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The Direct and Indirect Effect of Computer Use on Psychological and Somatic Symptoms Among Boys and Girls in Three Different Age Cohorts

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Abstract

This study focused on the direct and indirect effect (via sleep duration) of computer use on psychological and somatic symptoms among boys and girls (N = 6112) in 3 different age cohorts (11, 13, and 15-years old) from the 2013/2014 health behaviour in school-aged children (HBSC) study done in Sweden. Structural equation modeling (with SPSS AMOS 22) was used (specifying separate multigroup models for each age group). The mediating effect of sleep duration was tested for significance using a Bootstrap estimation. Across the age groups, the direct effect of computer use was found to be a significant risk factor for psychological and somatic symptoms among both girls and boys (all the P values < 0.05), as the associations between computer use was only partly mediated by sleep duration. Additionally, the magnitude of the effects for the association between computer use and both psychological and somatic symptoms was quite similar among boys and girls across different age cohorts, but tended to be more pronounced among 13-year old girls. In particular, the direct and indirect effect computer use on psychological symptoms was significantly stronger among girls in this age cohort (all the P values < 0.05). Even though the cross-sectional design of the study prevented causal conclusions, the development of strategies to reduce children and adolescents' computer screen time and the need to focus on mechanisms relating ICT use to somatic and psychological symptoms were emphasized.

Keywords: Health, Computer, Age

1. Background

During the last decade, information and communication technology (ICT) have become an integral part of adolescent life by playing an important part in social lives. However, high rates of ICT among adolescence may be associated with poorer health (1).

A number of recent studies report that screen time is adversely associated with sleep outcomes (2). The relationships between the use of ICT and sleep problems may suggest several possible mechanisms (3); for example, by replacing sleep or interfering with sleep through increased psychophysiological arousal caused by the stimulating material or by bright light exposure, or by causing physical discomfort (e.g., muscular pain, headache), which can impair sleep duration and quality. The reduced sleep duration and quality are, in turn, associated with a variety of negative health complaints (4).

Even though the association between ICT and health is possibly due to reduced or impaired sleep, only few studies, to date, have examined whether sleep mediates the association between electronic media use and health. The net impression from these studies (5-7) is that computer use is an independent risk factor for health complaints among children and adolescents.

The impact of gender and age on the association between computer use and health complaints is not well known. Previous studies have unfortunately undertaken separate analyses to test gender differences rather contrasting the effects for the genders. In this study, we looked more systematically at the direct and indirect effect of computer use on psychological and somatic symptoms compared to previous studies. To our knowledge, this was the first study to test for statistical gender differences with respect to the associations (direct and indirect through sleep) between computer use and symptom load among boys and girls in 3 different age cohorts.

2. Methods

2.1. Participants and Procedure

The participants consisted of 7867 individuals who were drawn from the Swedish sample of the 2013/2014 Health Behaviour in School-Aged Children (HBSC). The HBSC study is a tran-national study carried out every 4 years in 43 countries in Europe and North America (8) classes from each of the 5th, 7th, and 9th grades, corresponding to the age categories of 11, 13, and 15 years in the Swedish

education system. Only those with no missing data on all measures included in the models were retained for the analyses (N = 6112, 5th Grade; 1118 girls/973 boys, 7th Grade; 929 girls/870 boys, 9th Grade; 1163girls/1059 boys).

2.2. Measures

2.2.1. Computer Use

Two items referring to use on school days and/or weekends were used, answering the question: "How many hours a day do you usually use a computer (or tablet or smart phone) for chatting, social media use, 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".

2.2.2. Sleep Duration

This was based on the pupils' reports of bedtimes and wake-up times on school days. Response categories for bedtimes on school nights ranged in half an hour intervals from "at latest 9 pm" to "2 am or later". Response categories for wake-up times ranged in half an hour intervals from "5 am at the latest" to "8 am or later".

2.2.3. Health

In response the following question: "How often have you had the following symptoms during the past 6 months?" Psychological health was measured using 4 symptoms (feeling low, irritability or bad temper, feeling nervous, sleep difficulties) and somatic health was measured using four symptoms (headache, stomach ache, backache, feeling dizzy). The response categories were: (5) almost daily, (4) more often than weekly, (3) weekly, (2) monthly, and (1) seldom or never.

Frequency of physical activity served as a covariate in the models (estimates not presented).

2.3. Analytic Approach

Structural equation modeling with AMOS 22 (9) was used. Separate models (see Figure 1) were specified for each age group (11-year olds, 13-year olds, and 15-year olds). Apart from a reporting relative Chi-square statistics (χ^2/df) as a measure of fit, 3 conventional indices of goodness of fit were calculated; the root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMR), and the comparative fit index (CFI). With respect to the RMSEA, values below 0.06 are considered a good-fitting model. SRMR values around. 08 or lower indicate a good fit to the data. For the CFI, values above. 95 suggest a close fit. See Hu and Bentler (10)) for suggested cutoff criteria for fit indices.

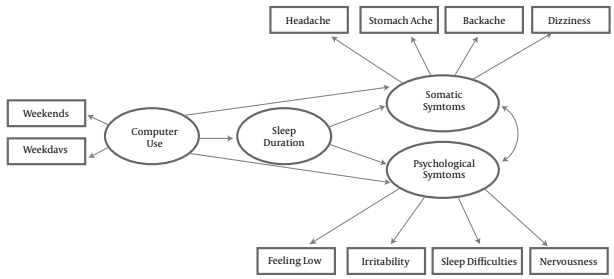

Figure 1. Structural Equation Model

The mediating effect of sleep duration on the association between computer use and psychological/somatic symptoms was tested for significance using a Bootstrap estimation (a bootstrap sample of 1000). The critical ratios for differences between parameters between genders were used; with a z-score $\geq$ 1.96 considered significantly different. For each model, we describe the overall model, provide estimates separately each gender, and note specific parameter estimate differences between genders. Bootstrap approximated P values and standard errors are reported for each direct (unmediated) and indirect b-coefficients.

3. Results

See Table 1 for descriptive data. The fit of the models suggested a good fit for all three models: (1) 11-year olds; χ^2/df = 1.96, RMSEA = 0.022, SRMR = 0.027, and CFI = 0.939, (2) 13-year olds; χ^2/df = 1.96, RMSEA = 0.023, SRMR = 0.028, and CFI = 0.963, (3) 15-year olds; χ^2/df = 2.14, RMSEA = 0.023, SRMR = 0.028, and CFI = 0.967.).

Greater computer use was associated with shorter sleep duration and with standardized regression weights being largely similar in magnitude across age groups as well as for boys and girls, respectively (15-year olds, -.180 and -.179; 13-year olds; -.220 and -.181; 11-year olds, -.231 and -.131).

As seen in Table 2, increased sleep duration was associated with lower symptom load. Among 11-year olds, the strength of the relationship was weak and sometimes insignificant. For 13 and 15-year olds, the standardized regression weights were largely similar in magnitude across age groups and genders, with exception of 13-year olds, where the strength of the relationship between sleep duration and psychological symptoms was significantly stronger among girls. Additionally, there were significant direct effects of computer use on psychological and somatic symptoms in all 3 cohorts for boys and girls; increased computer use being associated with higher symptom load. In general, strengths of the relationship between computer use,

Table 1. Means and Standard Deviation for Sleep Duration, Computer Use, Psychological and Somatic Symptoms Among Girls and Boys (Separately for Each Grade Cohort)

Age	Boys		Girls	
	M	SD	M	SD
	11-year olds			
Sleep duration	9.21	0.79	9.22	0.73
Computer use				
Weekdays	3.60	1.98	3.27	1.70
Weekends	4.11	2.34	3.61	1.99
Psychol. symptoms				
Feeling low	1.66	0.99	1.91	1.06
Irritability	2.24	1.13	2.42	1.15
Feeling nervous	1.81	0.99	2.09	1.11
Sleep difficulties	2.28	1.38	2.49	1.39
Somatic symptoms				
Headache	1.84	1.05	2.03	1.12
Stomach ache	1.72	0.96	2.02	1.11
Feeling dizzy	1.47	0.88	1.47	0.88
Backache	1.49	0.93	1.54	1.00
	13-year olds			
Sleep duration	8.55	1.01	8.30	1.08
Computer use				
Weekdays	4.53	2.32	4.95	2.21
Weekends	4.97	2.55	5.27	2.43
Psychol. symptoms				
Feeling low	1.78	1.04	2.59	1.36
Irritability	2.43	1.16	3.00	1.17
Feeling nervous	2.04	1.06	2.65	1.20
Sleep difficulties	2.43	1.37	2.82	1.44
Somatic symptoms				
Headache	1.98	1.08	2.43	1.24
Stomach ache	1.76	0.97	2.32	1.12
Feeling dizzy	1.60	1.01	1.89	1.25
Backache	1.73	1.07	1.94	1.20
	15-year olds			
Sleep duration	7.88	1.06	7.77	1.07
Computer use				
Weekdays	5.02	2.36	5.44	2.28
Weekends	5.38	2.55	5.74	2.48
Psychol. symptoms				
Feeling low	1.98	1.15	2.95	1.25
Irritability	2.66	1.15	3.30	1.08
Feeling nervous	2.25	1.12	2.83	1.18
Sleep difficulties	2.52	1.38	2.92	1.37
Somatic symptoms				
Headache	1.99	1.02	2.66	1.27
Stomach ach	1.77	0.099	2.49	1.13
Feeling dizzy	1.67	1.05	2.07	1.24
Backache	1.85	1.16	2.17	1.29

on symptom load, were stronger among girls and significantly stronger among 13-year olds for both psychological and somatic symptoms, and for somatic symptoms among 11-year olds.

The indirect effects of computer use on symptom load through sleep duration were quite modest, however, significant in all groups except among 11-year olds. Specifically, there was no indirect effect of computer use on psy-

Table 2. Standardized indirect (through sleep duration) and direct effects (b-coefficients with bootstrapped standard error and P values) of computer use and effect of sleep duration on psychological and somatic symptoms among girls and boys (separately for each grade cohort), and z-score for test difference between genders.

Predictors	Psychological (Girls/Boys)			Somatic (Girls/Boys)		
	β (SE)	P value	Z (P value)	β (SE)	P value	Z (P value)
11-year olds						
Direct effect of sleep duration	-0.079/-0.068 (0.041/0.047)	0.043/0.116	0.75 (0.45)	-0.042/-0.165 (0.047/0.051)	0.332/0.001	1.29 (0.19) 2.19
Direct effect of computer use	0.162/0.167 (0.040/0.048)	0.001/0.001	1.52 (0.13)	0.238/0.207 (0.047/0.051)	0.001/0.002	(0.028)
Indirect effect of computer use	0.018/.009 (0.010/0.008)	0.021/0.082	1.30 (0.19)	0.010/0.022 (0.011/0.010)	0.256/0.001	0.34 (0.73)
13-year olds						
Direct effect of sleep duration	-0.252/-0.176 (0.037/0.052)	0.001/0.001	2.42 (0.015)	-0.272/-0.245 (0.038/0.059)	0.002/0.002	1.21 (0.23)
Direct effect of computer use	0.202/0.108 (0.040/0.047)	0.005/0.019	2.59 (0.010)	183/0.097 (0.043/0.052)	0.004/0.071	2.06 (0.039)
Indirect effect of computer use	0.055/0.032 (0.0120/.012)	0.003/0.001	2.06 (0.020)	0.060/0.044 (0.012/0.015)	0.004/0.001	1.56 (0.12)
15-year olds						
Direct effect of sleep duration	-0.237/-0.232 (0.044/0.043)	0.002/0.003	0.90 (0.37)	-0.165/-0.253 (0.046/0.046)	0.003/0.002	0.11 (0.91)
Direct effect of computer use	0.130/0.102 (0.040/0.036)	0.004/0.003	0.96 (0.34)	0.165/0.119 (0.048/0.038)	0.002/0.002	1.65 (0.10)
Indirect effect of computer use	0.040/0.039 (0.004/0.005)	0.003/0.003	0.35 (0.73)	0.028/0.043 (0.004/0.004)	0.002/0.002	0.24 (0.81)

chological symptoms through sleep duration among boys, and computer use was not indirectly related to somatic symptoms through sleep duration among girls.

4. Discussion

The associations between computer use and both psychological and somatic symptoms were only partly mediated by sleep duration. That is, while the indirect effect of computer use on symptom load was rather weak, the direct effects of computer use on symptom load were quite substantial. Shorter sleep duration was associated with more psychological and somatic symptoms. Additionally, whereas the effect of sleep duration on symptom load tended to increase with increased age, the direct effect of computer use on health was highly similar across different age groups.

When looking at the effects concerning gender for different age groups, whereas there was a general weak tendency that the effects of computer use on symptom load was stronger among girls, the effects of both computer use and sleep on symptom load was significantly stronger for girls among 13-year olds.

In general, the results are in line with previous studies containing European adolescents (6), and they support the notion that greater computer use can negatively influence adolescents' health. The present study adds to the literature by showing that the magnitude of the effects for the association between computer use and both psychological and somatic symptoms is quite similar among boys and girls across different age cohorts, but, also by showing that the effects (along with sleep) tend to be more pronounced among 13-year old girls.

The strength of this study was the large sample (from randomly selected schools) covering 3 age cohorts. The cross-sectional design of the study prevented causal conclusions from the analyses. However, a prospective study (11) found weekday e-game/computer use being associated with increased risk for emotional problems. In this study, the assessments of computer could not specify which kind of computer use is harmful, such as the content, timing (day-or nighttime) or aspects relating to addictive computer use. Thus, future studies should focus on mechanisms relating ICT use to somatic and psychological symptoms in order to implement interventions to reduce excessive or harmful forms computer use for children and adolescents.

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