

# ULRR

## Device-based physical activity levels among Finish adolescents with functional limitations

Item Type	Article
Authors	Ng, Kwok W.;Rintala, Pauli;Husu, Pauliina;Villberg, Jari;Vasankari, Tommi;Kokko, Sami
Citation	Disability and Health Journal; 12 (1), pp. 114-120
Publisher	Elsevier
Download date	2026-03-17 05:42:30
Item License	<a href="https://creativecommons.org/licenses/by-nc-sa/1.0/">https://creativecommons.org/licenses/by-nc-sa/1.0/</a>
Link to Item	<a href="https://hdl.handle.net/10344/7187">https://hdl.handle.net/10344/7187</a>

# Accepted Manuscript

Device-based physical activity levels among Finnish adolescents with functional limitations

Dr Kwok W Ng, PhD, Pauli Rintala, PhD, Professor, Dr Pauliina Husu, PhD, Mr Jari Villberg, MSc, Dr Tommi Vasankari, MD, Dr Sami Kokko, PhD



PII: S1936-6574(18)30186-9

DOI: [10.1016/j.dhjo.2018.08.011](https://doi.org/10.1016/j.dhjo.2018.08.011)

Reference: DHJO 727

To appear in: *Disability and Health Journal*

Received Date: 23 April 2018

Revised Date: 22 August 2018

Accepted Date: 31 August 2018

Please cite this article as: Kwok W Ng D, Rintala P, Husu DP, Villberg MJ, Vasankari DT, Kokko DS, Device-based physical activity levels among Finnish adolescents with functional limitations, *Disability and Health Journal* (2018), doi: <https://doi.org/10.1016/j.dhjo.2018.08.011>.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

**Title:**

Device-based physical activity levels among Finnish adolescents with functional limitations

**Authors:**

Dr Kwok W Ng, PhD <sup>1,2</sup>

Professor Pauli Rintala, PhD <sup>1</sup>

Dr Pauliina Husu, PhD <sup>3</sup>

Mr Jari Villberg, MSc <sup>1</sup>

Dr Tommi Vasankari, MD <sup>3</sup>

Dr Sami Kokko, PhD <sup>1</sup>

<sup>1</sup> University of Jyväskylä, Jyväskylä, Finland

<sup>2</sup> University of Limerick, Limerick, Ireland

<sup>3</sup> UKK Institute, Tampere, Finland

**Corresponding Author:**

Dr Kwok W Ng

Department of Physical Education and Sport Sciences

University of Limerick,

Limerick

Ireland

[Kwok.ng@ul.ie](mailto:Kwok.ng@ul.ie)

Tel: +353 45 14 99919

Fax: none

**Keywords: teenagers, physical exercise, children, ICF, accelerometers**

**Funding**

The work was supported by the Ministry of Education [Grants number: OKM/89/626/2015]

**Conflict of interests**

The authors declare they have no competing interest

**Acknowledgements: n/a**

**Authors contributions.**

KN led the conceptualisation and wrote the first draft of the study. JV conducted the statistical analyses and PH revised the methods section. PR, TV and SK provided comments and edits to the manuscript. All authors revised and approved of the manuscript.

**Funding:** The work was supported by the Finnish Ministry of Education [Grants number: OKM/89/626/2015]

**Abstract word count: 250**

**Manuscript word count: 4045**

**Number of references: 40**

**Number of figures/tables: 4**

1 Device-based physical activity levels among Finnish adolescents with functional  
2 limitations

### 3 **Abstract**

#### 4 **Background**

5 Monitoring physical activity among young adolescents with disabilities is a top  
6 academic priority. People with disabilities are a diverse group with various abilities in  
7 different human functioning. Therefore, we used a novel approach through functional  
8 limitations as a marker for disabilities and examined physical activity levels.

#### 9 **Objective**

10 To investigate the levels and differences in light (LPA) and moderate-to-vigorous  
11 (MVPA) intensity physical activity between young adolescents with and without functional  
12 limitations.

#### 13 **Methods**

14 The study included young adolescents (n=1436) aged 11-15 years olds who attended  
15 general schools that were part of the 2016 Finnish School-aged Physical Activity (FSPA)  
16 study. PA levels were measured by hip-worn accelerometers during seven consecutive days.  
17 The data were disaggregated by the following functions related to; seeing, hearing, speaking,  
18 moving, breathing, and remembering or concentrating. Multiple general linear regression  
19 models were run to test the differences in amount of time of LPA and MVPA.

#### 20 **Results**

21 One in six young adolescents had disabilities. Young adolescents with functional  
22 limitations had 7 mins.day<sup>-1</sup> less LPA (p=0.021) and 8 mins.day<sup>-1</sup> less MVPA (p=.011) than  
23 their peers without functional limitations. After controlling for gender, age, and device wear  
24 time, the differences in LPA among young adolescents with and without functional  
25 limitations were the same, however MVPA was no longer significantly less. Results varied  
26 according to different functional limitations.

27 **Conclusions**

28           There were significant variations in physical activity behaviours by functional  
29 limitations and activity intensity. As such, tailored approaches to physical activity promotion  
30 may be dependent on understanding functional limitations as an indicator to disabilities.

31 **Keywords: teenagers, physical exercise, children, ICF, accelerometers**

32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56

**Introduction**

There is undisputed evidence that living a physically active lifestyle can be beneficial to the physical, social, and mental health.(1) Currently, the international physical activity recommendations for health in children aged between 5-18 years old is to take part in at least 60 minutes a day of moderate-to-vigorous intensity physical activity (MVPA).(2) Children who meet this recommendation are considered as ‘active’ and those not meeting the recommendation are described as ‘inactive’.(3) According to these labels, the proportion of children who are inactive requires monitoring and attention at a national level. In Finland, approximately 70% of children aged between 9-15 years old were inactive.(4) In other countries in Western Europe and North America, the inactivity prevalence is 75% for boys and 86% for girls.(5) Yet in many studies, children with disabilities are often excluded or simply not reported, and there is a need to provide better insight for the purposes of health promotion.(3) There are greater health disparities between children with and without disabilities. For example, children with disabilities have lower levels of physical activity.(6) Physical activity can be a protective factor of secondary conditions to existing disabilities, of which, both would be more complicated to treat.(7) Therefore, children with disabilities are considered an important population group to study.

According to the UN Convention on the rights of persons with disabilities, people with disabilities “have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others”.(8) Therefore, specific functions limitations are reported in research as markers for reporting disability.(9) Moreover, bodily impairments may affect the timing of puberty, which has traditionally been defining time for adolescence.(10) Sawyer and colleagues suggest that the endpoint of adolescence should include youth activities up to the age of 24 years old, thus there is a need to create a defining period for “young (or early)

57 adolescence” for children aged between 10-15 years old.(11) From a public health  
58 perspective, being aligned with current policies is crucial to help inform the relevant  
59 stakeholders. As such, the UN convention on the rights of persons with disabilities, of which  
60 Finland has signed and ratified the convention, states that in Article 30, data collected shall  
61 be disaggregated by disabilities to be used for assessing barriers faced by persons with  
62 disabilities.

63 Many studies have reported a variety of frequently reported barriers to physical  
64 activity that are unique to young adolescents with disabilities.(12) The barriers to physical  
65 activity could vary by the impairment types. For example, young adolescents with physical  
66 impairments may have difficulties to execute physical competencies(13) whereas, those with  
67 sensory impairments may experience unique social barriers such as lack of sighted  
68 guides,(14) and those with intellectual impairments may have difficulties to follow  
69 instructions on their own.(15) These differences can have theoretical and practical  
70 implications for increasing physical activity levels. As such, these reports confirm the need to  
71 investigate and report nationally representative data on physical activity behaviours after  
72 consideration of specific functional difficulties (as opposed to the non-categorical approach  
73 where all people with disabilities are grouped together and compared to people without  
74 disabilities).(16)

75 Measurements of physical activity among young adolescents has brought forth much  
76 debate on the accuracy of data collected and thus the interpretation of the results.(17) Costs  
77 and appropriateness in data collection are often a major factor towards the choice of  
78 measurements. Self-report instruments are the most cost-effective strategies to producing  
79 nationally representative reports of physical activity levels and are appealing when  
80 conducting studies that can be compared with other similar studies.(18) However, there has  
81 been some criticism of self-reported data, and surveillance surveys such as NHANES have  
82 included accelerometers to measure movement and therefore assess physical activity levels.

83 Accelerometers can be placed on the thigh, arms, hips, and other parts of the body to detect  
84 movement, however placement at the hip covers a vast range of movement that is sufficiently  
85 stable to approximate to overall physical activity.(19) Compliance to wearing the device may  
86 be an issue among young adolescents with disabilities,(20) and is needed to be considered  
87 when interpreting results.

88 Few studies are emerging that have used device-based measures of physical activity  
89 among young adolescents with functional limitations, and there is an obvious need to carry  
90 out studies based on nationally representative samples. Recruiting participants from the  
91 general school settings has the advantage of conducting research where the context of  
92 inclusion can be examined and to consider the recent growth, from 8% in 2010 to 16% in  
93 2016, in the proportion of pupils who need intensified or special educational support in the  
94 Finnish schools.(21) To our knowledge, this is the first nationally representative study  
95 describing device-based measures of physical activity by disability type, according to the  
96 core functions related to disabilities and physical activity. Thus, the purposes of this study are  
97 to investigate the levels and differences in light (LPA) and moderate-to-vigorous (MVPA)  
98 intensity physical activity among young adolescents with and without functional limitations,

## 99 **Methods**

### 100 **Procedures**

101 Data were collected from the 2016 Finnish School-aged Physical Activity (FSPA)  
102 study that is the national physical activity monitoring study for children and adolescents  
103 (LIITU in Finnish). The FSPA study was approved by the University of Jyväskylä ethical  
104 committee to carry out research based on survey data and device-based measures of physical  
105 activity and sedentary behaviours. To that effect, the sample was segmented into the survey  
106 participants (n=6369) and the device-based measures participants (n=3284) aged between 9  
107 and 15 years old during spring 2016 (Figure 1). The sample was organised so that a  
108 nationally representative sample was derived for survey participants. Selection of participants

109 was random and a regionally stratified sampling method was deployed with the class in the  
 110 school. The primary sampling unit was calculated through probability proportion size.  
 111 Overall, there were 285 Finnish-speaking schools, and 44 Swedish-speaking schools that  
 112 participated. Over half of the schools responded to the survey (Finnish schools: 61%,  
 113 Swedish schools: 58%).(22) The survey consisted of an online survey questionnaire  
 114 completed in a classroom, presided by a teacher with instructions. The survey was conducted  
 115 anonymously and voluntarily, allowing pupils to withdraw at any point in time. There were a  
 116 number of reasons for having fewer participants with device-based measures; 1) only  
 117 Finnish-speaking schools were invited for that part of the study, 2) only the schools within  
 118 100 km from the research centres were invited, 3) the schools were free to select only the  
 119 survey part of the study if they liked to (so they could deny from the accelerometer part), and  
 120 4) we needed to have an informed consent from the pupils and their guardians before the  
 121 pupil could participate. A specific code was allocated to individuals who were also assigned  
 122 to device-based measures. The pupils from the Finnish-speaking schools were asked to write  
 123 their specific code into the survey so that their data of device-based measurements of PA  
 124 could be matched with the survey. Following the cleaning of data with matched codes, the  
 125 sample (n=2129) was ready for analysis. Although the FSPA study included also 9 year old  
 126 pupils (n=635), the data of this study covers the ones aged 11, 13, and 15 years because the  
 127 survey of the youngest age group did not include questions about disabilities. Finally, some  
 128 other data were missing, such as gender of pupil, outlier of age and missing functional  
 129 difficulty data, and this reduced the sample size (n=1436).

130 **Measures**

131 The participants provided background information such as their gender (boy or girl),  
 132 month of birth and year of birth. Their age was then calculated based on the time of data  
 133 collection. The age groups of 11, 13, and 15 year olds were allocated by the closest age group  
 134 category. The academic year in Finland is from August to June, however age is determined

135 from January to December. Therefore, the mean ages for each age group were 11.7y, 13.7y,  
136 and 15.7y. We used a proxy measure of social-economic status that can be completed by  
137 young adolescents in the form of the family affluence scale (FASIII). The FASIII consists of  
138 six items about what the young adolescent has access to in their own family including; 1)  
139 number of cars, 2) family holidays, 3) bathrooms, 4) computers at home, and 5) whether they  
140 have their own bedroom and 6) dishwasher. We then created a composite score and ranked  
141 responses through relativeness and identified distributed integral transformation (ridit) in  
142 SPSS from 0 to 1. We then used this index as an indicator of socioeconomic position.

### 143 **Disabilities by functional limitations**

144 The Washington Group on Disability Statistics was used as a method for measuring  
145 disabilities.(23) The “short set” was designed based on international consensus, with the  
146 primary aim of reporting accurately prevalence of disabilities at the population level.(24) The  
147 short set included six items of body functions that are indicators for disabilities. This  
148 perspective corresponds to the WHO international classification of functioning, disability,  
149 and health (ICF) framework where functions are linked to health conditions, activities and  
150 participations as well as environmental factors of the ICF. We modified the items for self-  
151 reporting in the following way, “Do you have any difficulties in,” six functions were listed,  
152 “seeing, even with glasses”, “hearing, even with hearing aid”, “speaking”, “moving”,  
153 “breathing”, and “remembering or concentrating”. There was a five-point response scale (“no  
154 difficulties”, “a little difficulty”, “some difficulty”, “a lot of difficulty”, and “cannot do”) that  
155 corresponded with the functional modifiers within the ICF. A cut off for difficulty was  
156 aligned with the ICF core sets, whereby ratings of “no difficulties” and “a little difficulty”  
157 were considered not sufficiently limiting to be classified as a person with disabilities.  
158 Whereas responses of “some difficulty”, “a lot of difficulty”, and “cannot do” were  
159 considered as severe enough difficulties for the participant to be classified as a person with

160 disabilities.(25) The group of pupils without disabilities were the reference group in the  
161 statistical analyses.

### 162 **Device-based measures of physical activity**

163 Physical activity was measured with tri-axial, hip-worn accelerometers (UKK AM30  
164 and UKK RM42, UKK Terveyspalvelut OY, Tampere, Finland). Research assistants  
165 delivered the devices to pupils during a lesson and gave both oral and written information on  
166 how to use the device. The accelerometer was attached to a flexible belt on the right hip and  
167 the participants were instructed to wear the belt for seven consecutive days (1 week) during  
168 waking hours, except during showering and other water-based activities. The accelerometer  
169 measured and stored the acceleration of the device in three orthogonal directions at sampling  
170 rate of 100 Hz. The resultant acceleration (i.e. the magnitude of the acceleration vector) was  
171 determined from these three components. Then the mean amplitude deviation (MAD) of the  
172 resultant was analysed in 6-second epoch length.(26) The MAD values were then converted  
173 to metabolic equivalents (MET).(19) The epoch-wise MET values were further smoothed by  
174 calculating 1min exponential moving average to better indicate physiological responses (heart  
175 rate, oxygen consumption etc.) of activity. Using the smoothed MET values total physical  
176 activity was classified in light (1.5–2.9 MET), moderate (3.0–5.9 MET) and vigorous ( $\geq 6$   
177 MET) activity. In the results, moderate and vigorous activities were combined to moderate-  
178 to-vigorous activity (MVPA) because vigorous activity covered a very slight proportion of  
179 the total measurement time. In the present study, variables of physical activity are presented  
180 as mean time in each activity during measurement days.(22) To be included into present  
181 study, the participants needed to have accelerometer data for at least four days, at least 10 h  
182 each day.

183 **Statistical analyses**

184 Descriptive statistics were performed to test outcome variables of MVPA and LPA  
 185 against the missing values. Homogeneity between missing and completed data were tested  
 186 through student t-test. T-tests were performed repeatedly on MVPA and LPA for each  
 187 disability group. FAS did not significantly confound the results between group analysis, and  
 188 due to sample size, it was therefore omitted from further analyses. To account for gender and  
 189 age differences, general linear models were performed with physical activity as the outcome  
 190 variable, and disabilities as the independent variable with age, gender and device wear time  
 191 as covariates. Cohen's D was reported to produce effect size in the differences in the mean  
 192 MVPA and LPA. Statistically significant reporting were based on 95% confidence intervals.

193 **Results**

194 **Descriptive Results**

195 Less than one in six (13.2%) young adolescents reported to have functional  
 196 difficulties that were considered to be disabling. The most common type of disability was  
 197 related to remembering and concentrating difficulties (7.3%) and the least common was  
 198 related to moving difficulties (0.8%) (Table 1).

199 Over 40% of participants had seven-day compliance with over 10-hour wear time per  
 200 day (Table 1). There were no differences in device wear time between genders and across age  
 201 groups. However, fewer young adolescents with disabilities reported seven days of wear time  
 202 and more reported five days than the adolescents without disabilities ( $p=0.009$ ). More  
 203 specifically, 30.5% of adolescents with moving difficulties reported five days of wear time,  
 204 and 28.8% reported seven days, in contrast to the 17.2% of adolescents without disabilities  
 205 who had five days of wear time and the 44.7% who had recorded seven days of wear time.

206 **Light PA**

207 Children with disabilities ( $m=197.3 \text{ mins.day}^{-1}$ ,  $SD=47.9$ ) reported on average  
208 significantly less LPA minutes per day than children without disabilities ( $m=204.7 \text{ mins.day}^{-1}$ ,  $SD=40.7$ ,  $p=0.002$ ). The effect size, according to Cohen's D was 0.18 (Table 2).

209  
210 Young adolescents with remembering or concentrating difficulties had significantly  
211 less LPA than young adolescents without disabilities ( $m=191.5 \text{ mins.day}^{-1}$ ,  $SD=48.8$ ,  
212  $p=.002$ ). The effect size was 0.32.

213 After controlling for gender, age and device wear time, young adolescents with  
214 moving difficulties ( $p=0.042$ ) and remembering or concentrating difficulties were  
215 significantly less active ( $p=0.012$ ) than adolescents without disabilities after controlling for  
216 age, gender and wear time. The LPA of the other disability groups did not differ from the  
217 non-disabled group after adjustments. We did not compare all groups with each other. (Table  
218 3).

219 **Moderate to vigorous PA**

220 The average amount of time in moderate to vigorous physical activity was  
221 significantly ( $p=0.011$ ) greater in young adolescent without disabilities ( $m=97.3 \text{ mins.day}^{-1}$ ,  
222  $SD=42.2$ ) than in young adolescents with disabilities ( $m=88.9 \text{ mins.day}^{-1}$ ,  $SD=42.2$ ). The  
223 effect size, according Cohen's D was 0.20 (Table 2).

224 Young adolescents with speaking ( $m=74.6 \text{ mins.day}^{-1}$ ,  $SD=40.4$ ;  $p=0.008$ ) or  
225 remembering or concentrating ( $m=87.1 \text{ mins.day}^{-1}$ ,  $SD=41.6$ ;  $p=0.018$ ) difficulties were  
226 significantly less active than young adolescents without disabilities. There were relatively  
227 small effect sizes and no significant differences in MVPA among young adolescents with  
228 other disabilities.

229 After adjustment for gender, age and device wear time, young adolescents with  
230 speaking difficulties ( $p=0.011$ ) were significantly less active than adolescents without  
231 disabilities. Other differences were not statistically significant after the adjustment (Table 3).

232  
 233  
 234  
 235  
 236  
 237  
 238  
 239  
 240  
 241  
 242  
 243  
 244  
 245  
 246  
 247  
 248  
 249  
 250  
 251  
 252  
 253  
 254  
 255  
 256  
 257

**Discussion**

The main findings of this study were that, after controlling for gender, age and device wear time, light intensity physical activity (LPA) was significantly lower among young adolescents with functional limitations than same age peers without, however the difference was not statistically significant in moderate-to-vigorous intensity physical activity (MVPA). However, there was variation among the different types of functional limitations. In particular, light physical activity (LPA) was significantly lower among young adolescents with functional limitations when compared with same age peers without functional limitations, and specifically with moving difficulties, or difficulties with remembering or concentrating. In addition, there were significantly lower levels of MVPA among young adolescents with speaking difficulties when compared to their peers without functional limitations.

The majority of literature supports the notion that children with functional limitations have low levels of physical activity.(27) For example, in a study of children in special schools, physical activity levels were very low after measuring school time physical activity levels.(28) There are many factors that can explain school time as well as, out of school time PA may be low among children with functional limitations, such as lack of friends, family support, fun,(29) poor infrastructure,(30) and low efficacy among instructors.(31) However, few studies have been conducted in the context of general schools and participation of large scale surveys of children in these general schools.(3) Prior efforts to include functional limitations measures into the mainstream schools to assess differences in physical activity levels were based on a non-categorical approach to disabilities,(32) In such studies of self-reported physical activity, young adolescents with functional limitations were not significantly less active than their peers without functional limitations.(33) The results of the adjusted means analysis from this study largely concur with these previously reported findings, whereby the difference in MVPA between young adolescents with and without

258 functional limitations was not statistically significant. Yet, few studies have explored the  
 259 lower intensity of physical activity, such as LPA, and it was with this intensity that  
 260 differences were noticed. Health promotion activities may need to pay more attention to the  
 261 types of difficulties young adolescents have prior to considering ways to engage them into  
 262 doing more physical activity. Currently, the physical activity recommendations stress the  
 263 importance to be in the active category (at least 60 minutes of MVPA per day), yet it has  
 264 been well documented that even LPA has health benefits.(1) In this study, young adolescents  
 265 with moving difficulties took part in 22 minutes less of LPA per day than their peers without  
 266 functional limitations. Similarly, young adolescents with remembering or concentrating  
 267 difficulties took part in 10 minutes less LPA per day than their peers without functional  
 268 limitations. Therefore, there is a need for strategies that ensure sufficient opportunities, both  
 269 in and out of school contexts, specifically targeting young adolescents with moving  
 270 difficulties or difficulties with remembering or concentrating to take part in LPA.

271         Young adolescents with remembering or concentrating difficulties may have a lack of  
 272 social opportunities to engage in out of school physical activities(34) and this may be a  
 273 reason for the low levels of unadjusted MVPA and LPA. Parents may also be restricting  
 274 opportunities as they are worried that their child finds it hard to follow instructions and gain  
 275 friends.(15) However, there are possible strategies that can increase physical activity  
 276 opportunities. Klavina and colleagues demonstrated the use of social support in the form of  
 277 peers who slowly improve social acceptance into sports, to motivate children to be physically  
 278 active as well as, become a “buddy” whereby the individuals can provide reminders and  
 279 prompts to keep on task.(35) Once young adolescents with functional limitations are involved  
 280 in organised sports, they are two times more likely to meet the physical activity  
 281 recommendations than non-participants with functional limitations.(32) Such findings may  
 282 contribute to our understanding for why, in our study, the average levels of MVPA were not  
 283 significantly different between young adolescents with and without functional limitations.

284 It is often assumed that participation in physical activities requires communication  
 285 skills. Therefore, it was not surprising that young adolescents with speaking difficulties spent  
 286 significantly less time in MVPA than their peers without functional limitations. However,  
 287 communication comprises of both speaking and hearing functions. According to the findings  
 288 from our study, although not statistically significant, young adolescents with hearing  
 289 difficulties took part in 7mins more MVPA per day and almost 13min of LPA per day  
 290 compared to young adolescents without functional limitations. The polarity of physical  
 291 activity behaviours from young adolescents with functions that are related to each other may  
 292 preclude to a better understanding in creating targeted physical activity promotion strategies.  
 293 To do this, it would be important to investigate how and what communication skills are  
 294 influential for regular MVPA.

295 Disaggregation of the data by functional limitations as an indicator for disabilities is a  
 296 novel approach used in this study. Previous clinical studies and study reviews have been  
 297 limiting, because different methods were used, or that disability types tended to be merged  
 298 together into a non-categorical approach. Although epidemiological studies may be beneficial  
 299 to be presented with disabilities as a universal group (16), one size does not fit all approach in  
 300 health promotion and would suggest the importance for disaggregation of data. The measures  
 301 of disabilities were based on the working measures of the Washington Group on Disability  
 302 statistics,(23) which is becoming a standard for international comparisons of disability  
 303 data.(36) Coupled with the latest state of the art algorithms from the mean amplitude  
 304 deviation,(26) device-based measures provide an accurate picture of overall physical activity,  
 305 that also include sedentariness and sitting time. Data is without recall bias that has typically  
 306 been used to criticise self-reported physical activity among adolescents.(37)

307 Including data disaggregated by functional limitations is an important right for people  
 308 with disabilities to be represented in large national surveys.(8) The tool used as a marker for

309 disabilities is not a medically diagnostic tool, as disability is considered the interaction of  
 310 impairments and participation in society that first puts the focus on functional limitations.  
 311 Future studies may consider this or preferably, the updated version of the Washington group  
 312 questions for producing comparative data.(9) We modified the short set instrument for this  
 313 study whereby it was possible for the young adolescents to report themselves. Disability  
 314 advocacy and children rights groups suggest the need to include the people in the study where  
 315 possible, and this is the value from self-reported surveys. We also included another item  
 316 related to physical activity – breathing difficulties. The majority of physical activities suitable  
 317 for young adolescents relies upon the cardiovascular system and breathing is a vital  
 318 component of this. However, there were hardly any differences in both LPA and MVPA.  
 319 Difficulties with breathing may be considered a sign of contraindication to vigorous intensity  
 320 physical activities, thus individuals may feel that participation organized activities are  
 321 restricted.(38) However, symptoms from breathing difficulties may be reduced through  
 322 medication, and it may be possible that a divide in the amount of self-reported physical  
 323 activity among young adolescents with breathing difficulties appeared. This may have  
 324 depended on those that were encouraged to take part in organized sport activities (and  
 325 perhaps may take medication) to those who do not participate at all.(39) More analyses based  
 326 on the severity levels of functional difficulties may provide more insight into this  
 327 phenomenon.

328 Comparisons with other data sets or over time in trend data may be limited to similar  
 329 featured functional limitations. Currently, that would include the following functional groups,  
 330 difficulties in seeing, hearing, speaking and remembering or concentrating. Moreover, the  
 331 response scale in our study was a five-point scale, whereas the updated versions of the  
 332 Washington group are based on a four-point scale. We used a cut-off value of at least “some  
 333 difficulties”, and the results from this cut-off value are similar to the reported prevalence of  
 334 disabilities by the Finnish National Institute of Health and Welfare.(40) Despite our

335 confidence that the cut-off values were sufficient in representation of the population, the  
336 items themselves and the response categories may have influenced the results. Therefore, it is  
337 unclear if the differences in physical activity levels would have been magnified or  
338 diminished.

339 Study limitations include that the sampling of children in general schools exclude  
340 children who require more support in a special school. Interpretation of difficulties were  
341 subjective from the adolescent's experience, which must be taken into account when  
342 interpreting these results. Devices were worn over a week and seasonal changes between  
343 March to the end of May were not taken into account. Due to the anonymous nature of the  
344 data collection around the country, it was not possible to take into account weekly season  
345 changes. Furthermore, water-based activities, like swimming, were not included.  
346 Additionally, activities like cycling and Nordic skiing are not adequately captured at the  
347 moment and thus the intensity of this kind of activities is likely to be slightly underestimated.  
348 However, all participants of the present study used the same type of devices. Finally, the  
349 sample size of each functional difficulty was representative at a population level. Larger  
350 sampling with weights may be needed in future studies to reduce the underpowered results  
351 from this study.

### 352 **Conclusion**

353 The amounts of MVPA is used for measuring compliance with physical activity  
354 recommendations for young adolescents. However, in this study, the levels of MVPA were  
355 not significantly different between young adolescents with and without functional limitations.  
356 Some exceptions existed, whereby young adolescents with speaking difficulties had less  
357 MVPA when compared to their peers without functional limitations. However, when we  
358 examined LPA, young adolescents with functional limitations, moving difficulties, or  
359 difficulties in remembering or concentrating took part, on average, in less LPA.. Overall  
360 health promotion action plans need to recognise the techniques for increasing different

361 intensity physical activity levels to meet overall national targets in all school-aged  
362 populations based on information of functional limitations.

363 **Funding**

364 The funders of this study had no role in the design or analyses of the study.

365 **References**

366 (1) Janssen I, LeBlanc AG. Systematic review of the health benefits of physical  
367 activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act*  
368 2010;11(7):40.

369 (2) WHO. Global recommendations on physical activity for health. WHO 2010.

370 (3) Tremblay MS, Barnes JD, González SA, Katzmarzyk PT, Onywera VO, Reilly JJ,  
371 et al. Global Matrix 2.0: Report Card Grades on the Physical Activity of Children and Youth  
372 Comparing 38 Countries. *J Phys Act Health* 2016 11/01; 2016/11;13(11):S343-S366.

373 (4) Kokko S, Mehtälä A, Villberg J, Ng KW, Hämylä R. Self-reported physical  
374 activity, sitting and screentime [Itsearvioitu liikunta-aktiivisuus, istuminen ja ruutu-aika sekä  
375 liikkumisen seurantalaitteet ja -sovellukset]. In: Kokko S, Hämylä R, Husu P, Villberg J,  
376 Jussila A, Mehtälä A, et al, editors. *The Physical Activity Behaviours of Children and*  
377 *Adolescents in Finland: Results from the 2016 survey [Lasten ja Nuorten*  
378 *liikuntakäyttäytyminen Suomessa, LIITU-tutkimuksen tuloksia 2016]* Helsinki: Finnish  
379 National Sports Council 2016:4; 2016. p. 10-15.

380 (5) Kalman M, Inchley J, Sigmundova D, Iannotti RJ, Tynjälä JA, Hamrik Z, et al.  
381 Secular trends in moderate-to-vigorous physical activity in 32 countries from 2002 to 2010: a  
382 cross-national perspective. *Eur J Public Health* 2015;25(Suppl 2):37-40.

383 (6) Bedell G, Coster W, Law M, Liljenquist K, Kao Y, Teplicky R, et al. Community  
384 Participation, Supports, and Barriers of School-Age Children With and Without Disabilities.  
385 *Archives of Physical Medicine and Rehabilitation* 2013 2;94(2):315-323.

- 386 (7) Rimmer JH, Schiller W, Chen M. Effects of Disability-Associated Low Energy  
387 Expenditure Deconditioning Syndrome. *Exerc Sport Sci Rev* 2012 January;40(1):22-29.
- 388 (8) UN. Convention on the Rights of Persons with Disabilities  
389 . 2006;A/RES/61/106.
- 390 (9) Loeb M, Mont D, Cappa C, De Palma E, Madans J, Crialesi R. The development  
391 and testing of a module on child functioning for identifying children with disabilities on  
392 surveys. I: Background. *Disability and Health Journal* 2018/07.
- 393 (10) Sawyer SM, Drew S, Yeo MS, Britto MT. Adolescents with a chronic condition:  
394 challenges living, challenges treating. *Lancet* 2007;369(9571):1481-1489.
- 395 (11) Sawyer SM, Azzopardi PS, Wickremarathne D, Patton GC. The age of  
396 adolescence. *The Lancet Child & Adolescent Health* 2018 03/01; 2018/06;2(3):223-228.
- 397 (12) Jaarsma EA, Dijkstra PU, de Blécourt, Alida C. E., Geertzen JHB, Dekker R.  
398 Barriers and facilitators of sports in children with physical disabilities: a mixed-method  
399 study. *Disabil Rehabil* 2014 10/27; 2014/10:1-9.
- 400 (13) Li R, Sit CHP, Yu JJ, Duan JZJ, Fan TCM, McKenzie TL, et al. Correlates of  
401 physical activity in children and adolescents with physical disabilities: A systematic review.  
402 *Prev Med* 2016;89:184-193.
- 403 (14) Armstrong E, Lieberman LJ, Prokesova E, Martin JJ. A physical activity barriers  
404 questionnaire for youth with visual impairments. *AUC Kinanthropologica* 2018;54(1):41-52.
- 405 (15) McGarty AM, Melville CA. Parental perceptions of facilitators and barriers to  
406 physical activity for children with intellectual disabilities: A mixed methods systematic  
407 review. *Int Rev Res Dev Disabil* 2018 February 2018;73:40-57.
- 408 (16) Stein REK, Jessop DJ. A noncategorical approach to chronic childhood illness.  
409 *Public Health Rep* 1982 04;97(4):354-362.

410 (17) Kavanaugh K, Moore JB, Hibbett LJ, Kaczynski AT. Correlates of subjectively  
411 and objectively measured physical activity in young adolescents. *J Sport Health Sci* 2015  
412 9;4(3):222-227.

413 (18) Hardie Murphy M, Rowe DA, Belton S, Woods CB. Validity of a two-item  
414 physical activity questionnaire for assessing attainment of physical activity guidelines in  
415 youth. *BMC Public Health* 2015;15:23 October 2015-1080.

416 (19) Vähä-Ypyä H, Vasankari TJ, Husu P, Mänttari A, Vuorimaa T, Suni J, et al.  
417 Validation of Cut-Points for Evaluating the Intensity of Physical Activity with  
418 Accelerometry-Based Mean Amplitude Deviation (MAD). *PLOS ONE* 2015  
419 08/20;10(8):e0134813.

420 (20) Sit CHP, McKenzie TL, Cerin E, Chow B, Huang WY, Yu J. Physical Activity  
421 and Sedentary Time among Children with Disabilities at School. *Med Sci Sports Exerc*  
422 2017;49(2):292-297.

423 (21) Official Statistics of Finland. Special education - Concepts and Definitions [e-  
424 publication]. 2018; Available at: [http://www.stat.fi/til/erop/kas\\_en.html](http://www.stat.fi/til/erop/kas_en.html).

425 (22) Kokko S, Hämylä R, Husu P, Villberg J, Jussila A, Mehtälä A, et al. The  
426 Physical Activity Behaviours of Children and Adolescents in Finland; Results of the LIITU  
427 study, 2016. [Lasten ja Nuorten liikuntakäyttäytyminen Suomessa, LIITU-tutkimuksen  
428 tuloksia 2016]. Helsinki: National Sports Council 2016:4; 2016.

429 (23) Mont D. Measuring health and disability. *The Lancet* 2007 5/12-  
430 18;369(9573):1658-1663.

431 (24) Madans JH, Loeb ME, Altman BM. Measuring disability and monitoring the UN  
432 Convention on the Rights of Persons with Disabilities: the work of the Washington Group on  
433 Disability Statistics. *BMC Public Health* 2011;11(Suppl 4)(S4):8.

- 434 (25) Selb M, Escorpizo R, Kostanjsek N, Stucki G, Üstün TB, Cieza A. A guide on  
435 how to develop an International Classification of Functioning, Disability and Health Core  
436 Set . Eur J Phys Rehab Med 2015;51(1):105-117.
- 437 (26) Vähä-Ypyä H, Vasankari TJ, Husu P, Suni J, Sievänen H. A universal, accurate  
438 intensity-based classification of different physical activities using raw data of accelerometer.  
439 Clin Physiol Funct Imaging 2015;35(1):64-70.
- 440 (27) Raghavendra P. Participation of children with disabilities: Measuring subjective  
441 and objective outcomes. Child Care Health Dev 2013;39(4):461-465.
- 442 (28) Sit CHP, McManus A, McKenzie TL, Lian J. Physical activity levels of children  
443 in special schools. Prev Med 2007;45(6):424-431.
- 444 (29) Rosenbaum P, Gorter JW. The 'F-words' in childhood disability: I swear this is  
445 how we should think! Child Care Health Dev 2012 07;38(4):457-463.
- 446 (30) Shields N, Synnot AJ. An exploratory study of how sports and recreation  
447 industry personnel perceive the barriers and facilitators of physical activity in children with  
448 disability. Disabil Rehabil 2014 12;36(24):2080-2084.
- 449 (31) Block ME, Hutzler YS, Barak S, Klavina A. Creation and Validation of the Self-  
450 Efficacy Instrument for Physical Education Teacher Education Majors Toward Inclusion.  
451 Adapt Phys Activ Q 2013 04;30(2):184-205.
- 452 (32) Ng KW, Rintala P, Tynjälä JA, Välimaa RS, Villberg J, Kokko S, et al. Physical  
453 activity trends of Finnish adolescents with long-term illnesses or disabilities from 2002 to  
454 2014. J Phys Act Health 2016;13(8):816-821.
- 455 (33) Rintala P, Välimaa RS, Tynjälä JA, Boyce WF, King M, Villberg J, et al.  
456 Physical activity of children with and without long-term illness or disability. J Phys Act  
457 Health 2011;8(8):1066-1073.

- 458 (34) Mâsse LC, Miller AR, Shen J, Schiariti V, Roxborough L. Comparing  
459 participation in activities among children with disabilities. *Int Rev Res Dev Disabil* 2012  
460 0;33(6):2245-2254.
- 461 (35) Klavina A, Block ME. The Effect of Peer Tutoring on Interaction Behaviors in  
462 Inclusive Physical Education. *Adapt Phys Activ Q* 2008 04;25(2):132-158.
- 463 (36) UN Expert Group. Disability Data and Statistics, Monitoring and Evaluation:  
464 The Way Forward- a Disability- Inclusive Agenda Towards 2015 and Beyond. 2014.
- 465 (37) Troiano RP, McClain JJ, Brychta RJ, Chen KY. Evolution of accelerometer  
466 methods for physical activity research. *Br J Sports Med* 2014;48.
- 467 (38) Philpott J, Houghton K, Luke A. Physical activity recommendations for children  
468 with specific chronic health conditions: Juvenile idiopathic arthritis, hemophilia, asthma and  
469 cystic fibrosis. *Paediatr Child Health* 2010;15(4):213-225.
- 470 (39) Ng KW, Rintala P, Hutzler Y, Kokko S, Tynjälä JA. Organized Sport  
471 Participation and Physical Activity Levels among Adolescents with Functional Limitations.  
472 *Sports* 2017;5(4):81.
- 473 (40) Kanste O, Sainio P, Halme N, Nurmi-Koikkalainen P. Well-being of youth with  
474 disabilities and access to help - Is equality going to happen? The results of the school health  
475 promotion survey [Toimintarajoitteisten nuorten hyvinvointi ja avun saaminen – Toteutuuko  
476 yhdenvertaisuus? Kouluterveyskyselyn tuloksia]. 2017;Research Reports 24:1-8.
- 477
- 478

479

**Tables and Figures**

480

**Table 1. Descriptive device wear time of device by background characteristics**

481

**Table 2. Unadjusted means of MVPA and LPA minutes per day with differences**

482

**by disabilities and effect size**

483

**Table 3. Regression coefficients of Device worn MVPA and LPA minutes per**

484

**day, adjusted for gender, age, and wear time**

485

**Figure 1. Sample Flow Chart of the FSPA 2016 study**

486

**Table 1. Descriptive device wear time of device by background characteristics**

	n	Days of 10hr wear (%)				Chi p	Overall minutes	
		4	5	6	7		Mean	SD
Total	1436	9.3	18.5	28.8	43.5		846.59	70.64
Gender						0.354		
Boy	571	10.7	17.0	28.4	44.0		848.14	74.92
Girl	865	8.3	19.4	29.0	43.2		845.57	67.69
Age						0.874		
11y	595	8.4	18.3	28.1	45.2		840.83	77.10
13y	503	9.1	18.7	29.6	42.5		849.06	65.28
15y	338	27.8	23.4	23.5	22.7		853.05	65.66
Disability						0.009		
None (Ref)	1247	9.3	17.2	28.9	44.7		845.19	69.60
Disabilities	189	9.0	27.0	28.0	36.0		855.80	76.69
Functional Limitations								
Seeing	39	10.3	23.1	12.8	53.8	0.172	861.45	89.97
Hearing	15	13.3	26.7	26.7	33.3	0.699	843.22	93.04
Speaking	25	8.0	16.0	28.0	48.0	1.000	849.75	87.04
Moving	12	16.7	25.0	16.7	41.7	0.613	973.20	91.77
Breathing	59	8.5	30.5	32.2	28.8	0.028	855.56	84.71
Remember/Conc.	105	13.3	25.7	23.8	37.1	0.052	850.15	68.31

SD=standard deviation, Remember/Conc. = Remembering or Concentrating

Device worn PA measures by functional limitations

**Table 2. Unadjusted means of MVPA and LPA minutes per day with differences by disabilities and effect size**

	n	%	MVPA	sd	p	d	LPA	sd	p	d
Disability										
None (Ref)	1247	86.8	97.3	42.2			204.7	40.7		
Disabilities	189	13.2	88.9	42.2	0.011	0.198	197.3	47.9	0.022	0.179
Functional Limitations										
Seeing	39	2.7	94.9	42.4	0.728	0.057	208.5	49.3	0.577	-0.091
Hearing	15	1.0	118.0	46.3	0.060	-0.489	218.0	40.0	0.212	-0.324
Speaking	25	1.7	74.6	40.4	0.008	0.539	194.9	55.1	0.237	0.239
Moving	12	0.8	83.1	47.0	0.247	0.336	186.3	54.8	0.119	0.452
Breathing	59	4.1	92.8	40.6	0.423	0.107	213.0	41.9	0.127	-0.204
Remember/Conc.	105	7.3	87.1	41.6	0.018	0.241	191.5	48.8	0.002	0.318

N = number of study participants; MVPA = mean Moderate-to-vigorous physical activity; sd = standard deviation, d=Cohen's d, LPA = mean light physical activity, Remember/Conc. = Remembering or Concentrating.

Device worn PA measures by functional limitations

**Table 3. Regression coefficients of Device worn MVPA and LPA minutes per day, adjusted for gender, age, and wear time**

	MVPA				LPA			
	Beta	LCI	UCI	P	Beta	LCI	UCI	p
Disability								
None (Ref)	REF				REF			
Disabilities	-4.276	-9.662	1.111	0.120	-7.181	-13.108	-1.255	0.018
Functional Limitations								
Seeing	0.050	-11.100	11.200	0.993	0.709	-11.377	12.794	0.909
Hearing	7.504	-10.439	25.447	0.412	12.912	-6.379	32.203	0.190
Speaking	-17.984	-31.880	-4.089	0.011	-6.080	-21.163	9.004	0.430
Moving	-12.378	-32.371	7.615	0.225	-22.307	-43.828	-0.786	0.042
Breathing	-1.259	-10.407	7.888	0.787	4.190	-5.736	14.117	0.408
Remember/Conc.	-5.608	-12.655	1.396	0.116	-10.377	-18.064	-2.689	0.008

MVPA = moderate-vigorous-physical activity, LPA = light physical activity, LCI = Lower confidence interval, UCI = Upper confidence interval, Remember/Conc. = Remembering or Concentrating.