adolescents' electronic media use also varies by their parents' socioeconomic status. In a Finnish study, the father's higher socioeconomic status was associated with more frequent computer use among adolescents and lower socioeconomic status was associated with more frequent mobile phone use (Koivusilta 2007).

Future research would do well to adjust for the multitude of family and social factors that can influence symptom load among young people. Also, the assessments of computer use should specify and include the content, timing (bedtime or daytime use), as well as evaluate problematic, addictive Internet use, because internet addiction itself may lead to cognitive, emotional and behavioral symptoms (Block 2008). Specific characteristics of computer use can help one to identify which kind of computer use is harmful and which kind is not, or which kind may even prove beneficial.

As a conclusion we found that sleep duration partially mediates the association between computer use and health symptoms; the more the computer was used, the shorter the sleep duration and the higher the symptom load. The associations were quite similar across three countries despite varying symptom prevalence and computer use (Currie et al. 2012). In addition, many adolescents in Finland, France, and Denmark sleep less than recommended. Sleep loss during adolescence is actually driven not by a reduction in sleep requirements but arises from a convergence of biological, psychological, and socio-cultural influences (Carskadon 2011) where electronic media use clearly plays a significant role. However, parents are seldom cognisant of what happens after they say "goodnight" and leave their children and adolescents in their bedroom assuming that they will fall asleep immediately

Table 3 Standardized indirect and total effects (β-coefficients and 95 % CI) of computer use on psychological and somatic symptoms among 15-year olds by gender and country, Health Behaviour in School-aged Children study collected in Finland, France and Denmark in 2010

	Psychological symptoms β 95 % CI	p value	Somatic symptoms β 95 % CI	p value
Boys, Finland				
Indirect effects of computer use				
Through sleep duration	0.034 (0.009–0.059)	0.007	0.056 (0.03–0.089)	0.002
Total effects of computer use	0.179 (0.087–0.263′)	0.004	0.178 (0.086–0.290)	0.003
Boys, France				
Indirect effects of computer use				
Through sleep duration	0.03 (0.008–0.062)	0.004	0.027 (0.008–0.058)	0.005
Total effects of computer use	0.021 (−0.085–0.117)	0.666	0.093 (−0.001–0.198)	0.052
Boys, Denmark				
Indirect effects of computer use				
Through sleep duration	0.031 (0–0.063)	0.054	0.057 (0.019–0.100)	0.003
Total effects of computer use	0.121 (0.009–0.245)	0.037	0.188 (0.066–0.322)	0.003
Girls, Finland				
Indirect effects of computer use				
Through sleep duration	0.051 (0.028–0.074)	0.005	0.054 (0.033–0.08)	0.004
Total effects of computer use	0.218 (0.147–0.275)	0.011	0.165 (0.079–0.247)	0.005
Girls, France				
Indirect effects of computer use				
Through sleep duration	0.042 (0.020–0.068)	0.006	0.035 (0.015–0.061)	0.005
Total effects of computer use	0.196 (−0.114–0.277)	0.004	0.201 (0.110–0.297)	0.002
Girls, Denmark				
Indirect effects of computer use				
Through sleep duration	0.055 (0.026–0.097)	0.003	0.048 (0.021–0.099)	0.002
Total effects of computer use	0.190 (0.087–0.281)	0.007	0.176 (0.066–0.283)	0.004

(Short et al. 2011), and even less so as their children grow older (Schreck and Richdale 2011) and have access to and use of more electronic equipment than their younger counterparts do (Currie et al. 2012). Parental monitoring and rules about computer use and bedtimes are vital during adolescence. Despite the evidence, sleep is a topic that has attracted little attention, and thus, we recommend intensified health education about this topic for both adolescents and for their parents.

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