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ORIGINAL ARTICLE

Is the association between screen-based behaviour and health complaints among adolescents moderated by physical activity?

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Abstract
Objectives The aim of this study was to assess the association between screen-based (SB) behaviour and selected health complaints in adolescents and whether physical activity (PA) moderates this association.
Methods Data from the cross-sectional Health Behaviour of School-aged Children study collected in 2010 among Slovak adolescents (age 11–15 years, $N = 8{,}042$, 48.6 % boys) were used. Logistic regression models adjusted for age and gender were used to analyse the associations between watching TV, working with a computer or playing computer games and headache, backache, sleep difficulties, feeling low, irritability and feeling nervous. Next, we assessed the interactions of SB behaviours and PA regarding health complaints.
Results Watching TV more than 3 h is associated with increased chance of reporting headache, feeling low, being irritable or feeling nervous, while working with computer or playing computer games for more than 3 h does so in all of the explored health complaints. Being physically active does not moderate the associations of SB activities with health complaints.
Conclusions SB behaviours are associated with health complaints among adolescents, and these associations are not moderated by PA.

Keywords Watching TV · Computer use · Health complaints · Adolescence

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Introduction

With the development of information and communication technology, the number of school-aged children who use such technology in many areas of their life is increasing every year. They are using it not only in school as a component of education, but also in their free time. However, this is having both a positive and negative impact. Research suggests that children are spending too much of their free time watching TV, playing PC games or using the Internet at the expense of physical activity (PA), which is an important component in maintaining physical and mental health (Biddle et al. 2009). According to the findings of the international HBSC study, 63 % of 15-year-olds spend their free time watching TV. In 11-year-olds it is 56 %. Gender differences were not large. Among 15-year-olds, 64 % of boys and 62 % of girls watch TV for two or more hours on weekdays. As for 11-year-olds, 58 % of boys and 54 % of girls spend their time watching TV (Currie et al. 2012).

The data showed that sedentary behaviour involving screen-based (SB) media use (Iannotti et al. 2009a) is potentially detrimental to health and has some stability that needs "uncoupling" to successfully change behaviour among those with high levels (Biddle et al. 2010). Adolescents switch between different types of SB activities, whose common feature is that they usually involve a constant position relative to the screen, every day. A high level of SB sedentary behaviour was related to sleep problems and musculoskeletal pain (Costigan et al. 2013). Spending a high number of hours on a computer was related to neck pain (Smith et al. 2008), as well as recurrent backache and headache (Torsheim et al. 2010). Increasing any type of sedentary time was associated with more psychological complaints, such as depression, well-being, social support (Costigan et al. 2013) or poorer self-esteem (Tremblay et al. 2011). Furthermore, computer and video gaming seem to have an important role in shaping a person's social behaviour. Some studies indicated that these activities were independently related to an increased engagement in violence; however, these associations were relatively weak. Television viewing was not related to violence after consideration of time spent on the computer and watching video games (Janssen et al. 2012).

According to WHO recommendations (2010), children and youth aged 5–17 should accumulate at least 60 min of moderate-to-vigorous PA daily. Amounts of PA greater than 60 min also provide additional health benefits. Appropriate levels of PA contribute to the development of healthy musculoskeletal tissues (bones, muscles), the cardiovascular system and neuromuscular awareness, while also facilitating the maintenance of a healthy body weight.

PA has been associated with psychological benefits in young people, as well. It reduces social anxiety (Dimech and Seiler 2011), and symptoms of depression (Rothon et al. 2010), and improves sleep quality (Lang et al. 2013). Furthermore, good quality of sleep may boost one's mood and the ability to cope with a stressful situation (Rahl 2010).

Several authors have pointed out that an increase in SB behaviour is at the expense of PA, e.g. the displacement hypothesis (Carlson et al. 2010). On the other hand, there are indications that SB behaviour may also be combined with PA (Ferrar et al. 2013), potentially leading to compensation for the negative health consequences of high screen time. The aim of this article is to investigate the relationship between SB and selected health complaints in school-aged children as well as the moderating role of PA.

Methods

Sample and procedure

We used data from the Health Behaviour in School-aged Children (HBSC) study conducted in May–June 2010, in Slovakia. From a list of schools based on the information from the Slovak Institute of Information and Prognosis for Education, 134 larger and smaller schools located in rural as well as in urban areas from all regions of Slovakia were randomly chosen to create a representative sample. We contacted 108 schools, and 106 schools took part in our survey, representing a 98.1 % school response rate. According to the protocol of the HBSC study, classes from the 5th to 9th grades were selected randomly, one from each grade per school. We obtained data from 8,491 adolescents from the 5th to 9th grade of elementary school in Slovakia (response: 79.5 %). Non-response was primarily due to illness (10.3 %) and parental disapproval of the participation of their children (7.4 %). We decided to exclude children under age 11 and over 15 to make the sample more homogeneous and to avoid the influence of age extremes. After this step, the study sample consisted of 8,042 adolescents (mean age 13.13 years, 48.6 % boys) from elementary schools in Slovakia.

The study was approved by the Ethics Committee of the Faculty of Medicine at P.J. Safarik University in Kosice. Parents were informed about the study via the school administration and could opt out if they disagreed with it. Participation in the study was fully voluntary and anonymous, with no explicit incentives provided for participation. Questionnaires were administrated by trained research assistants in the absence of a teacher during regular class time.

Measures

PA was measured by an item asking adolescents about the number of days over the past week that they were physically active for a total of at least 60 min per day. The question was preceded by explanatory text that defined moderate-to-vigorous activity as "any activity that increases your heart rate and makes you get out of breath some of the time", offering examples of such activities (running, inline skating, cycling, dancing, swimming, ice skating etc.) (Currie et al. 2012). Responses were in a range from 0 to 7 days, and based on the WHO recommendation (WHO 2010) were classified into three categories as follows: (1) active less than 2 days, (2) active at least 3 days, (3) active every day.

SB activities represented by watching TV, playing computer games and using the Internet were assessed by three separate items. Watching TV was measured by the question: "About how many hours a day do you usually watch television (including videos) in your free time?" Computer gaming was measured by asking: "About how many hours a day do you play PC games or TV games (PlayStation, Xbox, GameCube etc.) in your free time?" Computer use was measured by an item that asked: "About how many hours do you spend using a computer (internet, chatting, e-mailing, homework, etc.)?" All questions had the same nine response categories separately for weekdays and weekends: none at all, about half an hour a day, about 1 h a day, about 2 h a day, about 3 h a day, about 4 h a day, about 5 h a day, about 6 h a day, about 7 or more hours a day (Torsheim et al. 2010). Using the recommendations of the American Academy of Pediatrics (2001) they were classified into three categories as follows: (1) active less than 2 h per day, (2) active 2–3 h per day, (3) active more than 3 h per day.

The HBSC-symptoms checklist (HBSC-SCL) assessed the occurrence of eight subjective physical and psychological health complaints. Participants indicated how frequently during the last 6 months they had each of eight symptoms, namely headache, stomachache, backache, feeling low, irritability and bad temper, feeling nervous, sleeping difficulties and feeling dizzy (Iannotti et al. 2009b). Responses for frequency were on a 5-point scale: rarely or never, about every month, about every week, more than once a week, and about every day. Responses for specific health complaints were dichotomized into those who suffer health complaints every week and more, and those who experienced them less than every week (Currie et al. 2012, 2010).

Statistical analyses

In the first step, we described the sample using descriptive statistics. Next, the relationships between SB activities (independent variables) and the chance of reporting health complaints (dependent variables) were explored using logistic regression models adjusted for age and gender, separately for watching TV and for computer-based activities (working with a PC or playing PC games). The potential moderating effect of PA was tested by adding the interaction of the effect of a particular SB behaviour and PA on health complaints into the models.

As our data were obtained from students per class, which might lead to correlations between outcomes of students in the same class, i.e. clustering, we repeated the analyses using multilevel models. These showed intraclass clustering to be statistically not significant.

Results

As can be seen in Table 1, a considerable proportion of school-aged children suffered from the selected health complaints every week and more (23 % with backache or sleeping disorders, but over 45 % with irritability or feeling nervous). On the other hand, only 28 % of the respondents watched TV and 36 % worked with a PC or played PC games less than 2 h per day.

The results of the regression analyses suggest that those watching TV more than 3 h reported having a headache, feeling low, being irritable or feeling nervous significantly more frequently in comparison with those watching TV less than 2 h, while those watching TV 2 or 3 h did not differ from the reference group (see Table 2).

Working with a PC or playing PC games more than 3 h significantly increased the chances of reporting any of the explored health complaints in comparison with those using a computer for less than 2 h. Those spending more than 3 h per day with a PC have a 1.3-times higher chance of suffering backache, a 1.4-times higher chance of suffering sleeping difficulties, a 1.5-times higher chance of feeling low, nervous or being irritable and a 1.7-times higher chance of experiencing a headache. Spending even 2–3 h with a computer significantly increases the chance of suffering a headache and irritability in comparison with those using a computer for less than 2 h (see Table 2).

A considerable proportion of excessive screen users reported the recommended level of PA: 30.0 % of boys and 17.7 % of girls who reported watching TV more than 3 h per day also reported being physically active for at least 60 min per day; among those who reported working with a PC or playing PC games for more than 3 h per day, 31.2 % of boys and 14.4 % of girls also reported being physically active for at least 60 min per day. Nevertheless, the interaction of SB behaviours on the association of PA with health complaints was not statistically significant (not shown). The only exception was the interaction of working

Table 1 Descriptive characteristics of the sample, Health Behaviour in School-aged Children study collected in Slovakia in 2010

		N (%)
Gender	Boys	3,910 (48.6)
	Girls	4,132 (51.4)
Age	11 years old	1,259 (15.7)
	12 years old	1,535 (19.1)
	13 years old	1,746 (21.7)
	14 years old	1,897 (23.6)
	15 years old	1,605 (20.0)
Headache	Every week and more	2,672 (33.6)
	Less than every week	5,278 (66.4)
Backache	Every week and more	1,757 (22.3)
	Less than every week	6,124 (77.7)
Sleeping difficulties	Every week and more	1,813 (23.0)
	Less than every week	6,064 (77.0)
Feeling low	Every week and more	2,584 (32.7)
	Less than every week	5,316 (67.3)
Irritability	Every week and more	4,802 (48.2)
	Less than every week	4,094 (51.8)
Feeling nervous	Every week and more	3,605 (45.6)
	Less than every week	4,297 (54.4)
Watching TV	Less than 2 h	1,919 (28.3)
	2–3 h	3,347 (49.4)
	More than 3 h	1,503 (22.2)
Working with a PC or playing PC games	Less than 2 h	2,574 (36.3)
	2–3 h	2,882 (40.6)
	More than 3 h	1,640 (23.1)
Being physically active	Every day (recommended)	1,807 (25.1)
	3–6 days	3,449 (47.9)
	2 days or less	1,945 (27.0)

with a PC or playing PC games with PA on backache (see Fig. 1). In the case of spending less than 2 h or more than 3 h with computer-based activities, being physically active decreased the chance of reporting backache, while in the case of spending 2–3 h with computer-based activities the pattern is opposite, e.g. being physically active increased the chance of reporting backache (OR/CI 1.7/1.17–2.46).

Discussion

The objective of the study was to investigate the relationship between SB activities and selected health complaints in adolescents and whether PA moderates this association. We found that SB behaviours are associated with health complaints among adolescents and that these associations are not moderated by PA. Furthermore, the results indicate that excessive working with a PC is related to more health problems than watching TV.

Our results show that spending time watching TV more than 3 h a day is significantly associated with increased chances of suffering headache and irritability, nervousness or feeling low. The positive association between headache and spending a great deal of time watching TV is also supported in other studies (Kröner-Herwig et al. 2011), especially in boys (Gaßmann et al. 2009). Furthermore, other findings suggest that higher levels of TV viewing increase psychological distress, including hyperactivity, emotional problems or conduct and peer problems (Hamer et al. 2009). Strong positive associations were also found between working with a PC more than 3 h a day and headache, backache, sleeping difficulties, feeling low, feeling nervous and irritability. This relationship was also found by Yang et al. (2012) who reported that spending more than 4 h a day at any kind of screen activity is related to worse mental well-being, mainly in early adolescence. Similarly, Nuutinen et al. (2014) reported that frequent computer use is associated with shorter sleep duration and higher psychological and somatic symptom loads.

Whether the associations between different types of SB behaviour, e.g. watching TV, chatting, surfing, working with files, watching films, playing games on PC, laptop or IPad, and using phone devices and various health complaints have exchangeable or unique causal pathways may be questionable. Some studies (e.g. Torsheim et al. 2010) have shown unique associations between different types of SB behaviour and health complaints. Adolescents who spend their time working with a PC or playing PC games more than 3 h a day seem to have more health complaints than those who spend the same amount of time watching TV. The high levels of video games use and their negative impact on physical and psychological well-being is supported by Mathers et al. (2009). These findings could reflect the important role of body postures during these activities. Incorrect sitting postures when spending time with a PC and watching TV might negatively affect different parts of body, mostly the back or neck. Incorrect postural angles, as an element of sitting, seem to be a risk factor for upper quadrant musculoskeletal pain, as found by Brink and Louw (2013). Moreover, the content of PC games may increase psychological arousal, and therefore this could be a cause of other psychological problems (Mathers et al. 2009). Other studies indicate that excessive playing of PC or video games negatively affects sleeping habits (Punamäki et al. 2007) or sleep latency (Higuchi et al. 2005) and is associated with elevated levels of anxiety, and depression and even poorer well-being and life satisfaction (Mentzoni et al.2011; Chanfreau et al. 2008).

A considerable number of children exceeded the recommended length of involvement in the SB behaviour while still meeting the recommendation on PA, which calls

Table 2 Logistic regression models of sedentary behaviour with health complaints among children adjusted for age and gender, Health Behaviour in School-aged Children study collected in Slovakia in 2010

	Headache	Backache	Sleeping difficulties	Feeling low	Irritability	Feeling nervous
Watching TV						
Less than 2 h	1	1	1	1	1	1
2–3 h daily	1.08 (0.95–1.22)	0.94 (0.82–1.08)	0.92 (0.80–1.06)	0.90 (0.80–1.02)	1.05 (0.94–1.18)	1.03 (0.92–1.15)
More than 3 h	1.26 (1.09–1.46)**	1.07 (0.91–1.26)	1.07 (0.91–1.23)	1.18 (1.02–1.37)*	1.21 (1.05–1.38)*	1.17 (1.02–1.34)*
Work with PC or play PC games						
Less than 2 h	1	1	1	1	1	1
2–3 h daily	1.18 (1.05–1.32)**	0.98 (0.86–1.12)	1.02 (0.89–1.16)	1.12 (1.00–1.27)	1.21 (1.08–1.35)**	1.10 (0.99–1.23)
More than 3 h	1.67 (1.45–1.90)***	1.28 (1.10–1.49)**	1.43 (1.24–1.66)***	1.46 (1.27–1.67)***	1.54 (1.35–1.75)***	1.52 (1.34–1.73)***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

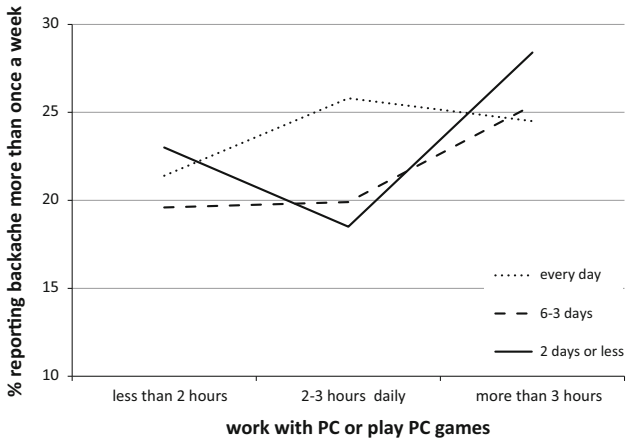

Fig. 1 The interaction of screen-based behaviour on the association of physical activity with health complaints—backache, Health Behaviour in School-aged Children study collected in Slovakia in 2010

into question the hypothesis on displacement behaviour (Carlson et al. 2010). Furthermore, given that we were unable to confirm that involvement in PA moderates the association between high involvement in SB behaviour and health problems, our findings do not support the hypothesis on compensation for negative health consequences (Ferrar et al. 2013). This study has several important strengths, but it has also some limitations. The most important strength is the representativeness of our sample of adolescents and its comparability with existing international data within HBSC study. On the other hand, the main limitation is that only self-reported data were used. While self-reported data on psychological complaints are a rather preferred source of information, the validity and reliability of self-reported as well as measured PA or sedentary behaviour indicators have been heavily discussed in the literature (Bobakova et al. 2014; Biddle et al. 2011; Corder et al. 2009; Slootmaker et al. 2009; Baquet et al. 2007; Nilsson et al. 2002) and should also be taken into account in our study. Some studies indicate that self-reported tools were unable to accurately estimate time spent on an activity, but they may rank individuals accurately (Bobakova et al. 2014; Corder et al. 2009). On the other hand, the accuracy of the accelerometer is dependent on the type of activity and the adherence of the respondents to wearing the accelerometer properly. In addition, its usage requires financial means to purchase large numbers of accelerometers and the available time and manpower needed to process data from them (Slootmaker et al. 2009; Baquet et al. 2007; Nilsson et al. 2002). Neither the questionnaire nor the objective measurements, such as using an accelerometer or pedometer, is a gold standard for measuring PA or SB, and validation studies are needed to estimate possible bias. Another limitation is the cross-sectional design of this study, because of its inability to formulate conclusive statements about the causality of our results. Hume et al. 2011 indicated that symptoms of depression predict a higher level of TV watching, which suggest that SB activities and some of health complaints do not have to be in a one-way association, but it is not possible to explore this association in a cross-sectional study. The findings, therefore, need to be confirmed in longitudinal studies.

At the present time, adolescents all over the world are getting used to spending much more time in front of the TV or computer than in being engaged in PA, which seems to have negative consequences on their psychological and physical health. It seems important to decrease the amount of time which adolescents spend with SB activity and at the same time to promote PA. Parents could play an essential role in the reduction of time spent with SB activities and in the promotion of PA. They have an opportunity to restrict the time spent watching TV or playing on a PC through agreed family rules and at the same time to promote PA among their children through participation in an active lifestyle.

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Ethical standards The Ethics Committee of the Faculty of Science at PJ Safarik University in Kosice approved the study.

Conflict of interest The authors declare that they have no conflict of interest.

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