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Short Report

Self-reported TV and computer time do not represent accelerometer-derived total sedentary time in 10 to 12-year-olds

Maïté Verloigne[1], Wendy Van Lippevelde[2], Lea Maes[2], Mine Yıldırım[3], Mai Chinapaw[3], Yannis Manios[4], Odysseas Androutsos[4], Éva Kovács[5], Bettina Bringolf-Isler[6,7], Johannes Brug[8], Ilse De Bourdeaudhuij[1]

1 Department of Movement and Sport Sciences, Ghent University, Ghent, Belgium
2 Department of Public Health, Ghent University, Ghent, Belgium
3 Department of Public and Occupational Health and the EMGO Institute for Health & Care Research, VU University Medical Center, Amsterdam, The Netherlands
4 Department of Nutrition and Dietetics, Harokopio University, Athens, Greece
5 Department of Paediatrics, University of Pécs, Pécs, Hungary
6 Department of Epidemiology and Public Health, Swiss TPH, Basel, Switzerland
7 University of Basel, Basel, Switzerland
8 Department of Epidemiology and Biostatistics and the EMGO Institute for Health & Care Research, VU University Medical Center, Amsterdam, The Netherlands

Correspondence: Maïté Verloigne, Ghent University, Faculty of Medicine and Health Sciences, Department of Movement and Sport Sciences, Watersportlaan 2, 9000 Gent, Belgium, Tel: +32 9 264 94 07, Fax: +32 9 264 64 84, e-mail: maite.verloigne@ugent.be

Screen-time activities are often used as proxies for sedentary time. We studied associations of self-reported television (TV), computer and total screen-time with accelerometer-derived total sedentary time in European children (10–12 years). Analyses showed significant positive associations between TV, computer and total screen-time with total sedentary time for the total sample, however, the explained variance was low and stratified analyses only revealed a significant positive association between total screen-time and total sedentary time in boys and between computer time and total sedentary time in Dutch children. This suggests that self-reported TV and computer time do not adequately reflect total sedentary time in schoolchildren.

Introduction

The potential role of sedentary time (ST) in the development of overweight, obesity and metabolic disease risk in children, independently of their physical activity levels, has been studied in recent years.[1,2] In most studies, ST is assessed as self- or parent-reported television (TV) time and/or other screen-viewing behaviours, mostly computer activities.[1,2] Based on such studies, insufficient evidence for the relationship between ST and health outcomes has been found. However, children may engage in a range of other sedentary activities besides TV and other screen-viewing behaviours, such as sitting at school, reading, etc.[2,3] Therefore, it is unclear if self-reported TV and/or computer time represent or reflect total ST among children. Accelerometry enables the objective measurement of ST. A recent study investigated the relationship between self-reported TV time and accelerometer-derived total ST in adults.[4] The researchers found a statistically significant positive relationship, although the strength was only fair and not consistent in all subgroups. This study aimed to investigate associations between accelerometer-derived total ST and self-reported TV, computer and total screen-time in 10- to 12-year-olds.

Methods

Sampling procedure

Participants were part of a larger cross-sectional survey across eight European countries within the ENERGY-project (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth).[5] In each country, schools were randomly selected in three cities from regions with a different urbanization degree (low/middle/high tertile) to reach a representative sample of 1000 children. Additionally, five countries—Belgium, Greece, Hungary, the Netherlands and Switzerland—collected accelerometer-data in a subsample of preferably 200 or more children.[6] The study was approved by medical ethical committees in each participating country.

Data collection

Data collection occurred on schooldays between March and September 2010. Children completed a questionnaire during one school hour, supervised by a research assistant. On the day of questionnaire completion, researchers distributed the accelerometers to the children, explained how to use them and handed out a brochure with accelerometer use information.

Measures

Demographic variables

Gender and age were assessed with one single question.

TV, computer and total screen-time

TV time was assessed by asking 'How many hours/day do you usually watch television in your free time?' for weekdays and

weekend days separately. Total TV time (minutes/day) was calculated by following formula: [(TV time weekday × 5) + (TV time weekend day × 2)]/7. Computer time (minutes/day) was assessed similarly by asking 'How many hours/day do you usually play games on a computer, or use your computer for leisure activities in your free time?'. Total screen-time was computed by adding up TV and computer time. These questions showed good test-re-test reliability (ICCs: 0.67–0.68) and moderate-to-good construct validity (ICCs: 0.56–0.68) in a separate study. Only average computer time on a weekday had poor construct validity (ICC: 0.38).[7]

Total ST

Total ST was assessed using three Actigraph (Pensacola, FL, USA) accelerometer models: GT1M, GT3X and Actitrainer. Since two triaxial and one uniaxial accelerometer model was used, only the vertical axis output was used. Accelerometers were initialized using ActiLife software (15 s recording epoch). Children wore the accelerometer during waking hours for six consecutive days, including two weekend days, and were asked to remove it during water-based activities. Meterplus 4.2 software was used to screen and clean the data files. Non-wearing time was calculated as periods of more than 20 min of consecutive zero counts. Children were included if they had at least two weekdays with 10 h-wearing time and one weekend day with 8 h-wearing time.[8] Minutes of ST were estimated using the cut-point of <100 cpm from Treuth *et al.*[9]

Statistical analyses

SPSS 15.0 (SPSS Inc, Chicago, IL, USA) was used to describe sample characteristics and study variables. Computer time had a skewness of more than 0.7: values >90th percentile were replaced by the value that equalizes the 90th percentile to obtain normal distribution. To examine associations between TV, computer and total screen-time with total ST, multivariate multilevel regression analyses were conducted using MLwiN 2.22 (Centre for Multilevel Modelling, University of Bristol, UK) for the total sample, per gender and per country. Multilevel modelling (two-level: school-pupil) was used to take clustering of children in schools into account. Since total screen-time related too strongly to TV ($r = 0.86$) and computer time ($r = 0.83$), analyses were executed separately (model 1: TV/computer time; model 2: total screen-time). Correlation coefficient for TV and computer time was 0.43. To estimate between-pupil variance in ST explained by the independent variables, the proportion of unexplained variance of the full model was compared with the model including the constant and covariates (for total screen-time) or with the model including the constant, covariates and one independent variable (for TV/computer time). $P < 0.05$ was considered significant.

Results

In total, 766 out of 1082 children provided valid accelerometer data. Since data were missing for one or more of the questionnaire variables for 94 children, 672 children were finally included (11.6 ± 0.8 years; 53.3% girls) (table 1). TV ($\beta = 0.100$ (SE = 0.046)) and computer time ($\beta = 0.128$ (SE = 0.058)) were significantly positively associated with total ST in the total sample and explained 4.2 and 2.1%, respectively of between-pupil variance in total ST. Total screen-time was significantly positively associated with total ST in boys ($\beta = 0.110$ (SE = 0.038)) and the total sample ($\beta = 0.099$ (SE = 0.026)) and explained respectively 8.3 and 7.0% of

Table 1 Descriptive statistics and multilevel analyses of the associations between TV, computer and total screen-time with total sedentary time

	Total sample (*n* = 672)	**Boys (*n* = 313)**	**Girls (*n* = 359)**	**Belgium (*n* = 103)**	**Greece (*n* = 165)**	**Hungary (*n* = 130)**	**Netherlands (*n* = 100)**	**Switzerland (*n* = 174)**
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
TV time[a]	107.5 (60.8)	113.9 (62.3)	102 (59.1)	115.1 (60.5)	127.3 (55.2)	124.3 (57.3)	93.4 (65.3)	79.9 (54.1)
Computer time[a, b]	69.9 (47.9)	83.5 (48.3)	58.0 (44.3)	73.5 (45.5)	77.6 (51.7)	81.2 (47.5)	75.7 (44.8)	48.7 (40.9)
Total screen-time[a]	181.5 (99.4)	203.1 (102.6)	162.7 (92.7)	191.5 (89.0)	210.8 (97.1)	210.9 (97.9)	172.3 (97.6)	131.3 (89.6)
Total ST[a]	489.5 (67.7)	477.8 (68.5)	499.7 (65.5)	488.0 (74.9)	515.8 (61.7)	489.2 (64.5)	456.0 (53.3)	485.0 (69.4)
MODEL 1	β (SE)[c]	β (*SE*)[d]	β (SE)[d]	β (SE)[c]	β (SE)[c]	β (SE)[c]	β (SE)[c]	β (SE)[c]
Fixed part								
TV time	**0.1(0.046)***	0.123(0.068)	0.084(0.060)	0.137(0.128)	0.083(0.092)	0.017(0.102)	−0.019(0.089)	0.123(0.104)
Computer time	**0.128(0.058)***	0.141(0.086)	0.116(0.079)	0.118(0.166)	0.054(0.1)	0.229(0.127)	**0.291(0.128)***	0.124(0.138)
Random part null model (+ TV)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)
School-level var.	531.4(164.1)	327.0(195.3)	679.9(256.3)	0.0(0.0)	152.6(172.0)	0.0(0.0)	116.0(186.4)	526.1(323.0)
Pupil-level var.	3838.3(219.3)	4213.5(352.4)	3521.2(275.3)	5187.1(722.8)	3364.1(388.1)	3738.2(461.9)	2716.3(406.6)	3968.4(441.4)
Random part null model (+ comp.)								
School-level var.	513.8(160.8)	357.0(203.9)	646.9(245.5)	0.0(0.0)	186.0(182.1)	55.2(160.5)	209.0(214.7)	401.7(281.7)
Pupil-level var.	3918.4(220.8)	4298.9(357.2)	3597.0(275.8)	5523.7(758.7)	3319.1(380.6)	3598.7(458.1)	2626.1(381.3)	4103.6(454.7)
Random part full model								
School-level var.	554.1(167.2)	359.2(201.4)	695.1(259.7)	0.0(0.0)	161.1(175.0)	2.1(144.7)	278.0(243.0)	508.9(315.1)
Pupil-level var.	3754.4(215.1)	4061.9(342.2)	3482.9(273.1)	5161.7(719.3)	3352.2(386.7)	3616.9(471.1)	2404.6(363.6)	3854.1(434.2)
MODEL 2	β (SE)[c]	β (SE)[d]	β (SE)[d]	β (SE)[c]	β (SE)[c]	β (SE)[c]	β (SE)[c]	β (SE)[c]
Fixed part								
Total screen-time	**0.099(0.026)*****	**0.11(0.038)****	0.093(0.036)	0.12(0.087)	0.056(0.051)	0.106(0.055)	0.081(0.054)	0.102(0.056)
Random part null model	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)	σ^2 (SE)
School-level var.	521.4(161.8)	398.0(213.5)	697.8(260.3)	0.0(0.0)	186.7(182.4)	0.0(0.0)	39.8(154.5)	389.8(272.2)
Pupil-level var.	4031.3(223.3)	4445.5(360.9)	3478.3(272.8)	5512.1(746.7)	3328.3(381.8)	3737.4(445.1)	2998.2(430.8)	4284.0(457.0)
Random part full model								
School-level var.	557.9(168.1)	368.3(204.3)	697.8(260.3)	0.0(0.0)	173.2(179.8)	48.2(163.6)	231.9(229.2)	510.6(316.3)
Pupil-level var.	3749.8(215.3)	4077.2(343.5)	3478.3(272.8)	5166.6(720.0)	3350.6(386.6)	3590.6(468.3)	2516.7(380.0)	3868.7(435.9)

var., variance; comp., computer
a: (min/day)
b: Mean and SD values for the adjusted variable
c: Controlled for age and gender
d: Controlled for age
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$

between-pupil variance in total ST. Computer time was significantly positively associated with total ST in Dutch children only ($\beta = 0.291$ (SE = 0.128)) and explained 11.5% of between-pupil variance in total ST.

Discussion

Several significant positive associations between total ST and self-reported sedentary activities were found. However, comparable to the results in adults,[4] the associations as indicated by regression coefficients and total explained variance were rather weak or accounted for specific subgroups only. A possible explanation is provided by Biddle *et al.*[3] These authors showed that although TV viewing was the most prevalent sedentary activity, it did not appear to be a good marker of total sedentary behaviour, because an inverse relationship was found between TV time and other leisure-time sedentary activities (e.g. listening to music and behavioural sedentary hobbies). Researchers suggested a 'compensation effect': adolescents may switch between TV viewing and other sedentary activities, rather than spending additional time in sedentary activities.

Accelerometry should be recommended when studying the possible effect of ST on health,[2] since accelerometers capture the total time spent sedentarily. However, two important limitations need to be taken into account. First, accelerometers do not distinguish well between standing and sitting. This differentiation could be captured by questionnaires or inclinometers. Secondly, accelerometers are not able to map the context of sedentary activities, although it may be that certain sedentary behaviours have larger health effects than others. TV time, for example, may be especially detrimental to health because of snacking while watching TV and exposure to food marketing.[10] Therefore, accelerometers combined with a questionnaire might be the preferred option. However, as this study points out, the questionnaire should assess a number of popular sedentary activities, instead of solely assessing screen-time behaviour.

Study limitations are the use of three different accelerometer models, the poor validity score for the computer time variable and the relatively large number of children with insufficient valid accelerometer data.

In conclusion, future research should carefully contemplate the choice of ST measurement, since TV, computer and/or screen-time measures should not be used as a proxy measure of total ST.

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Conflicts of interest: None declared.

Key points

- TV time, computer time and total screen-time do not represent total sedentary time well in 10 to 12-year-old children.
- To study the relationship between sedentary time and health outcomes in children, it is recommended to use accelerometers in combination with questionnaires to map the context of the time spent sedentarily.
- Findings from studies using TV, computer and/or screen-time measures should be interpreted for screen-time alone and not for total sedentary time.

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