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ORIGINAL

Examining the correlates of out-of-school television viewing, computer use and overall time in sedentary behaviors among Finnish 11-year-old children

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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abstract

Background This study aimed to examine the associations between individual, social and environmental characteristics and out-of-school television viewing, computer use, and overall time spent in sedentary behaviors.

Material/Methods A sample of 11-year-old children (N = 155) in Finland wore an accelerometer (Actigraph GT3X) for seven days. Before the accelerometer-use, questionnaire assessments of television viewing, computer use, reported PA, bedtimes, wake-up times, perceived parental PA and PA encouragement and measurements of weight and height were obtained. Weather data were obtained for the 7 days of accelerometer use and parents reported their educational background. Associations between the studied correlates and average minutes of out-of-school television viewing, computer use, and overall time spent in sedentary behaviors were tested using multiple linear regression analyses.

Results Television viewing, computer use, and overall time in sedentary behaviors primarily had separate individual and social correlates. Only recorded and reported PA were associated with all the outcomes. Of the physical environmental correlates, colder after school temperatures and less hours of daylight were associated with increased overall time in sedentary behaviors.

Conclusions Preventive interventions and studies should take into account the separate correlates of television viewing, computer use, and overall time in sedentary behaviors.

Key words sedentary lifestyle; obesity; early adolescence; television viewing; computer use.

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INTRODUCTION

All forms of low-intensity sitting behaviors, known as sedentary behaviors, have a role in the development of overweight, obesity and related metabolic disease risks in children, independent of physical activity (PA) levels [1-3]. Some sedentary behavior habits formed in childhood (e.g., television viewing and computer use) may persist later in life and predict negative health outcomes in adulthood [4,5]. Understanding the factors influencing children's sedentary behavior is of major importance for planning public health interventions.

An ecological framework can be used to identify a broad range of individual (e.g., biological), social (e.g., parental) and physical environmental (e.g., weather) factors influencing sedentary behaviors [6,7]. This framework has often been used to identify the correlates of PA [8,9], but the associations between these factors are less studied with sedentary behaviors [10]. Furthermore, television viewing is often used as an indicator of sedentary behaviors, although it does not represent the entire spectrum of sedentary behaviors [11-13]. Consequently, the factors associated with television view ing may differ from the factors associated with other sedentary behaviors or overall time in sedentary behaviors. The factors associated with sedentariness, herewith referred to 'correlates,' may also differ significantly by age group and by gender [14], and they should be studied within relatively narrow age ranges.

The correlates of sedentary behaviors are mainly studied using self-reported measures. However, self-reported methods are prone to recall and reporting bias [15,16]. Thus, these vulnerabilities may lead to erroneous results when studying their associations [17,18]. To overcome these problems, objective measurements, such as accelerometers, have increased in popularity, due to their accurate estimates of intensity, frequency, and duration [19]. Recorded measurements also provide the possibility of studying if certain correlates created by the conditions in the measurement week (e.g., weather) are associated with overall time in sedentary behaviors. However, such objective measurements fail to show specific types of sedentary behavior. Consequently, complementing objectively recorded time in sedentary behaviors with self-reported television viewing and computer use allows a detailed examination of the specific correlates of different sedentary behaviors.

The present study examines the associations between individual, social, and physical environmental correlates and sedentary behaviors in a sample of 11-year-old children. Two aims were set for the study: 1) to examine associations between individual and social correlates and television viewing, computer use, and overall time in sedentary behaviors; 2) to investigate associations between physical environmental correlates and overall time in sedentary behaviors.

MATERIALS AND METHODS

Study protocol

A convenience sample of school-aged children (N=282) participating in the Finnish Health in Teens survey (Fin-HIT) were recruited for this study. Fin-HIT is an on-going longitudinal survey on health among Finnish children attending the 5th school grade [20]. Schools in Southern Finland with the highest number of Fin-HIT participating children during February and May 2013 were contacted. In total, 12 of the 17 contacted principals provided permission for the study to be contacted in their school. After principals' acceptance, Fin-HIT field workers gave an information letter and a consent form to the children and their parents. The consent of the child and one of his/her parent was required for participation (response rate 60%). In the consent form, parents also reported their educational background. The study was approved by the Coordinating Ethics Committee of the Helsinki and Uusimaa Hospital District.

Children wore an accelerometer for seven days. The log-book was completed in during the week of the accelerometer use in order to separate school-hours, out-of-school hours and sleeping hours. The children were also asked to write their reported weight and height in the log-book. Before the use of the accelerometer, the children completed a questionnaire during a school lesson, and their weight and height were measured and recorded during a school visit. The questionnaire measured the out-of-school practices and the perceived parental role in out-of-school practices. Weather data were obtained from observations produced by Foreca Ltd., a digital weather data provider (foreca.fi). The observed weather data for each accelerometer data collection day were obtained.

Overall time in sedentary behaviors

An Actigraph GTX3 (Actigraph, LLC, Florida, USA) accelerometer, an accepted measure among school-aged children [21], was used to record out-of-school overall time in sedentary behaviors. The accelerometer was worn on the waist for seven consecutive days, and was only removed when the child was in water. The epoch length was set at 15 seconds. Each participant's Actigraph data was analyzed by separating out-of-school hours by using Actilife 5.1. Non-wear time was defined as 60 minutes of consecutive zeroes, and Evenson's cut-points were applied [22]. The limit of sedentary time was 100 counts per minute. A valid day for analysis was defined as at least eight hours of data from the child's out-of-school-hours. Each child was required to have four days of valid data, and one of these days had to be a weekend day. Reported sick days, days off school, and the first day of measurement were not selected as valid days. The sick days and days off school were reported in the log-book of the accelerometer use. For the four days, an average daily out-of-school sedentary time was calculated by dividing the total amount of sedentary time by four. In the analyses, the sedentary time measure was treated as continuous.

Television viewing and computer use

Television viewing and computer use were investigated with separate questions. The children replied to the following: "how many hours do you usually watch television, videos or DVDs in your out-of-school hours?" and "how

many hours do you usually use a computer, e.g., to chat with your friends, use the Internet or play games with a console in your out-of-school hours?" The questions were separate for weekdays and weekends. The answer alternatives varied from "I don't use computer/television at all" [1] to "seven hours or more per week" [9]. The responses to the questions on television and computer use were transformed into minutes of use. The weekday estimates were multiplied by five and the weekend estimates were multiplied by two; the totals were summed and divided by seven to generate average time (average television viewing and average computer use, min/day). The intraclass correlations (ICC) of these questions varied between .640 (television viewing on weekends) and .784 (Computer use on weekends). Because these measures were not normally distributed, square root transformations were computed for both measures. The measures were treated as continuous.

Studied correlates

The studied correlates were categorized into individual, social, and physical environmental correlates. The individual correlates were then divided into biological and behavioral correlates, whereas social correlates included only parental factors.

The biological correlates were gender, reported and recorded body mass index (BMI) and weight status (overweight – not overweight). The weight status was defined on the basis of the age- and gender-specific cut-off points [23].

The behavioral correlates included PA frequency, reported and objectively recorded PA per day, bedtimes and wake-up times on schooldays and on weekends. The children evaluated the frequency of their PA by reporting "how many times are you physically active in your weekly out-of-school-hours (times/week)". Out-of-school PA was defined as solitary PA, PA in sport clubs, and PA with family or friends. PA in school and during school trips were asked not to be taken into account. The options for PA times varied from "I am not physically active at all" to "seven times or more per week". The ICC of PA frequency was .653. Reported PA consisted of a question in which the children evaluated "how many hours per week are you physically active in your out-of-school hours (hours/week)?". The options varied from "one hour or less per week" to "ten hours or more per week." The ICC of reported PA was .652. The responses were transformed into minutes and divided by seven to generate the average activity time (min/day). Thus, the objectively recorded PA was calculated in a similar way to overall time in sedentary behaviors. . Moderate-to-vigorous-minutes of PA (at least 2296 counts per minute) in the four days were selected and divided by four to form the average PA per day.

Bedtimes on school days and at weekends were assessed with the question: "When do you usually go to bed if the next morning is a school day/is not a school day?" The answer alternatives for bed-time ranged from 19:30 to 01:00 or later. Wake-up times on school days and weekends were assessed with the question: "When do you usually wake up if the next morning is a school day/is not a school day?" For school days, the answer alternatives for wake-up time ranged from 5:30 to 8:30 and for weekends, the alternatives ranged from 5:30 to 13:00. The measures were treated as continuous.

The parental correlates were the educational background, PA, and encouragement of PA separate for mothers and fathers. The educational background

was reported by parents in consent forms separately for mothers and fathers. Educational background was dichotomized between highly educated (1) and others (0). Highly educated meant holding Master's degree or above. The mother's PA was measured with two questions in the children's questionnaire. Children evaluated on a five-point scale (1=not at all, 5=very much) if their mother exercised or was physically active, and if they participated in PA together with their mother. A summary variable was computed by summing the scores and dividing them by two. The mother's encouragement of PA consisted of two questions. The children answered on a five-point scale (1=not at all, 5 =very much) if their mother encouraged them to be physically active and if she encouraged them to compete. A summary variable was computed by summing the scores and dividing them by two. Similar questions were asked about the father, and these questions were similarly computed as summary variables. The ICC of these questions varied between .610 and .745.

The physical environmental correlates were the day length, average temperatures at 2pm and at 8pm, and snow depth. Due to the study's focus on the out-of-school-hours, the temperatures at 2pm and 8pm were selected from weather data. The school day ends usually between 1pm and 3 pm in Fin-land. Day length and snow depth were assessed on the final day of each collection week. The associations between physical environmental correlates and sedentary behaviors were only studied for objectively recorded overall time in sedentary behaviors data, because the reported questions measured habitual behavior.

Statistical analysis

Multiple linear regression analyses were performed. All the above-presented correlates were separately studied in the analyses. The self-reported outcomes were adjusted by gender except when studying the associations between gender and outcomes. The objectively recorded outcome was adjusted for gender and the average time the accelerometer was worn during out-of-school hours. All the analyses were conducted using the SPSS (Statistical Package for Social Sciences) version 21 (Chigago:IL).

RESULTS

The basic characteristics are presented in Table 1. The average age of the participating children was 11.2 years, and 60 percent of the children were girls. The associations between individual and social correlates and overall time in sedentary behaviors and reported television viewing and computer use are presented in Table 2. The following individual and social correlates were positively associated with overall time in sedentary behaviors: lower recorded PA, lower reported PA and lower PA frequency. The following correlates were positively associated with television viewing: gender (male), higher BMI, being overweight, lower recorded PA, lower reported PA, the mother being less educated, the father being less educated, and lower perception of the father's PA. The following correlates were positively associated with computer use: gender (male), lower recorded PA, lower reported PA, lower PA frequency, lower perceived mother's PA, and lower perceived father's PA.

The associations between the physical environmental correlates and overall time in sedentary behaviors are presented in Table 2. The following correlates were inversely associated with overall time in sedentary behaviors: day

length, average temperature at 2pm, and average temperature at 8pm.

Table 1. Description of characteristics in a sample of 11-year-old children participating in Fin-HIT study in 2013

Measure			N
Gender N (%)	Girls	93 (60)	155
	Boys	62 (40)	
Age, Mean (SD[1])		11.19(.33)	155
Accelerometer wearing time during out-of--school hours, Mean minutes (min. – max.)		637.0 (511.0 – 748.5)	126
Overall time in sedentary behaviors per day, Mean minutes (IQR)[2]		400.73 (367.59 – 438.26)	126
TV viewing per day, Mean minutes (SD[1])		114.22 (72.56)	155
Computer use per day, Mean minutes (SD[1])		94.03 (77.85)	155
BMI, Mean (SD[1])		18.61 (3.31)	147
Self-reported BMI, Mean (SD[1])		18.35 (2.89)	136
Weight status, N (%)	Overweight	27 (18.5)	146
	Not overweight	119 (81.5)	
Self-reported weight status, N (%)	Overweight	21 (16.7)	126
	Not overweight	105 (83.3)	
Objectively recorded PA[3] per day, Mean min (SD[1])		48.01 (20.54)	126
Reported PA[3] minutes per day, Mean min (SD[1])		57.08 (21.90)	153
PA[3] frequency, Mean (SD[1]), range 1 – 7 times per week		5.09 (1.60)	155
Bedtime in schooldays, Mean hours (range)		21.30 (20.00 – 23.50)	154
Bedtime at weekends, Mean hours (range)		22.50 (20.00 – 01.00)	154
Wake-up time on schooldays, Mean hrs (range)		7.00 (6.00 – 8.00)	154
Wake-up time at weekends, Mean hours (range)		9.00 (5.50 – 01.00)	154
Mother's education, N (%)	Highly educated	61 (40.7)	150
	Others	89 (59.3)	
Father's education, N (%)	Highly educated	55 (38.2)	144
	Others	89 (61.8)	
Mother's encouragement for PA, Mean (SD[1]), range 1-5		3.54 (.81)	152
Father's encouragement for PA , Mean (SD[1]), range 1-5		3.50 (.96)	148
Mother's PA[3], Mean (SD[1]), range 1-5		3.05 (.76)	154
Father's PA[3], Mean (SD[1]), range 1-5		3.12 (.84)	147
Collection month, N (%)	March	53 (34.2)	155
	April	60 (38.7)	
	May	42 (27.1)	
Day length, Mean minutes (SD[1])		874. 52 (125.15)	155
Snow depth, Mean centimeters (SD[1])		31.61 (30.23)	155
Average temperature at 2pm, Celcius, Mean (SD[1])		5.20 (7.87)	155
Average temperature at 8pm, Celcius, Mean (SD[1])		2.59 (8.71)	155

[1] SD=standard deviation, [2] IQR=interquartile range, [3] PA=Physical activity

Table 2. Studied correlates of overall time in sedentary behaviors, television viewing and computer use in a sample of 11-year-old children participating in the Fin-HIT study measured by linear regression analyses, significant results in bold

			Overall time in sedentary behaviors [1]	TV viewing [2 3]	Computer use [2 3]
			B (95% CI)	B (95% CI)	B (95% CI)
Individual correlates					
	Biological				
		Gender	-16. 34 (-32.80 – .113)	**1.21 (.115 – 2.31)**	**2.75 (1.52 – 3.98)**
		BMI	.056 (-2.33 – 2.44)	**.195 (.030 – .361)**	.100 (-.084 –.284)
		Self-reported BMI	-.915 (-3.74 – 1.91)	.166 (-.024 – .356)	.103 (-.114 – .320)
		Weight status	-2.96 (-24.55 –18.62)	**1.70 (.285 – 3.12)**	.583 (-.995 – 2.16)
		Self-reported weight status	-4.73 (-28.89 – 19.43)	.928 (-.625 – 2.48)	.556 (-1.22 – 2.33)
	Behavioral				
		Objectively recorded PA [4]	**-1.71 (-1.99 –-1.43)**	**-.061 (-.091 – -.032)**	**-.057 (-.090–-.024)**
		Reported PA	**-.405 (-.772 –-.032)**	**-.045 (-.069 – -.021)**	**-.034 (-.061–-.007)**
		PA frequency	**-7.23 (-12.03 –-2.49)**	-.316 (-.643 – .011)	**-.389 (-.754 – -.024)**
		Bedtime in schooldays	6.55 (-6.27 – 19.37)	**1.10 (.294 – 1.90)**	**1.33 (.432 – 2.24)**
		Wake-up time on schooldays	-4.38 (-25.48 – 16.71)	-.058 (-1.38 – 1.26)	.520 (-.973 – 2.01)
		Bedtime in weekends	-1.78 (-10.34 – 6.77)	**1.05 (.518 – 1.58)**	**1.06 (.460 – 1.66)**
		Wake-up time on weekends	4.38 (-2.15 – 10.89)	**.757 (.324 – 1.19)**	.276 (-.225 – .776)
Social, parental correlates					
		Mother's education	-12.42 (-28.83 –3.98)	**-1.77 (-2.84 – -.694)**	-1.14 (-2.39 –.107)
		Father's education	-10.87 (-27.73 –5.62)	**-1.62 (-2.75 – -.496)**	-.419 (-1.74 –.901)
		Mother's encouragement	-4.86 (-15.56 –5.84)	-.397 (-1.07 – .277)	-.363 (-1.12 –.401)
		Father's encouragement	-5.88 (-14.60 –2.83)	-.240 (-.832 – .353)	-.214 (-.885 – .456)
		Mother's PA	-6.54 (-16.99 –3.90)	-.561 (-1.26 – .143)	**-1.28 (-2.05 – -.513)**
		Father's PA	-1.92 (-11.50 –7.65)	**-.806 (-1.45 – -.156)**	**-.742 (-1.47 –-.007)**
Physical environmental correlates					
		Day length	**-.069 (-.135 – -.003)**		
		Snow depth	.224 (-.049 – .497)		
		Average temperature,2pm	**-1.16 (-2.19 –-.141)**		
		Average temperature,8pm	**-1.01 (-1.94 – -.083)**		

[1] Adjusted by gender and accelerometer wearing time

[2] Adjusted by gender, expect when studying the associations between gender and outcomes.

[3] Square root transformed measures

[4] moderate-to-vigorous PA by using Evenson cut-points

DISCUSSION

The first aim of this study was to examine associations between individual and social correlates and the recorded sedentary time, reported television viewing, and computer use. In line with most previous studies, the boys in our study reported more television viewing and computer use [24,25]. However, gender differences were not found in recorded ST. This finding suggests that the overall amount of time spent in sedentary activities is similar for both genders, but the activities themselves differ. Additional questions might be necessary in order to more precisely identify girls' sedentary behaviors.

Overweight children reported more television viewing, whereas no significant correlation was found between weight and overall sedentary time and computer use. This result supports most, but not all, previous research [26,27]. A possible explanation for the association between overweight and televi-sion viewing is the children's energy balance. Namely, television viewing diminishes the time of being physically active and increases snacking behavior and exposure to commercials promoting unhealthy foods [28].

Of the studied correlates, only reported and recorded PA were inversely associated with all outcomes. Previous findings on the associations between sedentariness and PA have been contradictory or inconsistent [13,29,30]. However, some researchers have proposed that time spent in sedentary activities may replace the time spent in more active pursuits [31]. If children do replace PA with sedentariness, our study suggests that some children replace PA time with computer use rather than television viewing.

Later bedtimes were associated with television viewing and computer use, a result that is in line with previous studies [32]. In this study, the associations between overall time in sedentary behav-iors and bedtimes were not found. It might therefore confirm that certain sedentary behaviors, such as screen--based activities, have negative influences on bedtimes.

As with previous studies, low parental educational background was positively associated with television viewing, but no association between low parental educational background and computer use and overall time in sedentary behaviors [10,25,29]. It is still unclear why parental educational background is associated with TV viewing but not with computer use. The children of more highly educated parents might spend more time on other sedentary behaviors, such as reading and doing homework, which could explain why the overall time in sedentary behaviors did not differ according to educational background even if TV viewing differed.

In the present study, greater perceived parental PA was inversely associated with computer use, whereas greater father's encouragement for PA was inversely associated with television viewing. Nevertheless, no associations between overall time in sedentary behaviors and parental influence were fo-

und. The importance for children's PA of perceived parental PA and parental encouragement of their child's PA is well documented [33], but it seems that these perceptions have im-portance also for reducing certain sedentary behaviors. Therefore, future interventions aimed at reducing television viewing and computer use need to address the perceived role of parental encouragement for PA and father's PA.

The second aim of this study was to examine the associations between physical environmental correlates and overall time in sedentary behaviors. Shorter day length and colder average temperatures at 2pm and 8pm increased overall time in sedentary behaviors among the children in our study. The negative influence of colder temperatures and the winter season on PA has been previously shown [34,35], and this study suggests that these factors also have an impact on the time in sedentary be-haviors. It is important that this result be taken into account in future studies and preventive interventions conducted in climates with a large seasonal variation in day length and temperature.

The strength of this study was its combination of both reported and recorded measurements, making it possible to study how the correlates associated with several outcomes. In addition, the associations between a wide variety of potential correlates and outcomes were studied. Consequently, a more comprehensive description of sedentary behaviors among 11-year-old children was formed. Nevertheless, this study has its limitations. The presented data are cross-sectional, and therefore no assumptions on causality can be drawn. The sample was selective, and therefore the correlates identified here may not be generalizable. However, the suitability of the sample size for analyses was tested and was shown to be sufficiently representative to detect the presented outcomes [36].

CONCLUSION

To conclude, the main correlates of television viewing, computer use, and recorded sedentary time are distinct and unconnected, which should be taken into account in future studies by including a wide range of sedentary behaviors, when measuring sedentary behaviors. In addition, day length and colder temperatures increased the overall time in sedentary behaviors. In development of future interventions, separate strategies for reducing television viewing, computer use, and overall time in sedentary behaviors might be more effective than using the same strategies for all types of sedentary behaviors. However, increasing PA might be beneficial part of interventions to reduce time in sedentary behaviors.

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