Reliability and validity of a screen time-based sedentary behaviour questionnaire for adolescents: The HELENA study

Juan P. Rey-López1,2, Jonatan R. Ruiz2,3, Francisco B. Ortega2,4, Maite Verloigne5, German Vicente-Rodriguez1, Luis Gracia-Marco1, Frederic Gottrand6, Denes Molnar7, Kurt Widhalm8, Maria Zaccaria9, Magdalena Cuenda-García4, Michael Sjöström2, Ilse De Bourdeaudhuij5, Luis A. Moreno1, HELENA Study Group*

1 GENUD (Growth, Exercise, Nutrition and Development in Adolescence) Research Group, Department of Physiotherapy and Nursing, University of Zaragoza, Spain
2 Department of Biosciences and Nutrition at NOVUM, Karolinska Institute, Huddinge, Sweden
3 Department of Physical Activity and Sport, School of Physical Activity and Sport Sciences, University of Granada, Granada, Spain
4 Department of Medical Physiology, Faculty of Medicine, University of Granada, Spain
5 Department of Movement and Sport Sciences, Ghent University, Ghent, Belgium
6 Inserm U995, Faculty of Medicine and University Lille 2, University of Lille, France
7 Department of Paediatrics, Medical Faculty, Pécs University, Hungary
8 Department of Paediatrics, Division of Clinical Nutrition, Medical University of Vienna, Austria
9 Human Nutrition Unit, INRAN, Rome, Italy

Correspondence: Juan Pablo Rey-López, GENUD research group. C/Corona de Aragon, 42. Zaragoza, Spain. E-50009, tel: +34 976 400 338 (ext. 301), fax: +34 976 400 340, e-mail: jprey@unizar.es

*The members of the HELENA Study Group are provided in the Appendix 1.

Background: Although there is a growing interest in the epidemiology of sedentary behaviours, it is unknown whether sedentary behaviour questionnaires are broad markers of sedentary time. The aims of this study were to determine the: (i) reliability of the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) screen time-based sedentary behaviour questionnaire; and (ii) its validity, i.e. the ability of the questionnaire to correctly rank adolescents according to the objectively measured sedentary time. Methods: A total of 183 adolescents (104 females aged 12.5–17.5 years) were involved in the reliability study. Participants completed the HELENA sedentary questionnaire twice (1 week apart). The validity study comprised 2048 (1212 females) adolescents (12.5–17.5 years of age) included in the HELENA cross-sectional study. Questions included television viewing, computer games, console games, Internet for study and non-study reasons and study during the week and weekend days. We compared median values of sedentary time, using accelerometers, by tertiles of self-reported sedentary behaviours and their sum (composite sedentary score). Results: Reliability study: \( \kappa \)-values showed a good agreement (>0.7), except for Internet for study reasons (0.46 weekdays, 0.33 weekend). The questionnaire correctly classified boys’ sedentary time when analysed by specific behaviours and by a composite sedentary score. In girls, median values of objectively measured sedentary time were not different across tertiles of self-reported sedentary behaviours or the composite sedentary score. Conclusion: The HELENA sedentary questionnaire is reliable, yet only correctly classifies objectively measured sedentary time in boys.
Introduction

There is a growing evidence that excessive time devoted to sedentary behaviours, regardless of the leisure-time physical activity level, is associated with a higher risk of cardiovascular diseases and all-causes mortality.\(^1\,^2\) It is, therefore, essential to investigate current levels of sedentary behaviour in order to establish evidence-based public health policies. Epidemiological studies have traditionally assessed screen time sedentary behaviours by self-reported questionnaires.\(^3\) Moreover, recent studies have shown that self-reported television (TV) viewing time is reliable\(^4\) and valid.\(^5\)

In adults, TV viewing seems to be a robust marker of sedentary lifestyle, especially in women.\(^6\) However, in children and adolescents sedentary patterns are much more complex,\(^7\) making the study of sedentariness a challenge. Remarkably, the majority of studies conducted on children and adolescents that assessed self-reported TV viewing did not examine their reliability or validity.\(^8\) Yet diaries provide valid estimates of sedentary behaviours;\(^9\) they are intrusive for the participants which may lead to low compliance rates. The use of accelerometer as an objective measure of physical activity has provided the epidemiology field new possibilities to measure sedentary time.\(^10\) Therefore, it is of interest to know whether sedentary behaviours questionnaires correctly classify objectively measured sedentary time. The Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) cross-sectional study (CSS)\(^11\) collected information about sedentary behaviours by questionnaire and objectively measured sedentary time by means of accelerometer.

The objectives of the current study were to: (i) determine the reliability of the HELENA screen time-based sedentary behaviour questionnaire and (ii) investigate its validity, i.e. the ability of the questionnaire to correctly rank adolescents according to the objectively measured sedentary time.

Methods

Reliability study

Adolescents were recruited from two schools that were included in the HELENA CSS, one from Ghent (Belgium) and the other from Zaragoza (Spain). Thus, we assumed that socio-demographic characteristics should not differ from the HELENA CSS sample. After receiving information about the aims and methods of the study, all the participants signed an informed written consent. In all, 209 adolescents were screened, and a total of 183 adolescents were enrolled in the study (79 males, 104 females; age range 12.5–17.5 years). They completed the HELENA sedentary questionnaire twice (1 week apart) at school hours, and wore accelerometers between test and retest measurements. The period between test and retest should be short enough to ensure that subjects had not changed their sedentary behaviours, but long enough to prevent recalling the previous answers.

Validity study

Altogether 3528 adolescents met the general HELENA inclusion criteria (age range 12.5–17.5 years, not participating simultaneously in another clinical trial and be free of any acute infection lasting <1 week before the inclusion).\(^12\) Among these, 3282 completed at least 75% of the HELENA sedentary behaviour questionnaire. Finally, 2048 had complete data of the HELENA screen time-based sedentary behaviour questionnaire and met the inclusion criteria for accelerometer. Socio-demographic characteristics (age, gender and socio-economic status), and prevalence of each sedentary behaviour were not significantly different between the general HELENA sample and the sub-sample used in the current study (n = 2048).

The HELENA study aimed to obtain a broad range of standardized, reliable and comparable health-related data (such as food patterns, physical activity level, physical fitness, body composition, sedentary behaviours, genotype, biochemical data) from a random sample of European adolescents. Data collection took place in 10 European cities (Vienna in Austria, Ghent in Belgium, Lille in France, Dortmund in Germany, Athens and Heraklion in Greece, Pécs in Hungary, Rome in Italy, Zaragoza in Spain, Stockholm in Sweden).\(^11\) All participants were recruited at schools. To guarantee that the heterogeneity of social background of the population would be represented, schools were randomly selected after stratification on school zone or district. In case of the selected schools refusing to participate, a second list of substitute schools was already foreseen. Up to three classes from two grades were selected per school. A class was considered eligible if the participation rate was at least 70%. After receiving complete information about the aims and methods of the study, all adolescents and their parents or guardians signed fully informed written consent. The reliability and validity study were performed following the ethical guidelines of the Declaration of Helsinki 1961 (revision of Edinburgh 2000), and approved by the Ethics Committee of every study centre. Description of ethical issues and good clinical practice within the HELENA CSS has been published elsewhere.\(^12\)

HELENA screen time-based sedentary behaviour questionnaire

We designed the HELENA sedentary behaviours questionnaire based on a previous study conducted in Spain,\(^13\) yet it was substantially improved with more behaviours and more options on the time engaged in each behaviour. In the classroom, researchers briefly explained the aim of the questionnaire and supported adolescents with all the unclear questions. Teachers were allowed to stay in the classroom during the study. Adolescents had to report their habitual time devoted to several sedentary behaviours during both week and weekend days: (i) TV viewing, (ii) computer games, (iii) console (video) games, (iv) Internet for non-study reasons (hobbies), (v) Internet for study reasons and (vi) study time (out of scholar schedule), e.g. during weekdays: how many hours do you usually watch TV? Adolescents had to tick one of the following categories: (i) 0 min, (ii) >0–30 min, (iii) >30–60 min, (iv) >60–120 min, (v) >120–180 min, (vi) >180–240 min and (vii) >240 min. We estimated the sedentary minutes per day as follows: category 1 = 0 min, 2 = 15 min, 3 = 45 min, 4 = 90 min, 5 = 150 min, 6 = 210 min and 7 = 241 min, respectively. Weekly time was calculated taking the mean time in the selected category and applying this formula: \(\left[\text{weekdays} \times 5 + (\text{weekend} \times 2)\right]/7\). Moreover, a total sedentary score was obtained by summing up the time reported in each category. Adolescents completed the sedentary behaviour questionnaire the day that the accelerometer was returned (see below). The questionnaire is explained in additional files (Supplementary data).

Objectively measured sedentary time

A uni-axial accelerometer (Actigraph MTI, model GT1M, Manufacturing Technology Inc., Fort Walton Beach, FL, USA) was used to measure sedentary time. Adolescents were instructed to place the monitor underneath the clothing, at the lower back, using an elastic waist band and wear it for seven consecutive days. They were also instructed to wear the accelerometer during all time awake and only to remove it during water-based activities. We excluded from the analysis bouts of 20 continuous minutes of 0 activity intensity counts, considering these periods as non-wearing time. Monitor wearing time was calculated by subtracting non-wear time from the total registered time for the day. At least 3 days of recording,\(^14\) with a minimum of 8 h registration per day was set as an inclusion criterion. The time sampling interval was set at 15 s. Sedentary time was defined as <100 counts per minute (c.p.m.).\(^14\) Sedentary time was expressed amount of time accumulated below 100 c.p.m. during periods when the accelerometer was worn, expressed as a proportion of monitor-wearing time (percent).

Statistical analysis

Reliability study

We assessed the test–retest reliability of the HELENA screen time-based sedentary behaviour questionnaire using the weighted Cohen’s χ-coefficients (quadratic). The strength of agreement for the χ-values.
was interpreted as follows: 0–0.20, slight; 0.21–0.40, fair; 0.41–0.60, moderate; 0.61–0.80, substantial; and 0.81–1.00, almost perfect.\textsuperscript{15}

Validity study

H-Kruskal–Wallis test was used to compare objectively measured sedentary time by groups (tertiles) of self-reported sedentary behaviour time. We performed the analyses by different sedentary behaviours, i.e. TV, computer games, video games, Internet for study and non-study reasons and study time (out of scholar schedule), and by using a composite sedentary score. For all statistical tests, a $P \leq 0.05$ was considered to be statistically significant. Statistical procedures were performed by using SPSS software, version 16.0 (SPSS, Chicago, IL, USA) and STATA software, version 10.0.

Results

Reliability study

Table 1 shows descriptive values and the weighted Cohen’s $ \kappa $ reliability coefficients for each sedentary category, by day of the week (weekdays and weekends). For the majority of sedentary behaviours, $ \kappa $-values showed a moderate, substantial or almost perfect agreement, except for Internet for study reasons that resulted in fair (weekend) or moderate (weekdays) agreement. $ \kappa $-values were lower during weekend days, except for study time.

Validity study

Table 2 shows the median percentage of objectively measured sedentary time by tertiles of TV time, computer games, videogames, Internet for study and non-study reasons and study time, and the composite sedentary score by day of the week (week and weekend days). In adolescent boys, the median percentage of objectively measured sedentary time was significantly different across tertiles of the majority of self-reported sedentary behaviours, except for TV viewing and console games. Moreover, the two composite sedentary scores (during week or weekend days) were useful to rank the adolescents’ inactivity according to their observed objectively measured sedentary time. In contrast, in adolescent girls, median percentage of objectively measured sedentary time was similar (non-significant) across tertiles of time spent in sedentary behaviours, except for Internet for non-study reasons and time studying (both $ P < 0.05 $). Likewise, median percentage of objectively measured sedentary time was not different across tertiles of the composite sedentary score regardless of the week or weekend day.

Discussion

In the present study, we investigated the reliability of the HELENA screen time-based sedentary behaviour questionnaire. Overall, it showed a good to excellent reliability. We observed that sedentary behaviours were less reliable at weekend (especially surfing Internet for study), which is in agreement with Hardy \textit{et al.}\textsuperscript{16} study where lower intra-class correlation coefficients of screen recreation activities during weekend days was found. Several reasons may explain the poorer reliability found when surfing the Internet for study: (i) this behaviour depends upon other external factors such as the academic chores; and/or (ii) adolescents are not able to estimate accurately when they are studying by the web because this activity is short and sporadic.

### Table 1 Test–retest values of sedentary behaviours and weighted Cohen’s $ \kappa $ reliability coefficients (n = 183)

<table>
<thead>
<tr>
<th>Sedentary behaviour</th>
<th>Weekdays</th>
<th></th>
<th></th>
<th>Weekend</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test</td>
<td>Retest</td>
<td>$ \kappa $</td>
<td>Test</td>
<td>Retest</td>
<td>$ \kappa $</td>
</tr>
<tr>
<td>Television viewing</td>
<td>77.6 ± 52.65</td>
<td>80.1 ± 52.8</td>
<td>0.71</td>
<td>127 ± 56.9</td>
<td>133.3 ± 62</td>
<td>0.68</td>
</tr>
<tr>
<td>Computer games</td>
<td>23.9 ± 45</td>
<td>21.7 ± 43.4</td>
<td>0.82</td>
<td>53.9 ± 71.5</td>
<td>42.8 ± 60</td>
<td>0.79</td>
</tr>
<tr>
<td>Console games</td>
<td>9.4 ± 26.5</td>
<td>10 ± 25.7</td>
<td>0.82</td>
<td>32.1 ± 56.3</td>
<td>26.7 ± 45.2</td>
<td>0.81</td>
</tr>
<tr>
<td>Internet non-study</td>
<td>53.5 ± 52</td>
<td>52.3 ± 49.3</td>
<td>0.86</td>
<td>99.2 ± 70.2</td>
<td>98 ± 68</td>
<td>0.71</td>
</tr>
<tr>
<td>Internet for study</td>
<td>25.6 ± 25.8</td>
<td>27.3 ± 27.2</td>
<td>0.46</td>
<td>32.6 ± 38.5</td>
<td>36.2 ± 41.4</td>
<td>0.33</td>
</tr>
<tr>
<td>Study</td>
<td>82.6 ± 58.4</td>
<td>88.6 ± 55.4</td>
<td>0.73</td>
<td>102.2 ± 72.5</td>
<td>101.7 ± 67.5</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Values are minutes per day, mean ± SD.

### Table 2 Sedentary time (as percentage of total registered) according to tertiles of sedentary behaviours (n = 2048)

<table>
<thead>
<tr>
<th>Sedentary behaviour</th>
<th>Tertile 1</th>
<th>Tertile 2</th>
<th>Tertile 3</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Girls (n = 1212)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TV viewing</td>
<td>82.3 (79.9–85.2)</td>
<td>82.8 (80.5–85.9)</td>
<td>82.8 (79.9–85.9)</td>
<td></td>
</tr>
<tr>
<td>Computer games</td>
<td>82.5 (80.3–85.1)</td>
<td>82.6 (79.9–85.7)</td>
<td>83.1 (80.8–85.9)</td>
<td>1–2</td>
</tr>
<tr>
<td>Console games</td>
<td>82.4 (80.3–85.7)</td>
<td>82.8 (80.5–85.4)</td>
<td>81.7 (79.6–85.2)</td>
<td></td>
</tr>
<tr>
<td>Internet non-study</td>
<td>82.8 (80.3–85.9)</td>
<td>82.5 (80.2–85.2)</td>
<td>82.6 (80.2–85.6)</td>
<td></td>
</tr>
<tr>
<td>Internet for study</td>
<td>82.5 (79.8–85.7)</td>
<td>82.9 (80.5–85.7)</td>
<td>82.7 (80.3–85.8)</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>82.4 (80.0–85.1)</td>
<td>82.7 (80.0–85.7)</td>
<td>83.1 (80.8–86.1)</td>
<td>1–3</td>
</tr>
<tr>
<td>Total SED_weekdays</td>
<td>82.4 (80.0–85.1)</td>
<td>82.7 (80.3–85.6)</td>
<td>83.0 (80.5–85.9)</td>
<td></td>
</tr>
<tr>
<td>Total SED_weekend</td>
<td>82.3 (79.9–85.1)</td>
<td>82.9 (80.3–85.3)</td>
<td>83.2 (80.1–86.1)</td>
<td></td>
</tr>
<tr>
<td><strong>Boys (n = 836)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TV viewing</td>
<td>80.1 (76.6–83.8)</td>
<td>80.7 (77.3–84.5)</td>
<td>80.0 (76.4–84.4)</td>
<td></td>
</tr>
<tr>
<td>Computer games</td>
<td>79.7 (76.2–83.6)</td>
<td>79.8 (77.0–83.6)</td>
<td>81.1 (77.6–85.2)</td>
<td>1–3; 2–3</td>
</tr>
<tr>
<td>Console games</td>
<td>80.6 (77.9–84.6)</td>
<td>80.1 (77.2–83.8)</td>
<td>80.0 (77.6–84.1)</td>
<td></td>
</tr>
<tr>
<td>Internet non-study</td>
<td>79.6 (76.0–83.5)</td>
<td>80.5 (77.6–84.5)</td>
<td>81.0 (77.9–84.6)</td>
<td>1–3</td>
</tr>
<tr>
<td>Internet for study</td>
<td>79.3 (75.7–83.7)</td>
<td>81.1 (78.2–84.8)</td>
<td>80.6 (77.3–84.5)</td>
<td>1–2; 1–3</td>
</tr>
<tr>
<td>Study</td>
<td>79.6 (76.2–83.8)</td>
<td>80.3 (77.0–84.0)</td>
<td>81.2 (78.2–84.7)</td>
<td>2–3; 1–3</td>
</tr>
<tr>
<td>Total SED_weekdays</td>
<td>79.9 (76.8–83.4)</td>
<td>80.8 (77.3–84.9)</td>
<td>80.7 (77.4–84.6)</td>
<td>1–2; 1–3</td>
</tr>
<tr>
<td>Total SED_weekend</td>
<td>79.5 (76.8–83.1)</td>
<td>81.1 (77.9–85.0)</td>
<td>81.0 (78.1–84.6)</td>
<td>1–2; 1–3</td>
</tr>
</tbody>
</table>

Values are median (25th–75th percentile); TotalSED = total sedentary time summing the six sedentary behaviours. In bold, values with statistically significant differences: 1–2: $ P \leq 0.05 $ between tertile 1 and tertile 2; 2–3: $ P \leq 0.05 $ between tertile 2 and tertile 3; 1–3: $ P \leq 0.05 $ between tertile 1 and tertile 3.
Sedentary behaviours are those daily behaviours that produce a low energy expenditure (lower than 1.5 metabolic equivalents (METs), 1 MET = 1.5 ml kg⁻¹ min⁻¹). Because direct observation is time consuming, self- or proxy-reported sedentary behaviours represent the most feasible approach for conducting population studies. Yet diaries may also be valid; they are intrusive. To illustrate this point, we initially included them in the methodology of the current study but a low compliance rate was observed. Therefore, diaries were excluded from the final analysis. Nowadays, accelerometers provide an objective measurement of physical activity in a full range of intensities. Although they have some technological limitations (e.g. our accelerometer model did not allow to record water-based physical activity), they provide an accurate information of the cumulative time spent each day sedentarily.

Another aim was to examine whether the HELENA screen time-based sedentary behaviour questionnaire was able to rank the adolescents’ objectively measured sedentary time. In adolescent girls, only one out of the six sedentary behaviours (study) was directly associated with their objectively measured sedentary time, whereas in boys, the majority of them showed association. The authors could only make speculations on possible reasons attributed to observed gender differences. It is possible that the HELENA sedentary behaviour questionnaire has captured with more accuracy sedentary time in boys because it is a screen time-based sedentary behaviour questionnaire. In support of this, the main sedentary behaviours reported by Scottish boys were homework, playing computer/video games and motorized transport, and for girls it was homework, motorized transport and sitting and talking. Furthermore, in one sample with teenage girls predominance (923 from a total 1484), TV viewing was not a good marker of sedentariness, representing only between 32% and 56% of the total time. It could be hypothesized that sedentary behaviour questionnaires with more categories of sedentary activities (such as reading magazines, listening to music, sitting and talking) may offer a better picture of the sedentary lifestyle in adolescent girls. Nonetheless, in adult women opposite results have been reported. TV viewing was positively associated with time spent on other sedentary behaviours and negatively with leisure-time physical activity. Another possibility could be that accelerometers may have produced more reactivity in girls compared with boys, do not reflecting the habitual sedentary activity level in the former. That is, sedentary girls (but not boys) may have decreased their habitual high levels of inactivity during the observation period. This should be investigated in future studies. In comparison with previous investigations, we found higher percentages of the recorded time as sedentary (~80%). Matthews et al. using data from the 2003–04 National Health and Nutrition Examination Survey found that children and adults in the USA spent 54.9% of their waking time, or 7.7 h/day, in sedentary behaviours. The use of different methods may explain the observed differences between studies (accelerometer model, minimum days wearing accelerometers or the employed criteria to define wearing time). Thus, researchers should adopt similar methodological procedures in future epidemiological studies.

Implications

Studies have traditionally reported the prevalence of screen time behaviours (TV viewing). However, the findings of current study indicate that time spent watching TV or playing videogames are not surrogates of total sedentary time. Consequently, sedentary behaviour questionnaires should include both screen time and non-screen time sedentary behaviours to capture a complete picture of adolescents’ sedentary time.

Conclusions

The HELENA screen time-based sedentary behaviour questionnaire seems reliable to be used in adolescents. However, screen time-based sedentary questionnaires reflect better the sedentary behaviour of boys compared with girls. These results should not prevent the use of sedentary behaviour questionnaires in epidemiological studies with young people, but efforts should be done to optimize them in the future, especially when female adolescents are recruited.

Supplementary data

Supplementary data are available at Eurpub online.

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Conflicts of interest: None declared.
Key points

- Screen time-based sedentary behaviours questionnaires are reliable to be used in epidemiological studies with adolescents.
- Our results show that screen time-based sedentary behaviours questionnaires are good markers for ranking objectively measured sedentary time among boys. However, they are not surrogates of total sedentary behaviour in girls.
- Questionnaires used to study sedentary behaviours in young people should include other types of sedentary activities (non-exclusively based on screen time) in order to improve their ability to correctly classify the most sedentary subjects.

References


Appendix 1: HELENA Study Group