

1 Article

## 2 Comparisons in Screen-Time Behaviours among 3 adolescents with and without long-term illnesses or 4 disabilities: Results from 2013/14 HBSC study

5 Kwok W Ng <sup>1,\*</sup>, Lilly Augustine <sup>2</sup> and Jo Inchley <sup>3</sup>

6 <sup>1</sup> University of Limerick, Ireland; kwok.ng@ul.ie

7 <sup>2</sup> Jönköping University, Sweden; lilly.augustine@ju.se

8 <sup>3</sup> St. Andrews University, Scotland; jci2@st-andrews.co.uk

9 \* Correspondence: kwok.ng@hbsc.org

10

11 **Abstract:** Reducing sedentary behaviours can help prevent non-communicable diseases,  
12 particularly among young adolescents with long term illnesses or disabilities (LTID). Much of  
13 young people's voluntary sedentary time is related to screen-time behaviours (STBs) such as TV  
14 viewing, playing computer games, and using the computer for other activities. Although public  
15 health data on adolescents' STB is growing, information about adolescents with LTID is currently  
16 lacking in a European context. The purpose of this study is to compare time on STBs between  
17 adolescents with and without LTID in European Countries through the HBSC 2013/14 study. Young  
18 adolescents (n=61,329, boys; 47.8%) from 15 European countries reported the time spent on TV  
19 viewing, playing computer games, and using the computer for other purposes on weekdays and  
20 the weekend. STBs were dichotomised based on international recommendations of less than 2 hours  
21 per day, and Chi-square test of independence were performed to investigate differences. STB time  
22 was combined to produce a sum score as dependent variable in multiple ANCOVA with age and  
23 family affluence as covariates. There were statistically significant differences in computer gaming  
24 among boys and other computer use among girls for both weekdays and weekends, whereby  
25 adolescents with LTID reported higher use. In addition, both boys and girls with LTID spent more  
26 time on STBs than their same sex peers without LTID (Boys,  $F=28.17$ ,  $p<.001$ ; Girls,  $F=9.60$ ,  $p=.002$ ).  
27 The results of this study indicate a need to address high levels of STB among young adolescents  
28 with LTID.

29 **Keywords:** sedentary behaviours; children; HBSC;

30

### 31 1. Introduction

32 Reducing sedentary behaviours is one of the main goals in preventing non-communicable  
33 diseases. However, rapid changes in availability of digital technologies has facilitated sedentary  
34 behaviours [1]. Engagement in screen-time behaviours (STB) such as watching the TV, playing  
35 computer games, or using computers for other purposes, such as social media or surfing the internet  
36 are common among adolescents and contribute to overall sedentary time [2-4]. Prolonged STB can  
37 have negative effects on physical and psychological health [5,6]. There are also longitudinal  
38 associations between STB and overweight and obesity [7].

39 Evidence of associations between sedentary behaviour and poor health outcomes has led to  
40 recommended limits for the amount of time spent in STB [8,9]. Despite these recommendations, there  
41 is evidence to suggest that a high proportion of adolescents do not keep to these limits, and this has  
42 been increasing over time [10].

43 Adolescents with long-term illnesses or disabilities (LTID) are at risk of developing further  
44 health conditions through sedentary lifestyles [11]. Adolescents with LTID are often excluded from  
45 different types of exercise programs, both in school and after-school, due to inaccessibility making

46 them more likely to engage in sedentary activities such as watching TV [12]. In the school setting,  
47 adolescents with LTID may be placed in environments with more sedentary activities rather than  
48 active ones. Adolescents with LTID may have more school absenteeism due to their condition as well  
49 as other exclusions from school life, such as PE class and field trips [13]. This type of exclusion from  
50 activities can be harmful to the child's social and emotional development because less time is spent  
51 with friends [14]. Taking part in STB, particularly computer-related activities, may offer an alternative  
52 for social interaction, especially for adolescents with disabilities whom might feel lonelier and more  
53 isolated than others [15]. However, too much use may lead to poor mental health through internet  
54 addiction [16]. Monitoring prevalence and enabling group comparisons, such as people with LTID,  
55 are needed to help inform development of more targeted interventions.

56 The research on STB among children with LTID is limited. There have been some small  
57 investigations of overall sedentary time measured using accelerometers, whereby children with LTID  
58 generally spend more time being sedentary than their peers without LTID [17]. In particular,  
59 adolescents with cerebral palsy were more inclined to spend more time playing electronic games [18].  
60 However, some studies suggest the differences between children with and without autism spectrum  
61 disorder were not statistically significant [19]. This confirmed a previous study after controlling for  
62 secondary health conditions and medication use [20]. On the other hand, adolescents with other types  
63 of disabilities from autism spectrum disorder are reported to spend less time on specific STB such as  
64 TV viewing time [21]. As such, it remains unclear whether there are differences among adolescents  
65 with LTID and if patterns of behaviour vary between countries.

66 From the perspective of public health, data that is disaggregated by disability is needed for  
67 monitoring purposes across different contexts to inform appropriate policies which aim to reduce  
68 STBs. Therefore, in this study, we use cross sectional data from various countries across Europe and  
69 compare the differences in STB among young adolescents with and without LTID. Sedentariness is a  
70 risk factor for future chronic diseases, therefore reducing adolescent's sedentary behaviour is  
71 essential for promoting good health now and into adulthood. Recommendations of maximum of two  
72 hour of screen time per day to reduce risk exists. Screen behaviour today can often include  
73 simultaneous use of different devices [22], therefore a higher cut off might be needed. By  
74 investigating patterns of STB among adolescents in 15 countries, disaggregated for LTID, we aim to  
75 investigate whether prevalence of STB varies by disability status and country of residence.

## 76 2. Materials and Methods

77 Data were collected from the World Health Organization cross-national collaborative Health  
78 Behaviour in School-aged Children (HBSC) study in Europe, North America and Israel. Young  
79 adolescents aged 11-, 13-, and 15-years old are included in the school-based survey, following a well-  
80 established international protocol for data collection in each participating country. The primary  
81 sampling units are the schools and classes and ethical approval for the study and consent for  
82 participation are carried out at the national level. According to the protocol, the survey consists of  
83 three types of questions, i) mandatory international items, ii) optional international items, iii) national  
84 items. All participating countries are requested to carry out data collection with the mandatory set of  
85 items. For this study, these items include the study demographics as well as items on screen time.  
86 Participating countries can choose if they would like to include optional items. The items in this study  
87 that fall under this category measure survey participant's status with regard to long-term illnesses or  
88 disabilities (yes or no). In accordance with the international study protocol, the language of the  
89 national questionnaires was checked through a back-translation protocol prior to data collection to  
90 ensure cross-national comparability. This process included checking for terminology and wording of  
91 the items as well as the response options.

### 92 *Sample*

93 From each country, a nationally representative sample was created through a randomized  
94 cluster sampling procedure, with the cluster set at the school level. A total of 61,329 young  
95 adolescents (Boys 47.8%, Girls 52.2%; 11y 31.1%, 13y 34.7%, 15y 34.2%) provided full responses to all

96 STB variables, LTID status and the covariates that were included. The survey was carried out in the  
97 classroom and was administered by the teachers assigned by the school who were given instructions  
98 in how to administer the survey. All participation was voluntary, anonymous and the right to  
99 withdraw at any time was possible. The administrators were not permitted to look at the results of  
100 the survey at the individual level to ensure confidentiality. Response rates were over 70% at the  
101 international study level and ranged between 40% and 92% at the national level. Many non-responses  
102 were reported to be absentees. The procedures for the survey can be downloaded from  
103 <http://www.hbsc.org/methods/index.html>.

#### 104 *Survey items*

105 All items related to STBs had the same response options whereby young adolescents were asked  
106 to select one option for weekdays and one option for weekends. Response options ranged from “none  
107 at all” to “About 7 or more hours a day”. Only in Slovakia, data on the weekend was not available.  
108 To measure the time spent watching TV during leisure time, participants were asked; “How many  
109 hours a day, in your free time, do you usually spend watching TV, videos (including YouTube or  
110 similar services), DVDs, and other entertainment on a screen?” Playing computer games was  
111 measured using the following question; “How many hours a day, in your free time, do you usually  
112 spend playing games on a computer, games console, tablet (like iPad), smartphone or other electronic  
113 device (not including moving or fitness games)?” Use of a computer for other purposes was measured  
114 using the following question; “How many hours a day, in your free time, do you usually spend using  
115 electronic devices such computers, tablets (like iPad) or smart phones for other purposes, for  
116 example, homework, emailing, tweeting, facebook, chatting, surfing the internet?”

117 These questions have been used repeatedly in the HBSC survey as indicators of STB. In 2001/2  
118 study, a test-retest study over seven days took place in Belgium. The authors of that study reported  
119 strong agreement for boys (ICC=.076) and girls (ICC=0.81) [23]. The stability of the items were tested  
120 again from the 2009/10 HBSC cycle across adolescents in China, where there was moderate agreement  
121 for computer games (weekdays, ICC=0.54; weekends, ICC=0.69) and lower agreement for using  
122 computer for other purposes (weekdays, ICC=0.33; weekends, ICC=0.50) [24]. In addition, measures  
123 of STB are difficult to measure its content validity [25], however some prior work on convergent  
124 validity through self-reported TV diaries and questionnaire reporting were stronger among girls  
125 (Boys, ICC=0.36; Girls, ICC=0.54) [23].

126 Each of the six STB variables were dichotomized in order to compare the proportion of young  
127 adolescents who spent less than 2h per day versus those who spends more than 2 hours per day were  
128 analyzed, corresponding to the international recommendations for STBs. In addition, a summed score  
129 of all the STB during the weekdays and the weekend were calculated. A cut off of 3h per day was  
130 used to allow for time spent reporting multiple ST use, and to keep the results comparable to a recent  
131 international comparison study by Hoare and colleagues [26]. Subsequently, the summed score for  
132 all STB combined was entered into the multivariate statistical analyses.

#### 133 *Covariates*

134 The young adolescents were asked to report their gender as either boy or girl. At the time of the  
135 survey no other options were available. Prior literature suggests there are large differences in STB  
136 between boys and girls [10], hence the analyses were stratified by gender. Also, the young adolescents  
137 reported the month and year of birth. Their age was then calculated based on the time of completion  
138 of the survey. For the purposes of reporting age categories, they were grouped in the 11-, 13- and 15-  
139 year-olds after rounding to the nearest age group. Relative wealth was measured through the Family  
140 Affluence Scale (FAS III) as a child-friendly indicator of socioeconomic status [27]. In all countries  
141 except for Armenia, the six item FAS III was used. In Armenia, the four item FAS II (number of  
142 computers, car ownership, family holidays in the past year, and having one’s own bedroom) was  
143 used. FAS III is newer than FAS II to reflect the changes in household possessions and is the same as  
144 FAS II, but with two additional items (dishwasher in household, number of bathrooms in household)  
145 [28]. All items were summed up, then a relative ridit score was created through a rankit command in

146 IBM SPSS. Quintiles were created and the lowest 20% represented low FAS, the middle 60%  
147 represented medium FAS, and the highest 20% represented high FAS.

#### 148 *Data Analyses*

149 All analyses were carried out on IBM SPSS 24.0. Descriptive data were presented as proportion  
150 of young adolescents who spent two or more hours watching TV, playing computer games, or use of  
151 computer for other purposes for the total sample and for each country. Chi-square tests of  
152 independence were used for determining statistical differences based on, having LTID or not, and  
153 spending less than 2 hours or not for each STB. There was no indication, from two step cluster  
154 analyses at the school or class level was necessary, therefore multivariate analyses were carried out  
155 at the individual level. Means and standard deviations of the summed STB were analysed with t-tests  
156 to investigate gender differences at the country level and for the pooled population. Repeated  
157 univariate analysis of covariance was undertaken with summed hours per day for week and weekend  
158 as the dependent variable, LTID status as the independent variable, controlling for age and family  
159 affluence. The level of statistical significance was .05. Results are presented separately for boys and  
160 girls and for weekdays and weekends. Data for this study can be made available by request through  
161 the HBSC data bank in Bergen (<http://www.uib.no/en/hbscdata>).

### 162 **3. Results**

#### 163 *Watching TV by countries*

164 Prevalence of TV watching was higher at the weekend; approximately three-fifths of young  
165 adolescents spent two hours or more per day watching TV during the week and four-fifths did so  
166 during the weekend (Table 1). For boys only one significant difference was found: In Sweden, more  
167 boys with LTID watched more TV during weekdays than boys without ( $p=.002$ ), no difference on  
168 weekends were found.

169 In Sweden, there were fewer boys with LTID than without LTID ( $p=.002$ ) who reported to watch  
170 TV during the weekdays between boys with and without LTID. In all other countries, there were no  
171 significant differences in watching TV on weekdays or at the weekend.

172 There were few significant differences regarding girls. Three countries indicated that more girls  
173 with LTID watched TV for two hours or more per day during weekdays (England: 66% v 60%;  
174 Ireland: 55% v 49%; and Sweden: 66% v 61%). On weekends more girls with LTID in the former  
175 Yugoslav Republic of Macedonia (86% v 77%) watched TV more than the recommended limits of two  
176 hours.

#### 177 *Boys computer gaming and use*

178 Almost half of boys spent less than 2h playing computer games or used the computer during the  
179 weekdays (Table 2). Boys with LTID were more sedentary through computer games and use of  
180 computers for other purposes during the weekdays ( $p<.001$ ) and weekends ( $p=.011$ ) than boys  
181 without LTID. More boys with LTID in Finland and in Sweden spent two hours or more per day  
182 playing computer games during the weekdays. After pooling the population data together, more  
183 boys with LTID ( $p=.008$ ) reported to use the computer use for other purposes than games for two  
184 hours or more per day during the weekdays. In Poland, there was a statistically significant difference  
185 ( $p=.005$ ) in the proportion of boys with and without LTID who used computers for other purposes  
186 than gaming for two hours or more per day during weekdays. The differences in other countries were  
187 not statistically significant.

188

Table 1. Proportion (0-1) of boys and girls who spend two hours or more per day watching TV during the week and the weekend

	Boys									Girls								
	TV Weekday					TV Weekend				TV Weekday					TV Weekend			
	No LTID		LTID		$\chi^2$	No LTID	LTID	$\chi^2$	No LTID		LTID		$\chi^2$	No LTID	LTID	$\chi^2$		
N	>2h	N	>2h	N					>2h	N	>2h	N					>2h	
All	22480	0.62	5352	0.63	0.24	0.79	0.79	0.55	24967	0.59	5998	0.6	0.15	0.77	0.78	0.50		
Armenia	857	0.60	76	0.60	0.89	0.77	0.72	0.34	1233	0.57	67	0.55	0.76	0.75	0.77	0.79		
Bulgaria	1952	0.69	197	0.72	0.47	0.74	0.72	0.44	1888	0.72	245	0.75	0.38	0.78	0.8	0.42		
Czechia	1714	0.63	612	0.61	0.39	0.77	0.79	0.17	1846	0.54	729	0.58	0.12	0.7	0.72	0.31		
England	1555	0.60	482	0.62	0.39	0.8	0.8	0.77	1543	0.6	488	0.66	0.03	0.81	0.8	0.49		
Finland	1018	0.64	428	0.61	0.30	0.81	0.82	0.95	1141	0.56	527	0.53	0.20	0.8	0.78	0.34		
France	1930	0.57	513	0.59	0.43	0.79	0.77	0.34	1991	0.52	517	0.54	0.53	0.74	0.76	0.57		
Hungary	1110	0.55	345	0.52	0.49	0.79	0.8	0.55	1210	0.51	410	0.51	0.94	0.8	0.8	0.98		
Ireland	917	0.51	278	0.52	0.74	0.74	0.71	0.41	1630	0.49	380	0.55	0.03	0.72	0.75	0.28		
MKD	1281	0.56	103	0.54	0.81	0.77	0.7	0.09	1529	0.54	104	0.59	0.34	0.77	0.86	0.04		
Poland	1797	0.59	371	0.62	0.23	0.81	0.82	0.65	1792	0.59	422	0.62	0.33	0.8	0.77	0.21		
Romania	1158	0.71	83	0.66	0.38	0.77	0.8	0.53	1354	0.68	139	0.7	0.62	0.79	0.77	0.58		
Scotland	1824	0.66	454	0.68	0.42	0.81	0.81	0.96	2036	0.59	401	0.56	0.22	0.77	0.78	0.68		
Sweden	2227	0.64	691	0.70	<.01	0.81	0.81	0.81	2353	0.61	786	0.66	0.03	0.81	0.83	0.29		
Slovakia	1648	0.65	360	0.67	0.4	nd	nd	nd	1830	0.64	463	0.65	0.56	nd	nd	nd		
Wales	1492	0.69	359	0.71	0.54	0.81	0.81	0.9	1591	0.64	320	0.62	0.61	0.78	0.75	0.22		

LTID, Long-term illnesses or Disabilities; >2h, two hours or more of TV viewing;  $\chi^2$ , Chi-square test of independence between no LTID and LTID groups; MKD, former Yugoslav Republic of Macedonia; nd, no data

Table 2. Proportion (0-1) of boys who spend two hours or more per day on computers during the weekdays and the weekend

	Computer Games Weekdays			Computer Games Weekend			Use of Computer Weekdays			Use of Computer Weekends		
	No LTID	LTID	$\chi^2$	No LTID	LTID	$\chi^2$	No LTID	LTID	$\chi^2$	No LTID	LTID	$\chi^2$
Country	>2h	>2h	$\chi^2$	>2h	>2h	$\chi^2$	>2h	>2h	$\chi^2$	>2h	>2h	$\chi^2$
All	0.55	0.58	<.01	0.73	0.74	0.01	0.52	0.54	0.01	0.61	0.63	0.16
Armenia	0.37	0.33	0.57	0.53	0.49	0.53	0.4	0.45	0.35	0.55	0.55	0.96
Bulgaria	0.66	0.61	0.15	0.73	0.74	0.77	0.61	0.64	0.39	0.64	0.7	0.11
Czechia	0.6	0.63	0.19	0.7	0.7	0.90	0.52	0.52	0.96	0.57	0.56	0.54
England	0.53	0.54	0.72	0.73	0.73	0.73	0.53	0.56	0.24	0.65	0.69	0.11
Finland	0.51	0.59	0.01	0.71	0.73	0.49	0.48	0.47	0.72	0.57	0.56	0.79
France	0.48	0.49	0.66	0.75	0.71	0.07	0.46	0.46	0.85	0.59	0.57	0.54
Hungary	0.51	0.51	0.95	0.75	0.82	0.02	0.37	0.41	0.21	0.53	0.6	0.03
Ireland	0.37	0.4	0.29	0.61	0.61	0.96	0.43	0.46	0.43	0.56	0.56	0.95
MKD	0.47	0.53	0.27	0.7	0.72	0.73	0.51	0.54	0.48	0.68	0.65	0.55
Poland	0.48	0.48	0.85	0.7	0.75	0.03	0.49	0.57	0.01	0.62	0.7	<.01
Romania	0.61	0.61	0.95	0.73	0.68	0.35	0.48	0.47	0.88	0.57	0.57	0.88
Scotland	0.63	0.67	0.20	0.78	0.8	0.30	0.58	0.6	0.35	0.67	0.67	0.90
Sweden	0.62	0.68	0.01	0.8	0.81	0.45	0.57	0.6	0.28	0.64	0.64	0.99
Slovakia	0.59	0.64	0.13	nd	nd	nd	0.53	0.55	0.58	nd	nd	nd
Wales	0.64	0.67	0.27	0.76	0.81	0.05	0.6	0.63	0.27	0.66	0.71	0.11

LTID, Long-term illnesses or Disabilities; >2h, two hours or more of computing;  $\chi^2$ , Chi-square test of independence between no LTID and LTID groups; MKD, former Yugoslav Republic of Macedonia; nd, no data

1        Less than three quarter of boys played computer games for two hours or more per day during  
2 weekends, whereas three out of every five boys used computers for other purposes for two hours or  
3 more per day during the weekends. More boys with LTID (72.6% vs 74.4%,  $p=.011$ ) were playing  
4 computer games for two hours or more per day during the weekend than boys without LTID. More  
5 specifically, more boys with LTID in Hungary, Poland, and Wales spent two hours or more playing  
6 computer games on the weekend than boys without LTID. There were similar differences in Hungary  
7 and Poland in the use of computers for other purposes during weekends. However, the differences  
8 were not statistically significant across the pooled data or in other countries.

#### 9 *Girls computer use and gaming*

10        During weekdays, less than one thirds, girls stay within the recommended time limit regarding  
11 playing computer games (see Table 3). In England, the former Yugoslav Republic of Macedonia, and  
12 Sweden, girls with LTID were more sedentary than girls without LTID, by reporting to have played  
13 computer games for two hours or more per day during the week. Moreover, during the weekends,  
14 more girls with LTID in England and in Sweden played computer games for two hours or more per  
15 day than girls without LTID. Differences in other countries or the pooled sample were not statistically  
16 significant.

Table 3. Proportion (0-1) of girls who spend less than 2hr per day on computers during the week and the weekend

Country	Computer Games Weekdays			Computer Games Weekend			Use of Computer Weekdays			Use of Computer Weekends		
	No LTID	LTID	$\chi^2$	No LTID	LTID	$\chi^2$	No LTID	LTID	$\chi^2$	No LTID	LTID	$\chi^2$
All	0.31	0.31	0.85	0.44	0.43	0.17	0.53	0.57	<.01	0.63	0.65	<.01
Armenia	0.22	0.3	0.13	0.38	0.38	0.93	0.35	0.46	0.01	0.51	0.72	0.64
Bulgaria	0.47	0.46	0.75	0.52	0.54	0.60	0.62	0.65	0.70	0.66	0.68	0.96
Czechia	0.25	0.22	0.27	0.32	0.32	0.83	0.5	0.52	0.14	0.55	0.6	0.46
England	0.37	0.42	0.03	0.49	0.56	0.01	0.56	0.63	<.01	0.67	0.58	<.01
Finland	0.08	0.09	0.75	0.14	0.14	0.75	0.56	0.6	<.01	0.66	0.6	0.10
France	0.28	0.29	0.67	0.42	0.45	0.24	0.47	0.48	0.37	0.6	0.72	0.51
Hungary	0.31	0.28	0.26	0.52	0.48	0.22	0.4	0.43	0.38	0.56	0.72	0.41
Ireland	0.3	0.31	0.90	0.44	0.41	0.33	0.48	0.5	0.23	0.6	0.63	0.73
MKD	0.25	0.36	0.02	0.49	0.56	0.18	0.49	0.58	<.01	0.67	0.69	0.01
Poland	0.2	0.23	0.24	0.36	0.36	0.83	0.54	0.6	0.21	0.66	0.67	0.09
Romania	0.35	0.39	0.31	0.46	0.48	0.75	0.49	0.55	0.03	0.61	0.63	0.67
Scotland	0.44	0.45	0.61	0.56	0.58	0.50	0.62	0.62	0.28	0.71	0.69	0.17
Sweden	0.29	0.34	0.01	0.41	0.46	0.01	0.59	0.63	0.04	0.65	0.67	0.01
Slovakia	0.31	0.35	0.06	nd	nd	nd	0.54	0.55	0.59	nd	nd	nd
Wales	0.39	0.35	0.18	0.52	0.51	0.77	0.6	0.62	0.93	0.68	0.7	0.56

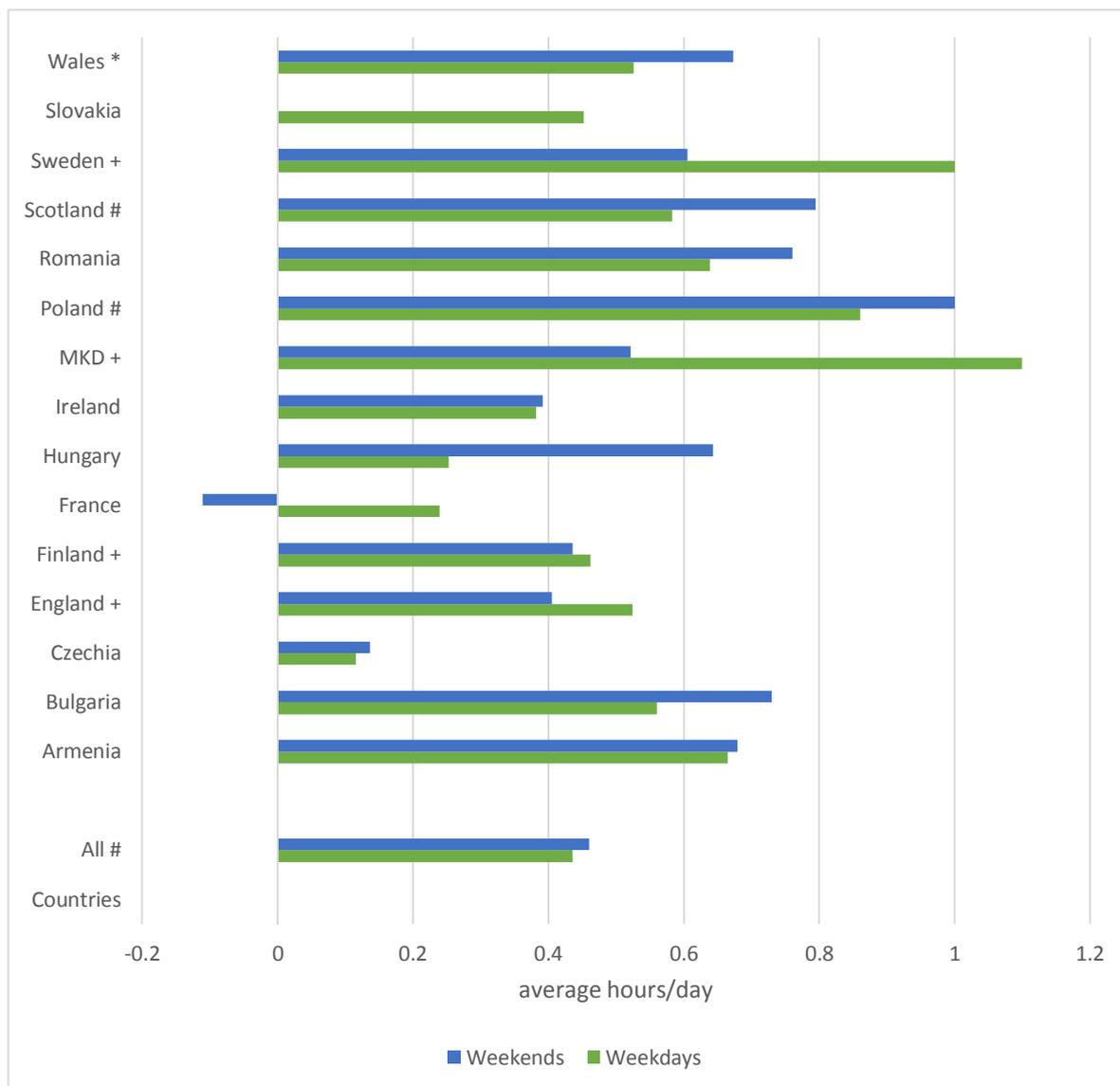
LTID, Long-term illnesses or Disabilities; >2h, two hours or more of computing;  $\chi^2$ , Chi-square test of independence between no LTID and LTID groups; MKD, former Yugoslav Republic of Macedonia; nd, no data

1 During weekdays more than half the girls report using computers for other purposes than  
2 gaming for two hours or more per day, however during weekends only two out of five keep within  
3 the 2-hour recommendation and girls with LTID are more sedentary. More girls with  
4 LTID reported two hour or more per day of computer use during the weekdays ( $p<.001$ ) and  
5 the weekends ( $p=.001$ ) than girls without LTID. More girls with LTID in Armenia, England, Finland,  
6 the former Yugoslav Republic of Macedonia, and Sweden reported to use the computer for two hours  
7 or more per day during the weekdays. Similar differences between girls with and without LTID were  
8 reported in England and Sweden for computer use during the weekend. Differences in other  
9 countries were not statistically significant.

#### 10 *Sum screen time by countries*

11 The summed time of STB was greater among boys (mean=6.8h, SD=4.8) than girls (mean=6.0h,  
12 SD=4.4) on weekdays. During the weekend, boys (mean=9.3h, SD=5.5) reported over 1h more than  
13 girls (mean=8.1h, SD=5.1) of summed STB time (Appendix A). The gender difference was statistically  
14 significant at the pooled population level for both weekdays ( $p<.001$ ) and weekends ( $p<.001$ ) and for  
15 each country, apart from STB during the weekdays in England ( $p=.743$ ) and in Ireland for STB during  
16 the weekdays ( $p=.083$ ) and weekends ( $p=.647$ ).

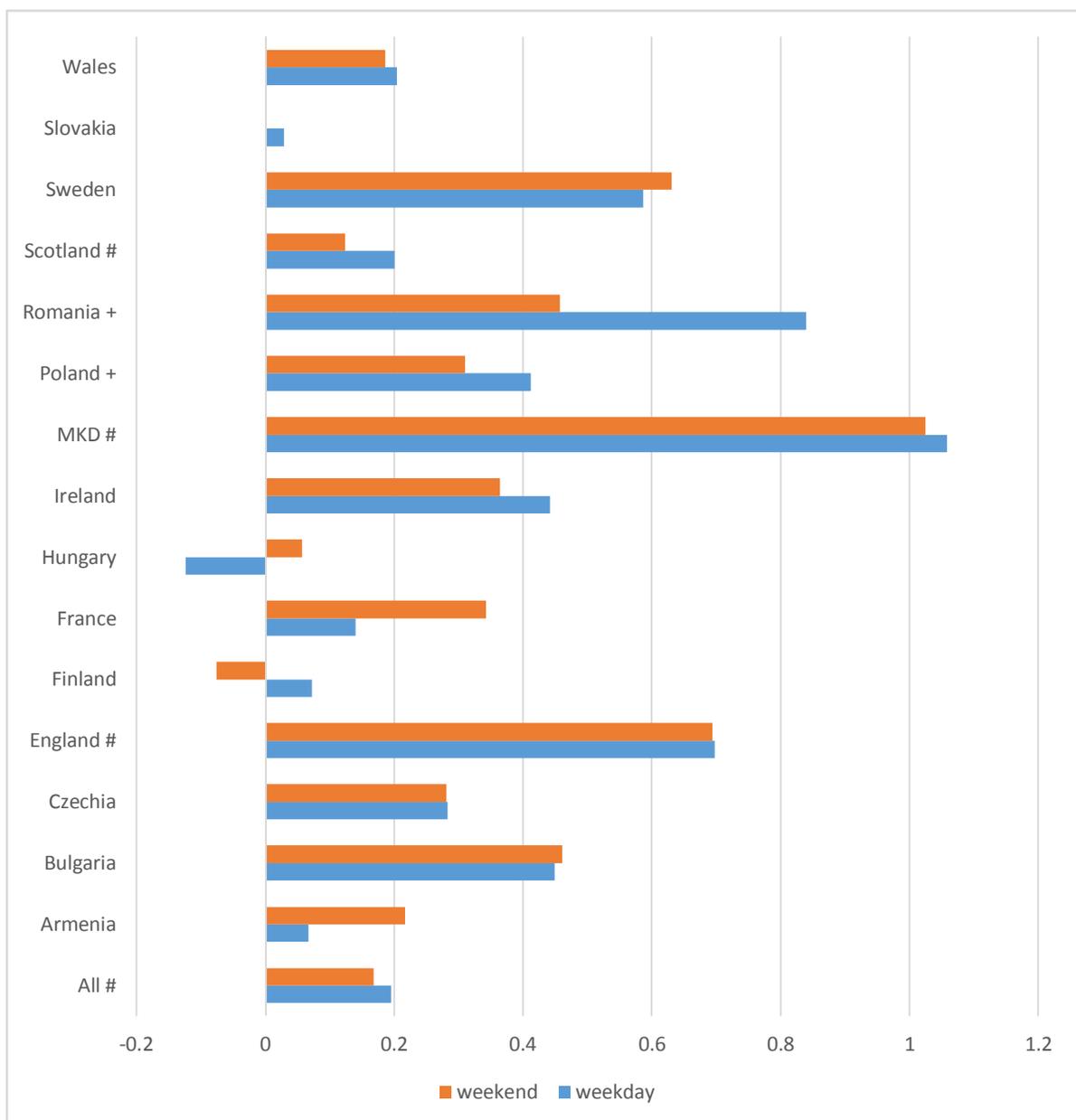
17 After adjusting for age and FAS, in the pooled population, there were statistically significant  
18 differences in reported total time STBs between boys with and without LTID during weekdays  
19 ( $F=35.417$ ,  $p<.001$ ) and weekends ( $F=28.170$ ,  $p<.001$ ), whereby boys with LTID spent more time on  
20 STBs than boys without LTID (Figure 1). At the country level, statistically significant differences were  
21 observed in six countries (England;  $F=4.686$ ,  $p=.031$ ; Finland;  $F=4.569$ ,  $p=.033$ ; the former Yugoslav  
22 Republic of Macedonia;  $F=4.678$ ,  $p=.031$ ; Poland;  $F=10.893$ ,  $p=.001$ ; Scotland;  $F=4.969$ ,  $p=.026$ ; Sweden;  
23  $F=23.775$ ,  $p<.001$ ). Similarly, on the weekends, these differences were significant in four countries  
24 (Poland;  $F=10.819$ ,  $p=.001$ ; Scotland;  $F=7.758$ ,  $p=.005$ ; Sweden;  $F=6.296$ ,  $p=.012$ ; Wales;  $F=4.156$ ,  $p=.042$ ).



25

26 Figure 1. .Difference in mean hours/day of screen time between Boys with and without LTID; + p<.05  
 27 for weekdays, \* p<.05 for weekends, # p<.05 for weeks and weekends. MKD, the former Yugoslav  
 28 Republic of Macedonia

29 On average, across all countries, girls with LTID reported more total time on STBs than those  
 30 without LTID on weekdays (F=9.599, p=.002) and weekends (F=.4894, p=.027) (Figure 2). At country  
 31 level, these differences were statistically significant for weekday STB in five countries (England;  
 32 F=8.230, p=.004; the former Yugoslav Republic of Macedonia; F=5.371, p=.021; Poland; F=4.069, p=.044;  
 33 Romania; F=4.311, p=.038; Sweden, F=12.727, p<.001). For the total time on STBs during the weekend,  
 34 there were statistically differences in three countries (England (F=6.719, p=.010), the former Yugoslav  
 35 Republic of Macedonia (F=3.891, p=.049), and Sweden (F=10.448, p=.001)).



36

37

38

39

Figure 2. Difference in mean hours/day of screen time between Girls with and without LTID; +  $p < .05$  for weekdays, \*  $p < .05$  for weekends, #  $p < .05$  for weeks and weekends. MKDM KD, the former Yugoslav Republic of Macedonia

40

#### 4. Discussion

41

42

43

44

45

46

47

48

49

50

51

52

In this study, screen time behaviour, measured by self-reported TV, computer games, and other use of computer, was compared between young adolescents with and without LTID in 15 European countries. For each behaviour, boys reported, on average 1.5 h more screen time than girls during the week and 1.3 h during the weekend. There were no significant differences in the proportion of adolescents who met the recommendations of less than 2h per day in TV viewing, but use of a computer for playing games or other purposes on weekdays was significantly higher among adolescents with LTID suggesting that these young people spend more time being sedentary than their peers without LTID. These differences were not consistent across all countries, indicating cultural variations in social norms for young people with LTID across Europe.

The amount of STBs is only part of the overall sedentary time adolescents experience. The amount of composite time was distributed almost evenly, although TV viewing was the most common activity and computer gaming was the least common overall, for both weekdays and

53 weekends. With the increasing pervasiveness of digital technologies in young people's lives and the  
54 greater role of computers in education and extra-curriculum activities [29], it may be challenging to  
55 increase the proportion of young adolescents who adhere to the recommendations. Through  
56 replacement of sedentary time with light physical activity, there are immediate and long term health  
57 benefits health benefits [30,31]. Our results suggest that there is a difference in computer use between  
58 young people with and without LTID during the weekdays and weekend. Adolescents with LTID  
59 may feel they require more time on studies and get assistance through online resources [15].  
60 However, they may also feel excluded from participating with other peers [18,32], due to  
61 inaccessibility or decreasing social participation [33] and therefore be more likely to use their leisure  
62 time on screen based activities. Online communication may also provide important opportunities for  
63 social interaction among young people who may be more socially isolated. Given the well-established  
64 health benefits of physical activity and the risks associated with sedentary behaviour, higher  
65 frequency of STB among adolescents with LTID is of concern for both current and future health  
66 outcomes. Some peer-led activities have been found to be useful in increasing physical activity levels  
67 among adolescents [34], suggesting that it may also be possible to use similar strategies reduce  
68 sedentary behaviour and screen time in particular. Further research is required to identify effective  
69 prevention and intervention approaches.

70 Many other comparison studies or reviews often do not report data based on adolescents with  
71 LTID. For example, an international trend study reported the changes in STBs among young  
72 adolescents [10] and there was no reporting on whether there were measures of LTID to know if the  
73 adolescents were included or not. Making data available to disaggregate by LTID is an urgent need  
74 to help provide monitoring for the sustainable disaggregate goals [35]. Moreover, countries that have  
75 ratified the United Nations Convention on the Rights of Persons with Disabilities are also aware that  
76 collection of data by disaggregation is compliant to the article 31 [36]. In our study, we have  
77 attempted to report the results after disaggregation by disability to help inform future studies in  
78 STBs.

79 Another study [26] that compared STBs of adolescents across countries explicitly identified  
80 individuals with LTID as an exclusion criteria in their searches, but the authors did not state a reason  
81 for it. However, it possible because studies involving individuals with LTIDs tend to be small. The  
82 prevalence of adolescents with LTID in this study was approximately 19% and has been reported  
83 elsewhere [37]. Therefore, we were able to carry out such analyses. We could not find statistical  
84 differences in TV viewing behaviours, therefore suspect it is unnecessary to have an exclusion criteria  
85 for future reviews. Rather, we would encourage the use of disaggregation by LTID where possible,  
86 as we carried out in this study. This would give use more insights into addressing the sedentary  
87 behaviours across various population groups.

88 The results of this study have some limitations that need to be addressed when considering the  
89 findings. Our measures of STB were self-reported and there may have been some error in the  
90 reporting because nowadays it is possible to use the TV and computer simultaneously, leading to  
91 over reporting the amount of sedentary behaviour [22]. Measures of self-reported LTID may have  
92 different internal validity across the included countries. However, the HBSC data used in the study  
93 are based on a common protocol allowing robust comparability of findings across different countries.

94 In summary, the adolescents with LTD in our study reported to spend more time on STBs during  
95 weekdays and weekends than same sex peers without LTID. Although the measures of viewing TV,  
96 playing computer games, and using the computer for other purposes are not the only means of being  
97 sedentary, they are still behaviours that remain at the forefront in methodologies in pan-European  
98 surveillance [38]. There is a global need to address reducing sedentary time throughout the waking  
99 hours. Separate intervention strategies may be needed when targeting adolescents with LTID.

100 **Author Contributions:** Conceptualization, KN, LA, JI; Methodology, KN, LA, JI; Formal Analysis, KN; Writing-  
101 Original Draft Preparation, KN, LA; Writing-Review & Editing, LA,JI;

102 **Funding:** This research received no external funding

103 **Conflicts of Interest:** The authors declare no conflict of interest

## 104 Appendix A

105 Differences in Gender Means (hours per day) and Standard deviation of sum of screen time during  
 106 the week and the weekend by countries

Country	Total Screen Time on Weekdays					Total Screen Time on Weekends				
	Boys Mean	SD	Girls Mean	SD	T-test p	Boys Mean	SD	Girls Mean	SD	T-test p
All	6.84	4.8	6	4.39	<.001	9.35	5.5	8.08	5.09	<.001
Armenia										
Bulgaria	5.39	3.92	4.57	3.59	<.001	7.35	4.83	6.51	4.44	<.001
Czechia	8.07	5.4	7.68	4.9	0.016	9.44	5.85	9.06	5.46	0.028
England	6.93	4.53	5.3	3.8	<.001	8.88	5.37	6.66	4.64	<.001
Finland	6.63	4.68	6.59	4.74	0.806	9.39	5.35	8.86	5.23	0.002
France	6.11	3.72	5	3.01	<.001	8.5	4.41	6.68	3.62	<.001
Hungary	6.37	5.06	5.63	4.66	<.001	9.49	5.67	8.04	5.4	<.001
Ireland	5.71	4.2	5.11	4.04	<.001	9.38	5.35	8.16	5.13	<.001
MKD	5.19	4.07	5.47	4.47	0.066	7.7	5.13	7.63	5.15	0.716
Poland	6.32	4.93	5.6	4.6	<.001	9.45	5.77	8.49	5.25	<.001
Romania	6.26	4.58	5.48	3.84	<.001	9.18	5.32	7.88	4.73	<.001
Scotland	7.25	4.98	6.35	4.45	<.001	8.88	5.65	8.03	4.96	<.001
Sweden	7.69	5.05	7.16	4.96	<.001	10.19	5.55	9.41	5.46	<.001
Slovakia	7.54	4.79	6.31	4.11	<.001	10.29	5.57	8.13	4.82	<.001
Wales	7.1	4.85	5.97	4.2	<.001	nd		nd		nd

107 MKD, former Yugoslav Republic of Macedonia; nd, no data

## 108 References

- 109 1. Tremblay, M.S.; Aubert, S.; Barnes, J.D.; Saunders, T.J.; Carson, V.; Latimer-Cheung, A.; Chastin, S.F.M.;  
 110 Altenburg, T.M.; Chinapaw, M.J.M.; Altenburg, T.M.; Aminian, S.; Arundell, L.; Atkin, A.J.; Aubert, S.;  
 111 Barnes, J.; Barone Gibbs, B.; Bassett-Gunter, R.; Belanger, K.; Biddle, S.; Biswas, A.; Carson, V.; Chaput, J.;  
 112 Chastin, S.; Chau, J.; ChinAPaw, M.; Colley, R.; Coppinger, T.; Craven, C.; Cristi-Montero, C.; de Assis,  
 113 T.S.; del, P.C.; del Pozo-Cruz, J.; Dempsey, P.; do Carmo, S.G.; Ekelund, U.; Ellingson, L.; Ezeugwu, V.;  
 114 Fitzsimons, C.; Florez-Pregonero, A.; Friel, C.P.; Fr  berg, A.; Giangregorio, L.; Godin, L.; Gunnell, K.;  
 115 Halloway, S.; Hinkley, T.; Hnatiuk, J.; Husu, P.; Kadir, M.; Karagounis, L.G.; Koster, A.; Lakerveld, J.;  
 116 Lamb, M.; Larouche, R.; Latimer-Cheung, A.; LeBlanc, A.G.; Lee, E.; Lee, P.; Lopes, L.; Manns, T.;  
 117 Manyanga, T.; Martin Ginis, K.; McVeigh, J.; Meneguci, J.; Moreira, C.; Murtagh, E.; Patterson, F.;  
 118 Rodrigues Pereira, d.S.; Pesola, A.J.; Peterson, N.; Pettitt, C.; Pilutti, L.; Pinto Pereira, S.; Poitras, V.;  
 119 Prince, S.; Rathod, A.; Rivi  re, F.; Rosenkranz, S.; Routhier, F.; Santos, R.; Saunders, T.; Smith, B.; Theou,  
 120 O.; Tomasone, J.; Tremblay, M.; Tucker, P.; Umstattd Meyer, R.; van, d.P.; Villalobos, T.; Viren, T.;  
 121 Wallmann-Sperlich, B.; Wijndaele, K.; Wondergem, R.; on behalf of SBRN Terminology  
 122 Consensus, Project Participants Sedentary Behavior Research Network (SBRN) Terminology Consensus  
 123 Project process and outcome. *Int J Behav Nutr Phys Act* **2017**, *14*, 75.  
 124 2. Verloigne, M.; Lippevelde, W.V.; Maes, L.; Yildirim, M.; Chinapaw, M.; Manios, Y.; Androustos, O.; Kov  cs,  
 125   ; Bringolf-Isler, B.; Brug, J.; Bourdeaudhuij, I.D. Self-reported TV and computer time do not represent  
 126 accelerometer-derived total sedentary time in 10 to 12-year-olds. *Eur J Public Health* **2012**, *23*, 30-32.

- 127 3. Klitsie, T.; Corder, K.; Visscher, T.L.S.; Atkin, A.J.; Jones, A.P.; van Sluijs, E.,M.F. Children's sedentary  
128 behaviour: descriptive epidemiology and associations with objectively-measured sedentary time. *BMC*  
129 *Public Health* **2013**, *13*, 1092.
- 130 4. Olds, T.S.; Maher, C.A.; Ridley, K.; Kittel, D.M. Descriptive epidemiology of screen and non-screen  
131 sedentary time in adolescents: a cross sectional study. *Int J Behav Nutr Phys Act* **2010**, *7*, 92.
- 132 5. Mark, A.E.; Janssen, I. Relationship between screen time and metabolic syndrome in adolescents. *J Public*  
133 *Health* **2008**, *30*, 153-160.
- 134 6. Biddle, S.J.H.; Marshall, S.J.; Gorely, T.; Cameron, N. Temporal and Environmental Patterns of Sedentary  
135 and Active Behaviors during Adolescents' Leisure Time. *International Journal of Behavioral Medicine* **2009**,  
136 *16*, 278-286.
- 137 7. Henderson, V.R. Longitudinal Associations Between Television Viewing and Body Mass Index Among  
138 White and Black Girls. *J Adolesc Health* **2007**, *41*, 544-550.
- 139 8. Melkevik, O.; Torsheim, T.; Ronald, I.; Bente, W. Is spending time in screen-based sedentary behaviors  
140 associated with less physical activity: a cross national investigation. *International Journal of Behavioral*  
141 *Nutrition and Physical Activity* **2010**, *7*, 17 June 2013.
- 142 9. Finne, E.; Bucksch, J.; Lampert, T.; Kolip, P. Physical activity and screen-based media use: cross-sectional  
143 associations with health-related quality of life and the role of body satisfaction in a representative sample  
144 of German adolescents. *Health Psychol Behav Med* **2013**, *1*, 15-30.
- 145 10. Bucksch, J.; Sigmundova, D.; Hamrik, Z.; Troped, P.J.; Melkevik, O.; Ahluwalia, N.; Borraccino, A.; Tynjälä,  
146 J.; Kalman, M.; Inchley, J. International Trends in Adolescent Screen-Time Behaviors From 2002 to 2010.  
147 *Journal of Adolescent Health* **2016**, *58*, 417-425, DOI <https://doi.org/10.1016/j.jadohealth.2015.11.014>.
- 148 11. Walker, R.G.; Obeid, J.; Nguyen, T.; Ploeger, H.; Proudfoot, N.A.; Bos, C.; Chan, A.K.; Pedder, L.; Issenman,  
149 R.M.; Scheinemann, K.; Larché, M.J.; McAssey, K.; Timmons, B.W. Sedentary Time and Screen-Based  
150 Sedentary Behaviors of Children With a Chronic Disease. *Pediatr Exerc Sci* **2015**, *27*, 219-225.
- 151 12. Rowland, J.L. Exercise, leisure, and well-being for people with disability. In *The Oxford handbook of positive*  
152 *psychology and disability*; Wehmeyer, M.L., Ed.; Oxford University Press: New York, USA, 2014; pp. 82-90.
- 153 13. Lightfoot, J.; Wright, S.; Sloper, P. Supporting pupils in mainstream school with an illness or disability:  
154 young people's views. *Child Care Health Dev* **1999**, *25*, 267-284.
- 155 14. Rosenbaum, P.; Gorter, J.W. The 'F-words' in childhood disability: I swear this is how we should think!  
156 *Child Care Health Dev* **2012**, *38*, 457-463.
- 157 15. Locke, J.; Ishijima, E.; Kasari, C.; London, N. Loneliness, friendship quality and the social networks of  
158 adolescents with high-functioning autism in an inclusive school setting. *JORSEN* **2010**, *10*, 74-81.
- 159 16. Kim, S.; Kim, J.; Jee, Y. Relationship between smartphone addiction and physical activity in Chinese  
160 international students in Korea. *Journal of Behavioral Addictions* **2015**, *4*, 200-205.
- 161 17. Lobenius-Palmér, K.; Sjöqvist, B.; Hurtig-Wennlöf, A.; Lundqvist, L. Accelerometer-Assessed Physical  
162 Activity and Sedentary Time in Youth With Disabilities. *Adapt Phys Activ Q* **2018**, *35*, 1-19.
- 163 18. Michelsen, S.I.; Flachs, E.M.; Damsgaard, M.T.; Parkes, J.; Parkinson, K.; Rapp, M.; Arnaud, C.; Nystrand,  
164 M.; Colver, A.; Fauconnier, J.; Dickinson, H.O.; Marcelli, M.; Uldall, P. European study of frequency of  
165 participation of adolescents with and without cerebral palsy. *Eur J Paediatr Neurol* **2014**, *18*, 282-294.
- 166 19. Healy, S.; Haegele, J.A.; Grenier, M.; Garcia, J.M. Physical Activity, Screen-Time Behavior, and Obesity  
167 Among 13-Year Olds in Ireland with and without Autism Spectrum Disorder. *J Autism Dev Disord* **2017**,  
168 *47*, 49-57.

- 169 20. Corvey, K.; Menear, K.S.; Preskitt, J.; Goldfarb, S.; Menachemi, N. Obesity, Physical Activity and Sedentary  
170 Behaviors in Children with an Autism Spectrum Disorder. *Matern Child Health J* **2016**, *20*, 466-476.
- 171 21. Mazurek, M.O.; Shattuck, P.T.; Wagner, M.; Cooper, B.P. Prevalence and Correlates of Screen-Based Media  
172 Use Among Youths with Autism Spectrum Disorders. *J Autism Dev Disord* **2012**, *42*, 1757-1767.
- 173 22. Jago, R.; Sebire, S.J.; Gorely, T.; Cillero, I.H.; Biddle, S.J.H. "I'm on it 24/7 at the moment": A qualitative  
174 examination of multi-screen viewing behaviours among UK 10-11 year olds. *Int J Behav Nutr Phys Act*  
175 **2011**, *8*, 85.
- 176 23. Vereecken, C. Paper pencil versus pc administered querying of a study on health behaviour in school-aged  
177 children. *Arch Public Health* **2001**, *59*, 43-61.
- 178 24. Liu, Y.; Wang, M.; Tynjälä, J.A.; Lv, Y.; Villberg, J.; Zhang, Z.; Kannas, L.K. Test-retest reliability of selected  
179 items of Health Behaviour in School-aged Children (HBSC) survey questionnaire in Beijing, China. *BMC*  
180 *Med Res Methodol* **2010**, *10*, 73.
- 181 25. Lubans, D.R.; Hesketh, K.; Cliff, D.P.; Barnett, L.M.; Salmon, J.; Dollman, J.; Morgan, P.J.; Hills, A.P.; Hardy,  
182 L.L. A systematic review of the validity and reliability of sedentary behaviour measures used with  
183 children and adolescents. *Obesity Reviews* **2011**, *12*, 781-799.
- 184 26. Hoare, E.; Milton, K.; Foster, C.; Allender, S. The associations between sedentary behaviour and mental  
185 health among adolescents: a systematic review. *International Journal of Behavioral Nutrition and Physical*  
186 *Activity* **2016**, *13*, 108.
- 187 27. Torsheim, T.; Cavallo, F.; Levin, K.A.; Schnohr, C.; Mazur, J.; Niclasen, B.; Currie, C. Psychometric  
188 Validation of the Revised Family Affluence Scale: a Latent Variable Approach. *Child Indicators Research*  
189 **2016**, *9*, 771-784.
- 190 28. Hartley, J.E.K.; Levin, K.A.; Currie, C. A new version of the HBSC Family Affluence Scale - FAS III: Scottish  
191 Qualitative Findings from the International FAS Development Study. *Child Indic Res* **2015**, *9*, 233-245.
- 192 29. Underwood, J.D.M.; Farrington-Flint, L. *Learning and the E-generation*, 2015; pp. 216.
- 193 30. del Pozo-Cruz, J.; García-Hermoso, A.; Alfonso-Rosa, R.M.; Alvarez-Barbosa, F.; Owen, N.; Chastin, S.; del  
194 Pozo-Cruz, B. Replacing Sedentary Time: Meta-analysis of Objective-Assessment Studies. *American*  
195 *Journal of Preventive Medicine* **2018**, *55*, 395-402, DOI <https://doi.org/10.1016/j.amepre.2018.04.042>.
- 196 31. Aadland, E.; Kvalheim, O.M.; Anderssen, S.A.; Resaland, G.K.; Andersen, L.B. The multivariate physical  
197 activity signature associated with metabolic health in children. *Int J Behav Nutr Phys Act* **2018**, *15*, 77.
- 198 32. Ullenhag, A.; Almqvist, L.; Granlund, M.; Krumlinde-Sundholm, L. Cultural validity of the Children's  
199 Assessment of Participation and Enjoyment/Preferences for Activities of Children (CAPE/PAC).  
200 *Scandinavian Journal of Occupational Therapy* **2012**, *19*, 428-438.
- 201 33. King, G.; Law, M.; Hurley, P.; Petrenchik, T.; Schwellnus, H. A Developmental Comparison of the Out-of-  
202 school Recreation and Leisure Activity Participation of Boys and Girls With and Without Physical  
203 Disabilities. *International Journal of Disability, Development and Education* **2010**, *57*, 77-107.
- 204 34. Klavina, A.; Block, M.E. The Effect of Peer Tutoring on Interaction Behaviors in Inclusive Physical  
205 Education. *Adapt Phys Activ Q* **2008**, *25*, 132-158.
- 206 35. Tardi, R.; Njelesani, J. Disability and the post-2015 development agenda. *Disabil Rehabil* **2015**, *37*, 1496-1500.
- 207 36. Bickenbach, J.E. Monitoring the United Nation's Convention on the Rights of Persons with Disabilities: data  
208 and the International Classification of Functioning, Disability and Health. *BMC Public Health* **2011**, *11*, 68.
- 209 37. Ng, K.; Tynjälä, J.; Sigmundová, D.; Augustine, L.; Sentenac, M.; Rintala, P.; Inchley, J. Physical Activity  
210 Among Adolescents With Long-Term Illnesses or Disabilities in 15 European Countries. *Adapt Phys Activ*  
211 *Q* **2017**, *34*, 456-465.

- 212 38. De Craemer, M.; Chastin, S.; Ahrens, W.; Bernaards, C.; Brug, J.; Buck, C.; Cardon, G.; Capranica, L.;  
213 Dargent-Molina, P.; De Lepeleere, S.; Hoffmann, B.; Kennedy, A.; Lakerveld, J.; Lien, N.; Ling, F.; Løyen,  
214 A.; MacDonncha, C.; Nazare, J.; Oâ€™Donoghue, G.; Oâ€™Gorman, D.; Perchoux, C.; Pigeot, I.; Simon,  
215 C.; Mueller-Stierlin, A.; van, d.P.; Van Cauwenberg, J.; Oppert, J. Data on Determinants Are Needed to  
216 Curb the Sedentary Epidemic in Europe. Lessons Learnt from the DEDIPAC European Knowledge Hub.  
217 *Int J Environ Res Public Health* **2018**, *15*.  
218