



Associations between perceived social and physical environmental variables and physical activity and screen time among adolescents in four European countries

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1 **Abstract**

2 **Objectives**

3 Associations between the perceived social and physical environment and self-
4 reported moderate-to-vigorous physical activity (MVPA) and screen time (ST) were
5 examined among adolescents in four European countries.

6 **Methods**

7 Representative samples were surveyed with standardised methodologies.
8 Associations between environmental variables and meeting MVPA recommendations
9 and tertiles of ST were tested in gender-specific logistic regression models.
10 Moderation by country and country-specific relationships were also examined.

11 **Results**

12 The most consistent findings across countries were found for the significant
13 associations between neighbourhood social environment and MVPA in both boys
14 and girls. Significant associations with the physical environment varied more between
15 countries and by gender. The most consistent negative associations with ST were
16 with found for the social environmental variable of having parental rules for spending
17 time outside the home.

18 **Conclusions**

19 The present findings provided evidence for the generalisability of the associations
20 between environmental correlates and MVPA across four European countries. The
21 findings show clear differences in correlates for MVPA and ST. Further research is
22 needed to better understand the unique aspects of the social and physical
23 environment which explain each of the two behaviours.

24 **Introduction**

25 Moderate-to-vigorous intensity physical activity (MVPA) is positively associated with
26 better health in youth (Poitras et al. 2016), but MVPA levels are low in most
27 developed countries. For example, recent data from 32 mainly European countries
28 suggest that only 23% of boys and 14% of girls meet the current guideline of at least
29 60 minutes MVPA per day. (Kalman et al. 2015). Furthermore, evidence indicates
30 that sedentary behaviour - especially screen time (ST) - is linked to various adverse
31 health-related outcomes. These associations are largely independent of MVPA levels
32 (Carson et al. 2016). Although the prevalence of ST in industrialised countries is
33 already high (Verloigne et al. 2016), marked increases in ST among youth from 2002
34 to 2010 have recently been reported with an increase of 2.16 hours per weekday in
35 15-year-old boys and of 2.11 in 15-years-old girls (Bucksch et al. 2016).

36 Social ecological models emphasise that lifestyle behaviours, such as physical
37 activity, are influenced by wider societal and environmental factors as well as
38 individual level factors (Sallis et al. 2008). However, evidence on environmental
39 correlates of MVPA and ST among youth are inconsistent (Chastin et al. 2016; Ding
40 et al. 2011; Stierlin et al. 2015). With regard to ST in particular, most studies to date
41 have focused on demographic and behavioural variables (Chastin et al. 2016; Stierlin
42 et al. 2015). Findings indicate social and physical environmental variables, such as
43 having rules for restricting TV use (Bjelland et al. 2015) or a physical activity friendly
44 neighborhood, are associated with lower ST (Veitch et al. 2011). In terms of MVPA,
45 physical environmental features, such as neighborhood walkability and access or
46 proximity to recreation facilities have the most robust associations (Ding et al. 2011).
47 In addition the social environment seems to play an important role for youth MVPA
48 and ST by providing social networks and social support for healthy behaviors

49 (Macdonald-Wallis et al. 2012; Sawka et al. 2013; Stierlin et al. 2015). Furthermore
50 several studies have shown that the physical activity of friends is connected to higher
51 MVPA and lower screen time (Garcia et al. 2017; Sirard et al. 2013).

52 Interestingly most evidence on social and physical environmental correlates of MVPA
53 and ST is from individual countries outside of Europe (Ding et al. 2011; Ferreira et al.
54 2007; Stierlin et al. 2015) or from pooled cross-national data (Kopcakova et al. 2017).
55 Therefore more generalisable findings from cross-national studies sharing the same
56 methodological approach are limited (Ding et al. 2013; Kerr et al. 2013). Especially in
57 youth, cross-national data are scarce. Recently, The International Study of Childhood
58 Obesity, Lifestyle and the Environment examined correlates of total sedentary time
59 and ST across 12 countries and did not find significant associations with
60 neighborhood environmental variables, but spending more time outside was
61 significantly correlated with reduced overall sitting and ST (Leblanc et al. 2015).

62 Therefore, the purpose of this study was to examine the associations between
63 perceived social and physical environment and MVPA as well as ST among
64 adolescents in four European countries participating in the Health Behaviour in
65 School-aged Children (HBSC) study: Czech Republic, Germany, Poland and
66 Slovakia.

67

68 **Methods**

69 The HBSC study is a World Health Organization collaborative cross-national study
70 conducted in countries across Europe and North America. All participating countries
71 have to use a a standardised mandatory questionnaire assessing a broad range of
72 self-reported health behaviours and health outcomes, as well as social contextual

73 factors. In addition, countries may include additional items (optional packages) to
74 provide more in-depth knowledge about certain topics (e.g. active travel, physical
75 activity motivation, snacking behaviour). To ensure cross-national comparability, the
76 mandatory and optional items are standardised and have been back-translated in
77 each language of participating countries. Data are collected every four years from a
78 nationally representative random cluster sample of 11-, 13- and 15-year-old
79 adolescents within each participating country. The primary sampling units are schools
80 and classes. This paper presents data from the 2014 survey conducted in the Czech
81 Republic, Germany, Poland and Slovakia on MVPA and ST (TV viewing, computer
82 use for gaming and non-gaming purposes) as well as an optional package about
83 physical activity-related perceptions of social and physical environment (Currie et al.
84 2014).

85

86 **Sample**

87 A total of 18,781 (Czech Republic: n=5082 [52.4% girls], Germany: n=5961 [49.0%
88 girls], Poland: n=4545 [50.2% girls], Slovakia: n=3193 [50.5% girls]) students were
89 recruited. Surveys were administered by the class teachers or trained interviewers,
90 participation was voluntary, with anonymity and confidentiality of the participants
91 ensured. Response rates were 89.2% in Czech Republic, 72.5% in Germany, 86.1%
92 in Poland and 78.8% in Slovakia.

93

94 **Survey items**

95 **Moderate-to-vigorous intensity physical activity**

96 MVPA was assessed by asking: “On how many days in the past week were you
97 physically active for 60 minutes or more”. MVPA was defined as “any activity that
98 increases your heart rate and makes you get out of breath some of the time” with
99 examples of such activities. Response categories were: “0 days” to “7 days”. The
100 original version of this MVPA question asked one item about physically active days in
101 a typical week and one item about the last seven days and has moderate validity
102 when assessed against accelerometry data ($.40 \leq r \leq .49$) (Prochaska et al. 2001;
103 Ridgers et al. 2012). In our study we used only the item about last seven days as
104 both items are highly correlated (Currie et al. 2014). This item has an acceptable test-
105 retest reliability ($.60 \leq ICC \leq .82$) (Bobakova et al. 2015; Liu et al. 2010; Prochaska et
106 al. 2001).

107 MVPA was dichotomised as meeting current guidelines (Janssen and Leblanc 2010)
108 for adolescents responding that they were active for at least 60 minutes on each of
109 the last seven days and not meeting guidelines was < 60 minutes per day over the
110 last seven days.

111

112 **Screen time**

113 ST was assessed by asking about TV viewing and computer use during leisure time
114 for gaming and non-gaming purposes on weekdays. These items previously showed
115 acceptable test-retest reliability ($.57 \leq ICC \leq .80$) across three countries (Bobakova et
116 al. 2015).

117 TV viewing during leisure time was assessed by asking “About how many hours a
118 day do you usually watch television (including DVDs and videos) in your free time?” .

119 Computer use for gaming purposes was measured by asking “How many hours a
120 day, *in your free time*, do you usually spend playing games on a computer, games

121 console, tablet (like iPad), smartphone or other electronic device (**not** including
122 moving or fitness games)?”. A second item for computer use was phrased “How
123 many hours a day, *in your free time*, do you usually spend using electronic devices
124 such computers, tablets (like iPad) or smart phones for other purposes, for example,
125 homework, emailing, tweeting, facebook, chatting, surfing the internet?” and
126 represents the non-gaming part of computer use. As not all countries asked about
127 weekend days, we only use the data for the question about weekdays. Response
128 options ranged from “none at all” to more than 7 hours/day for all three questions.
129 Responses were recoded as a continuous variable as follows: “none at all” = 0,
130 “about half an hour a day” = 0.5, “about 1 hour a day” = 1, “about 2 hours a day” = 2
131 etc. and “about 7 or more hours a day” = 7.5. To represent overall ST, we summed
132 up the hours per day reported for each of the three ST behaviours. Since the
133 distribution of overall ST was skewed, we computed tertiles for the whole sample to
134 analyse low (< 3.5 hours per school day), middle (3.5 to 7 hours per school day) and
135 high (>7 hours per school day) ST.

136

137 **Perceived social and physical environment**

138 Seven items measuring aspects of the perceived social and physical environment
139 were included as independent variables. These were phrased as follows: “It is safe to
140 walk or play alone in my neighbourhood during the day”; “There are other children
141 nearby home to go out and play with.”; “There is somewhere at home I can go out
142 and play.”; “There are playgrounds or parks close to my home where I can play.”; “At
143 school there are playgrounds or fields where I can run around.”; “I always have to tell
144 my parents where I am when I go out.” and “If I am going out I always have to be
145 back by a certain time.” For each item, a 3-item response scale was used (definite

146 agreement, definite disagreement or undecided). According to the list above the
147 items cover four distinct domains - safety [1 item], social with respect to home and
148 neighbourhood [2], built environment [2] and social with respect to parental rules [2] –
149 and were previously cross-nationally validated in terms of factorial and construct
150 validity (Ommundsen et al. 2008). For the purposes of the current analysis,
151 associations were examined for each item separately since each one represents a
152 unique and discrete aspect of the social and physical environment. Accordingly,
153 social and physical environmental variables were dichotomised by collapsing
154 disagreement and undecided responses (referent) compared to agreement. As we
155 are using variables about the perceived environment, we decided that only an
156 agreement can be interpreted as a positive perception that should be compared with
157 undecided/disagreement.

158

159 **Covariates**

160 We controlled for age and family affluence in analyses. Since the sampling was
161 based on three specific age groups, age was treated as a three-stage categorical
162 variable. The family affluence scale (FAS) provides a measure of household material
163 affluence among adolescents and has previously been shown to be valid. Four items
164 were included in the FAS: number of computers, car ownership, family holidays in the
165 past year, and having one's own bedroom (Boyce et al. 2006). Responses were
166 summed to a composite score and treated as a continuous variable ranging from 0-7,
167 with higher scores representing higher family affluence.

168

169 **Data analysis**

170 Analyses were conducted with SPSS v21, using the complex samples module to
171 account for the clustered study design with “school class” as the primary sampling
172 unit. Descriptive data for gender, MVPA, ST, each social and physical environmental
173 variable, age group and FAS are presented as numbers and percentages overall and
174 for each country. Logistic regression was used to examine the association between
175 each social and physical environmental variable and meeting recommendations for
176 MVPA. In addition, multinomial logistic regression was used to examine the
177 association between each environmental variable and tertiles of ST. Odds ratios are
178 calculated with high levels of ST as the reference category. For both outcomes we
179 tested whether associations with the social and physical environment varied by
180 country by including interaction terms into each model. If the interaction was
181 significant, we present only country specific results. In the case of non-significant
182 interactions, we also present an overall odds ratio for all 4 countries combined. We
183 display the odds ratios and 95-% confidence intervals for country with forest plots. All
184 models adjusted for age and family affluence. Results are presented separately for
185 boys and girls, since prevalence of MVPA/ST and their correlates differs by gender
186 (Atkin et al. 2014; Stierlin et al. 2015). The level of significance was set at 0.05.

187

188 **Results**

189 Table 1 presents the overall and country-specific characteristics of participants. The
190 prevalence of meeting the MVPA recommendation ranged from 15.6% in Germany to
191 32.9% in Slovakia. Across the four countries, the proportion of youth classified as
192 engaging in a high level of ST ranged from 26.4% in Slovakia to 37.8% in Germany.
193 Aspects of the social and physical environment were generally perceived positively
194 with the lowest agreement for parental rules.

195 In Figure 1, the association between each social and physical environmental variable
196 and meeting MVPA guidelines is shown with forest plots, stratified by gender. While
197 associations varied across countries and between boys and girls within countries, the
198 direction of effects was similar. Furthermore no significant interaction between
199 country and environmental correlates was observed. Within the total sample,
200 significant positive associations with meeting MVPA recommendation were found for
201 the two neighborhood-related social environmental variables (i.e. other children
202 nearby or at home to play with) as well as with having playgrounds and parks near
203 home in boys (OR=1.24; 95%-CI: 1.10-1.40) and girls (OR=1.17; 95%-CI: 1.03-1.34).
204 Having school yards to run around was only associated with meeting the MVPA
205 recommendation among girls (OR=1.22; 95%-CI: 1.06-1.41). No significant
206 association was found for safety of walking and parental rules (i.e. tell parents when I
207 go out and being back at a certain time).

208 In Figures 2 and 3, the findings are presented for ST in boys and girls, respectively.
209 Since all interactions between country and environmental correlates with ST in each
210 gender group were statistically significant, only country specific results are shown.
211 Odds ratios greater than 1 indicate less ST.

212 Across countries the most consistent significant associations with low and medium
213 ST were found for the two parental rules variables. Associations between ST and
214 other environmental variables, showed different patterns by country and gender.

215 Taken gender and country more specifically into account, we observed except for
216 girls in Germany and boys in Slovakia non-significant associations for one item of the
217 parental rules the item (i.e. being back home by a certain time). Furthermore, having
218 someone at home to play with as well as having places at school to play and run
219 around showed significant associations in German girls and in case of having

220 someone at home also in Czech girls. In boys, both social items are related with ST
221 in Germany, where those having other children to play with were significantly more
222 likely to report low or medium ST. Concerning the perceived neighborhood safety we
223 found an association with lower levels of ST among German girls. In boys this
224 association was observed in all countries except Poland.

225

226 **Discussion**

227 The most consistent findings across four European countries were found for the
228 associations between neighbourhood-related social environment and MVPA in both
229 boys and girls. Some significant associations with the physical environment were also
230 observed in the whole sample but varied more between countries. Additionally, our
231 study gives more insights into the connection between the social and physical
232 environment and ST. In contrast with MVPA, the most consistent associations with
233 lower ST were with social aspects of having rules for going outside and coming back
234 at a certain time, indicating that correlates might be behaviour specific. Other
235 associations varied more widely between countries and might therefore be more
236 dependent on social and cultural conditions within each country.

237 *Physical activity*

238 The consistent findings on neighbourhood related social environmental correlates
239 and MVPA in our study highlights the importance of having others at home or nearby
240 for children to play with and be active. Other studies confirm this finding (Ferreira et
241 al. 2007; Ommundsen et al. 2006). Interpersonal relationships are one important
242 dimension of the social environment that are able to shape and promote MVPA in
243 youth through social support or social networks (Macdonald-Wallis et al. 2012;

244 Sawka et al. 2013). In contrast, young people's perception of how safe it is to walk or
245 play alone in their neighbourhood was unrelated to MVPA in our study. A recent
246 review also reported equivocal findings for safety issues (Ding et al. 2011). In
247 addition, it has been shown that the perceptions of safety concerns among parents
248 are more important predictors of physical activity in their children than the children's
249 perceptions (Carver et al. 2008).

250 We also found that perceived physical environment features such as having parks or
251 playgrounds close to home or having schools with playgrounds or fields where youth
252 can play and be physically active near home were positively related to MVPA in the
253 overall sample. Another European study using the same two built environment
254 measures also observed a small but significant positive relationship with PA
255 (Ommundsen et al. 2006). Systematic reviews found that access to parks and
256 playgrounds was positively associated with physical activity in about half of the
257 studies (Davison and Lawson 2006; Ding et al. 2011). In sum, it is difficult to draw
258 firm conclusions across studies as both physical activity and neighbourhood
259 environmental characteristics are measured in different ways (subjectively or
260 objectively) and studies focus on different domains and types of physical activity.

261 Some gender differences are also apparent in our findings. For example, we
262 observed that having school grounds where fields and places for running around are
263 available may be more supportive for MVPA in girls than in boys. Some studies also
264 suggest that girls may benefit more than boys from activity-friendly environments
265 (Davison and Lawson 2006; Patnode et al. 2010). The reasons for such gender
266 differences are likely to be varied. Similar to participation in organised sports, boys
267 are generally more likely to take part in unstructured physical activity and free play
268 compared to girls (Badura et al. 2015; Patnode et al. 2010) and spend more time in

269 independent and unsupervised mobility (Schoeppe et al. 2014; Stone et al. 2014).
270 This appears to indicate that boys find ways of being active outside without the need
271 for supervised physical activity and areas where specific physical activities are
272 structured or guided.

273 While our findings reveal significant associations between the social and physical
274 environment and MVPA in the overall sample, we also observed differences in the
275 magnitude of associations across countries. However, the direction of the
276 associations in most cases were not different. Therefore it could be argued that the
277 pooled effect size (i.e., odds ratio) has a higher power and including data from
278 different countries provides a larger variability in environmental features to determine
279 the true effect size (Kerr et al. 2013). However, the overall effect size is an average
280 estimate that prevents from observing between-country differences which might be
281 important to decide about at a national level (Ding et al. 2013). Comparing countries,
282 it seems that for example in Czech Republic and Poland parks and playgrounds are
283 unrelated to MVPA.

284 *Screen time*

285 The findings for ST reveal a more complex picture that is different from MVPA
286 correlates. First, the variability in the associations with the social and physical
287 environment across countries indicated by significant interactions prevented us from
288 calculating overall odds ratios. The most consistent finding was in relation to social
289 environment with respect to parental rules. If girls and boys have to tell their parents
290 where they are when they go out and play, they are more likely to report lower ST.
291 Our items on parental rules do not relate specifically to ST. However, it could be
292 hypothesised in more general terms that families who have rules about daily life
293 activities like going out, might also use rules to restrict ST which, in turn, have been

294 shown to reduce ST behaviour (Bjelland et al. 2015). Higher levels of parental
295 monitoring may be applicable across a number of different aspects of a young
296 person's life. Comparably, one study has shown that restricting outdoor play
297 increases ST (Atkin et al. 2013). This association warrants further investigation.

298 Our data also suggest that having other children to go out and play with is not
299 important for ST,. As there is clear evidence that ST and MVPA are largely
300 independent behaviours, children and adolescents can be both physically active and
301 also find time to use screens for a high amount of time (Pearson et al. 2014).
302 Accordingly, having friends to go out and play with may not result in fewer
303 opportunities for ST; indeed it is possible that these same friends also engage in ST
304 together.

305 Our findings also reveal an association between perceiving the neighbourhood as
306 safe for walking during daytime and reduced ST in three countries for boys. In
307 contrast, perceiving the neighbourhood as safe was unrelated to MVPA in our
308 findings. It might be that those adolescents who feel their neighbourhood is unsafe
309 are less likely to spend time outdoors and consequently more likely to engage in ST.
310 A recent international study has shown that spending a lot of time outside is one of
311 the most consistent predictors of reduced ST in youth (Leblanc et al. 2015). Similarly,
312 greater independent mobility is related to reduced ST (Stone et al. 2014). In addition,
313 other studies have shown that greater independent mobility among young people is
314 associated with higher perceived safety (Schoeppe et al. 2015; Veitch et al. 2006).
315 This highlights the importance of creating safe places where young people are
316 allowed to spent time outdoors. Among girls, a significant association between
317 neighbourhood safety and ST was only observed in Germany, suggesting that safety
318 issues are less important for girls. As highlighted before, a number of studies

319 emphasise that boys are more likely to be allowed to spend time unsupervised
320 outdoors and therefore safety issues may be more relevant for boys than girls, or
321 boys may be more aware of safety concerns within their neighbourhood. This finding
322 also underlines the need to address parental safety concerns so that girls are
323 allowed to play outside more and be more independently mobile.

324 Physical environment was mainly unrelated with ST in our study. Existing reviews
325 confirm the inconsistent association between physical neighbourhood environment
326 and ST, with the exception of living in urban areas which was related to higher ST
327 (Pate et al. 2011; Uijtdewilligen et al. 2011). However, understanding the
328 (environmental) correlates of sedentary behaviours such as ST in its infancy and
329 more studies are needed to identify the most important correlates (Stierlin et al.
330 2015).

331

332 *Strengths and limitations*

333 The main strengths of this study are the comparisons across four European countries
334 with large representative samples of youth and using a common methodological
335 approach that is essential for providing a more robust evidence base. However, some
336 limitations have to be considered when interpreting our findings. First, we present
337 cross-sectional data so that we are not able to infer causality. Second, we used self-
338 reports to assess MVPA, ST, and the social and physical environment. While most
339 items have been shown to have acceptable validity and reliability, self-reports are
340 prone to misclassification leading to biased effects. With respect to ST it has been
341 shown that at least TV viewing is overestimated compared to a diary by 1 hour per
342 day in boys and 20 minutes per day in girls (Vereecken et al. 2006). However, self-

343 reports of ST are limited in terms of quantifying valid estimates (Atkin et al. 2012).
344 Therefore we decided to use tertiles to rank adolescents as low, medium and high
345 users of ST. This approach seems to be acceptable as it attenuates bias.
346 Furthermore, we only used weekday patterns of ST as not in all countries data for
347 weekend day. While ST patterns differ between weekdays and weekend days
348 (Bucksch et al. 2012) our findings are limited only to weekdays. Third, since we
349 focused on perceived social and physical environmental correlates, it is possible that
350 active adolescents are more aware of these features and may therefore be more
351 likely to report about them. Lastly, we only adjusted for individual variables and may
352 therefore have missed potential country-level confounders such as economic factors,
353 social norms or climate.

354

355 *Conclusion*

356 Our study is among the first to present European cross-national data on the
357 associations between the social and physical environment and both MVPA and ST in
358 youth with a standardised methodological approach. The findings provided evidence
359 for the generalisability of the associations between the social and physical
360 environment and PA. The findings show clear differences in correlates of MVPA and
361 ST. Further research is therefore needed to better understand the unique aspects of
362 the social and physical environment which could explain each of the two behaviours,
363 independently. Future studies should also use objectively georeferenced features of
364 the environment in addition to perceived measures to gain more insights into the
365 relationships with MVPA and ST. Future studies will also increase explanatory power
366 by using objective measures to capture MVPA and ST levels. More international
367 studies with a broader variety of countries are needed to confirm the generalisability

368 of findings found herein. It is clear that in accordance with a socio-ecological
369 approach both the social and physical environment are associated with young
370 people`s physical activity and sedentary behaviour. Therefore interventions to
371 promote physical activity and reduce sedentary behaviour must target multiple
372 societal levels and should also take gender differences into account.

373 **Competing interests/ethical standards**

374 The authors declare that they have no competing interests and study was in
375 compliance with ethical standards.

376

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