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

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Abstract

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

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

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

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

Keywords Screen time · Physical activity · Social and physical environment · European countries · Health Behaviour in School-aged Children (HBSC) study

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Introduction

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

Social ecological models emphasise that lifestyle behaviours, such as physical activity, are influenced by wider societal and environmental factors as well as individual level factors (Sallis et al. 2008). However, evidence on environmental correlates of MVPA and ST among youth is inconsistent (Chastin et al. 2016; Ding et al. 2011; Stierlin et al. 2015). With regard to ST in particular, most studies to date have focused on demographic and behavioural variables (Chastin et al. 2016; Stierlin et al. 2015). Findings indicate social and physical environmental variables, such as having rules for restricting TV use (Bjelland et al. 2015) or a physical activity-friendly neighbourhood, are associated with lower ST (Veitch et al. 2011). In terms of MVPA, physical environmental features, such as neighbourhood walkability and access or proximity to recreation facilities have the most robust associations (Ding et al. 2011). In addition, the social environment seems to play an important role for youth MVPA and ST by providing social networks and social support for healthy behaviours (Macdonald-Wallis et al. 2012; Sawka et al. 2013; Stierlin et al. 2015). Furthermore, several studies have shown that the physical activity of friends is connected to higher MVPA and lower screen time (Garcia et al. 2017; Sirard et al. 2013).

Interestingly most evidence on social and physical environmental correlates of MVPA and ST is from individual countries outside of Europe (Ding et al. 2011; Ferreira et al. 2007; Stierlin et al. 2015) or from pooled cross-national data (Kopcakova et al. 2017). Therefore, more generalisable findings from cross-national studies sharing the same methodological approach are limited (Ding et al. 2013; Kerr et al. 2013). Especially in youth, cross-national data are scarce. Recently, The International Study of Childhood Obesity, Lifestyle and the Environment

examined correlates of total sedentary time and ST across 12 countries and did not find significant associations with neighbourhood environmental variables, but spending more time outside was significantly correlated with reduced overall sitting and ST (Leblanc et al. 2015).

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

Methods

The HBSC study is a World Health Organization collaborative cross-national study conducted in countries across Europe and North America. All participating countries have to use a standardised mandatory questionnaire assessing a broad range of self-reported health behaviours and health outcomes, as well as social contextual factors. In addition, countries may include additional items (optional packages) to provide more in-depth knowledge about certain topics (e.g. active travel, physical activity motivation, snacking behaviour). To ensure cross-national comparability, the mandatory and optional items are standardised and have been back-translated in each language of participating countries. Data are collected every four years from a nationally representative random cluster sample of 11-, 13- and 15-year-old adolescents within each participating country. The primary sampling units are schools and classes. This paper presents data from the 2014 survey conducted in the Czech Republic, Germany, Poland and Slovakia on MVPA and ST (TV viewing, computer use for gaming and non-gaming purposes) as well as an optional package about physical activity-related perceptions of social and physical environment (Currie et al. 2014).

Sample

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

Survey items

Moderate-to-vigorous intensity physical activity

MVPA was assessed by asking: "On how many days in the past week were you physically active for 60 min or more". MVPA was defined as "any activity that increases your heart rate and makes you get out of breath some of the time" with examples of such activities. Response categories were: "0 days" to "7 days". The original version of this MVPA question asked one item about physically active days in a typical week and one item about the last 7 days and has moderate validity when assessed against accelerometry data ($0.40 \leq r \leq 0.49$) (Prochaska et al. 2001; Ridgers et al. 2012). In our study, we used only the item about last 7 days as both items are highly correlated (Currie et al. 2014). This item has an acceptable test–retest reliability ($0.60 \leq ICC \leq 0.82$) (Bobakova et al. 2015; Liu et al. 2010; Prochaska et al. 2001).

MVPA was dichotomised as meeting current guidelines (Janssen and Leblanc 2010) for adolescents responding that they were active for at least 60 min on each of the last 7 days and not meeting guidelines was < 60 min per day over the last 7 days.

Screen time

ST was assessed by asking about TV viewing and computer use during leisure time for gaming and non-gaming purposes on weekdays. These items previously showed acceptable test–retest reliability ($0.57 \leq ICC \leq 0.80$) across three countries (Bobakova et al. 2015).

TV viewing during leisure time was assessed by asking "About how many hours a day do you usually watch television (including DVDs and videos) in your free time?". Computer use for gaming purposes was measured by asking "How many hours a day, *in your free time*, do you usually spend playing games on a computer, games console, tablet (like iPad), smartphone or other electronic device (**not** including moving or fitness games)?". A second item for computer use was phrased "How many hours a day, *in your free time*, do you usually spend using electronic devices such computers, tablets (like iPad) or smart phones for other purposes, for example, homework, emailing, tweeting, facebook, chatting, surfing the internet?" and represents the non-gaming part of computer use. As not all countries asked about weekend days, we only use the data for the question about weekdays. Response options ranged from "none at all" to more than 7 h/day for all three questions. Responses were recoded as a continuous variable as follows: "none at all" = 0, "about half an hour a day" = 0.5, "about 1 h a day" = 1, "about 2 h a day" = 2

etc. and "about 7 or more hours a day" = 7.5. To represent overall ST, we summed up the hours per day reported for each of the three ST behaviours. Since the distribution of overall ST was skewed, we computed tertiles for the whole sample to analyse low (< 3.5 h per school day), middle (3.5 to 7 h per school day) and high (> 7 h per school day) ST.

Perceived social and physical environment

Seven items measuring aspects of the perceived social and physical environment were included as independent variables. These were phrased as follows: "It is safe to walk or play alone in my neighbourhood during the day"; "There are other children nearby home to go out and play with."; "There is somewhere at home I can go out and play."; "There are playgrounds or parks close to my home where I can play."; "At school there are playgrounds or fields where I can run around."; "I always have to tell my parents where I am when I go out." and "If I am going out I always have to be back by a certain time." For each item, a 3-item response scale was used (definite agreement, definite disagreement or undecided). According to the list above the items cover four distinct domains—safety [1 item], social with respect to home and neighbourhood [2], built environment [2] and social with respect to parental rules [2]—and were previously cross-nationally validated in terms of factorial and construct validity (Ommundsen et al. 2008). For the purposes of the current analysis, associations were examined for each item separately since each one represents a unique and discrete aspect of the social and physical environment. Accordingly, social and physical environmental variables were dichotomised by collapsing disagreement and undecided responses (referent) compared to agreement. As we are using variables about the perceived environment, we decided that only an agreement can be interpreted as a positive perception that should be compared with undecided/disagreement.

Covariates

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

Data analysis

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

Results

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

In Fig. 1, the association between each social and physical environmental variable and meeting MVPA guidelines is shown with forest plots, stratified by gender. While associations varied across countries and between boys and girls within countries, the direction of effects was similar. Furthermore, no significant interaction between country and environmental correlates was observed. Within the total sample, significant positive associations with meeting MVPA recommendation were found for the two neighbourhood-related social environmental variables (i.e. other children nearby or at home to play with) as well as with having playgrounds and parks near home in boys

(OR = 1.24; 95%-CI: 1.10–1.40) and girls (OR = 1.17; 95%-CI: 1.03–1.34). Having school yards to run around was only associated with meeting the MVPA recommendation among girls (OR = 1.22; 95%-CI: 1.06–1.41). No significant association was found for safety of walking and parental rules (i.e. tell parents when I go out and being back at a certain time).

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

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

Taken gender and countries more specifically into account, we observed except for girls in Germany and boys in Slovakia non-significant associations for one item of the parental rules the item (i.e. being back home by a certain time). Furthermore, having someone at home to play with as well as having places at school to play and run around showed significant associations in German girls and in case of having someone at home also in Czech girls. In boys, both social items are related with ST in Germany, where those having other children to play with were significantly more likely to report low or medium ST. Concerning the perceived neighbourhood safety we found an association with lower levels of ST among German girls. In boys this association was observed in all countries except Poland.

Discussion

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

Table 1 Demographic, behavioural, and environmental characteristics of European youth, overall and by country

	Overall	Czech Republic	Germany	Poland	Slovakia
Gender, % (n)					
Girls	50.5 (9486)	52.4 (2662)	49.0 (2926)	50.2 (2282)	50.6 (1616)
Boys	49.5 (9295)	47.6 (2420)	51.0 (3035)	49.8 (2263)	49.4 (1577)
Age, % (n)					
11	25.9 (4817)	31.1 (1574)	29.7 (1736)	33.4 (1507)	0 (0)
13	38.2 (7141)	34.0 (1721)	34.9 (2070)	33.8 (1525)	57.6 (1825)
15	35.8 (6690)	34.8 (1760)	35.4 (2104)	32.9 (1484)	42.4 (1342)
Family affluence, % (n)					
Low	15.4 (2715)	9.8 (479)	7.9 (439)	28.2 (1221)	20.5 (576)
Medium	42.2 (7488)	44.0 (2157)	36.8 (2092)	47.3 (2051)	42.3 (1188)
High	42.4 (7541)	46.2 (2268)	55.3 (3189)	24.5 (1062)	37.1 (1042)
Meeting MVPA recommendation[a], %	22.2	21.5	15.6	24.2	32.9
Screen time, %					
Low (< 3.5 h/school day)	32.3	30.7	33.4	28.6	38.9
Medium (3.5–7)	33.2	35.0	28.7	35.9	34.7
High (> 7)	34.5	34.4	37.8	35.5	26.4
Social and physical environment	Yes (%), undecided, no	Yes (%), undecided, no	Yes (%), undecided, no	Yes (%), undecided, no	Yes (%), undecided, no
Safe to walk in my neighbourhood	77.9, 17.6, 4.5	67.7, 26.0, 6.3	84.5, 13.1, 2.4	78.4, 17.2, 4.3	81.2, 13.1, 5.7
Other children nearby home to go out and play with	65.1, 19.3, 15.7	64.0, 22.4, 13.5	58.4, 25.0, 16.6	69.0, 11.9, 19.1	75.7, 9.5, 14.7
Someone at home to go out and play with	69.7, 15.7, 14.6	80.5, 13.2, 6.3	50.1, 24.9, 25.0	77.4, 9.6, 13.0	82.5, 7.7, 9.7
Playgrounds and parks near home	67.2, 14.3, 18.5	71.8, 14.8, 13.4	67.0, 19.3, 13.7	60.5, 8.0, 31.5	65.8, 9.9, 24.3
At schools there are playgrounds or fields I can run around	72.1, 18.3, 9.6	64.0, 24.5, 11.5	67.3, 23.3, 9.4	86.1, 6.2, 7.7	81.7, 9.5, 8.9
Tell my parents when I will go out	58.8, 25.7, 15.6	65.7, 21.8, 12.4	51.1, 38.4, 10.4	64.0, 13.7, 22.4	57.5, 18.3, 24.2
Always being back at a certain time	54.3, 30.1, 15.6	63.6, 25.7, 10.7	46.1, 43.1, 10.8	54.6, 20.6, 24.8	54.7, 20.9, 24.3

Data from Czech Republic, Germany, Poland and Slovakia in 2014

[a]Moderate-to-vigorous physical activity (MVPA) recommendation equals 60 min of moderate-to-vigorous physical activity (MVPA) each day per week
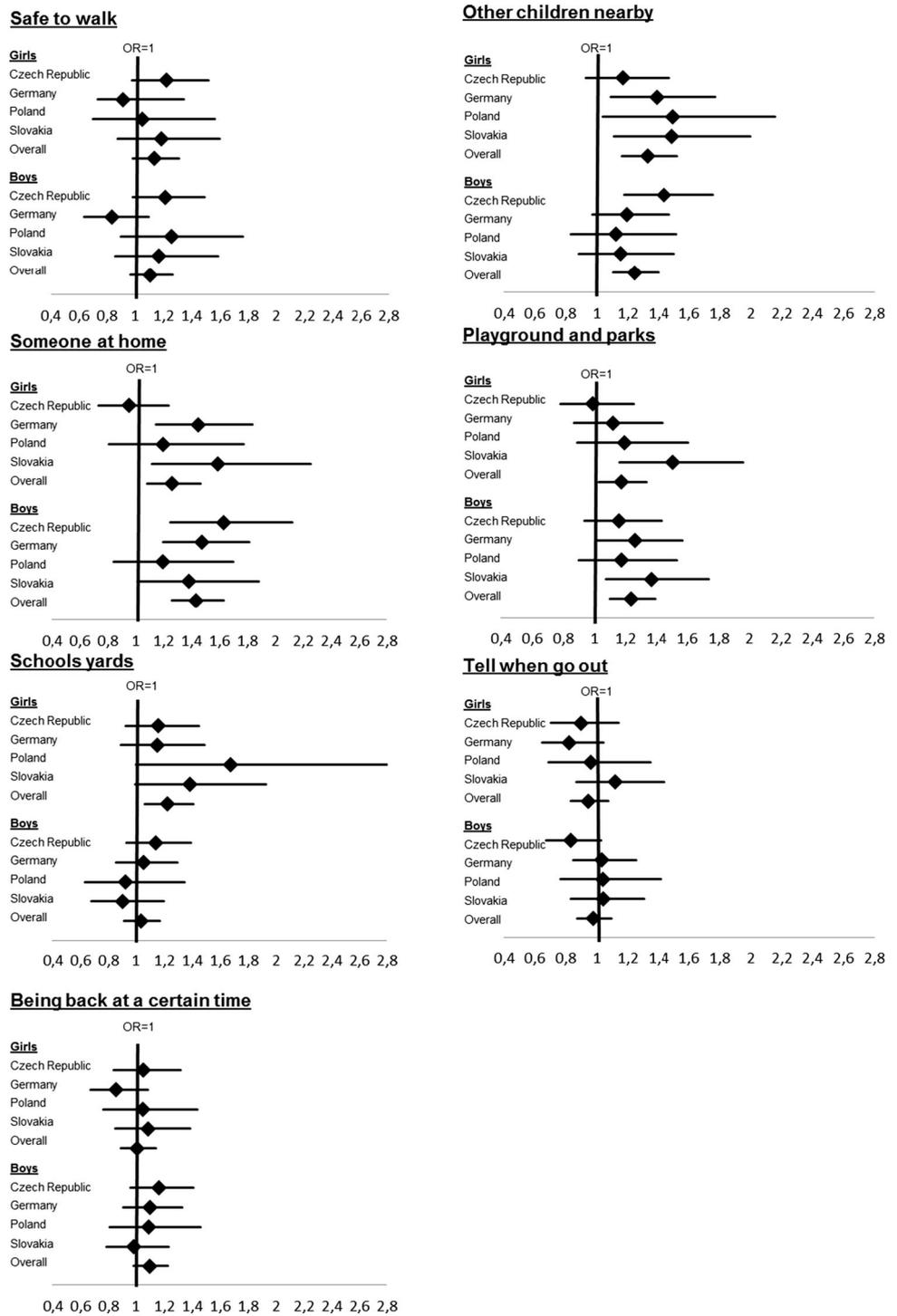
Physical activity

The consistent findings on neighbourhood-related social environmental correlates and MVPA in our study highlights the importance of having others at home or nearby for children to play with and be active. Other studies confirm this finding (Ferreira et al. 2007; Ommundsen et al. 2006). Interpersonal relationships are one important dimension of the social environment that are able to shape and promote MVPA in youth through social support or social networks (Macdonald-Wallis et al. 2012; Sawka et al. 2013). In contrast, young people's perception of how safe it is to walk or play alone in their neighbourhood was unrelated to MVPA in our study. A recent review also reported equivocal findings for safety issues (Ding et al. 2011). In addition, it has been shown that the perceptions of safety concerns among parents are more important predictors of physical activity in their children than the children's perceptions (Carver et al. 2008).

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

Fig. 1 Country- and gender-specific odds ratios (95%-confidence interval) at the *x*-axis or associations between social and environmental variables and meeting physical activity guideline (controlled for age and family affluence); boys and girls not meeting the guideline represent the reference group for each environmental variable and each country. Data from Czech Republic, Germany, Poland and Slovakia in 2014

(subjectively or objectively) and studies focus on different domains and types of physical activity.

Some gender differences are also apparent in our findings. For example, we observed that having school grounds where fields and places for running around are available may be more supportive for MVPA in girls than in boys. Some studies also suggest that girls may benefit more than

boys from activity-friendly environments (Davison and Lawson 2006; Patnode et al. 2010). The reasons for such gender differences are likely to be varied. Similar to participation in organised sports, boys are generally more likely to take part in unstructured physical activity and free play compared to girls (Badura et al. 2015; Patnode et al. 2010) and spend more time in independent and

Fig. 2 Country-specific odds ratios (95%-confidence interval) for associations between social and physical environmental variables and screen time in girls (girls in the high screen time tertile represent the reference group for each environmental variable and each country; black line represents odds ratio comparing medium vs. high level of screen time; grey line represents odds ratios comparing low vs. high level of screen time). Data from Czech Republic, Germany, Poland and Slovakia in 2014
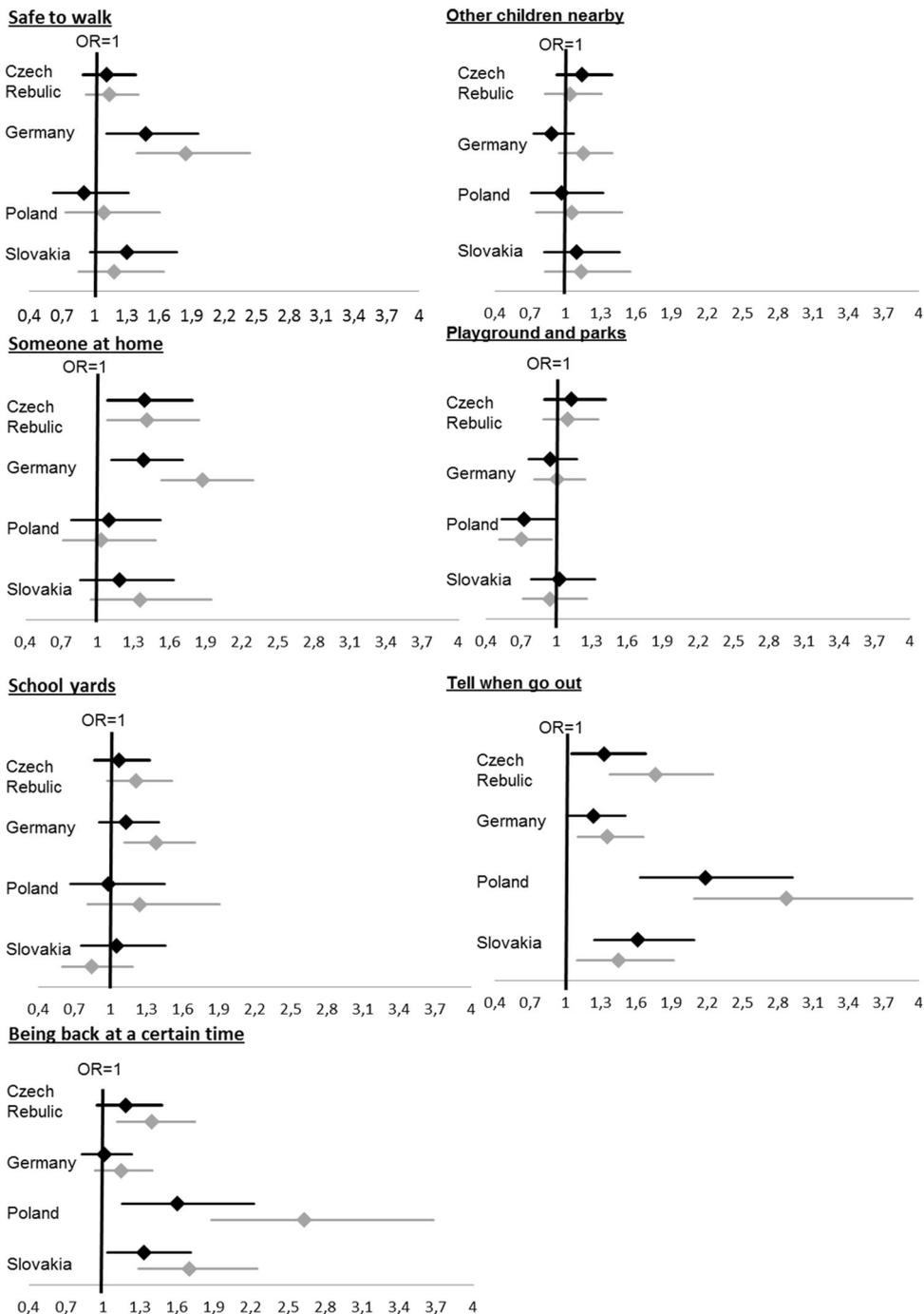

unsupervised mobility (Schoeppe et al. 2014; Stone et al. 2014). This appears to indicate that boys find ways of being active outside without the need for supervised physical activity and areas where specific physical activities are structured or guided.

While our findings reveal significant associations between the social and physical environment and MVPA in the overall sample, we also observed differences in the magnitude of associations across countries. However, the direction of the associations in most cases was not different. Therefore, it could be argued that the pooled effect size (i.e. odds ratio) has a higher power and including data from different countries provides a larger variability in environmental features to determine the true effect size (Kerr et al. 2013). However, the overall effect size is an average estimate that prevents from observing between-country differences which might be important to decide about at a national level (Ding et al. 2013). Comparing countries, it

Fig. 3 Country-specific odds ratios (95%-confidence interval) for associations between social and physical environmental variables and screen time in boys (boys in the high screen time tertile represent the reference group for each environmental variable and each country; black line represents odds ratio comparing medium vs. high level of screen time; grey line represents odds ratios comparing low vs. high level of screen time). Data from Czech Republic, Germany, Poland and Slovakia in 2014
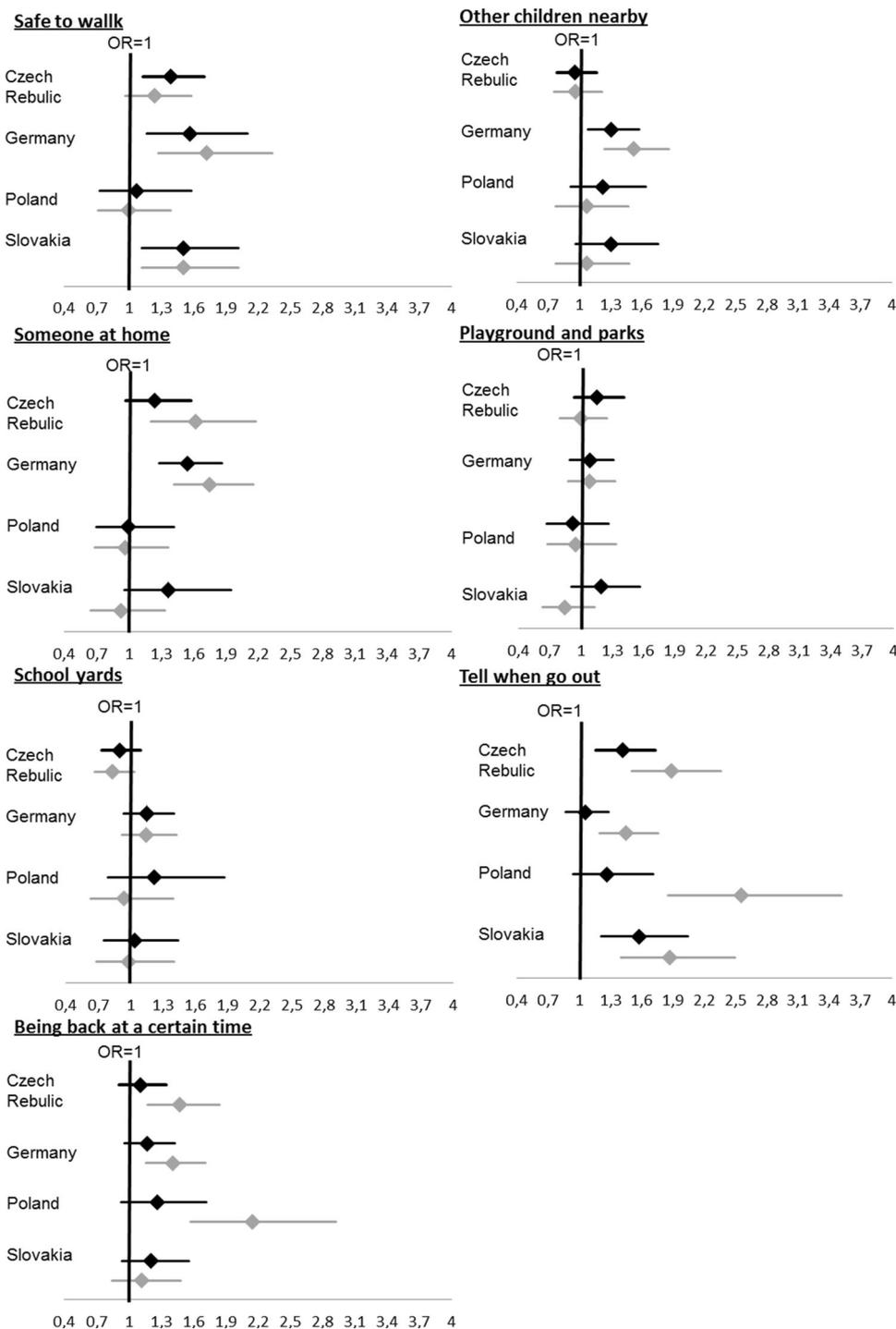
seems that for example in Czech Republic and Poland parks and playgrounds are unrelated to MVPA.

Screen time

The findings for ST reveal a more complex picture that is different from MVPA correlates. First, the variability in the associations with the social and physical environment across countries indicated by significant interactions prevented us from calculating overall odds ratios. The most consistent finding was in relation to social environment with respect to parental rules. If girls and boys have to tell their parents where they are when they go out and play, they are more likely to report lower ST. Our items on parental rules do not relate specifically to ST. However, it could be hypothesised in more general terms that families,

who have rules about daily life activities like going out, might also use rules to restrict ST which, in turn, have been shown to reduce ST behaviour (Bjelland et al. 2015). Higher levels of parental monitoring may be applicable across a number of different aspects of a young person's life. Comparably, one study has shown that restricting outdoor play increases ST (Atkin et al. 2013). This association warrants further investigation.

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

Our findings also reveal an association between perceiving the neighbourhood as safe for walking during daytime and reduced ST in three countries for boys. In contrast, perceiving the neighbourhood as safe was unrelated to MVPA in our findings. It might be that those adolescents who feel their neighbourhood is unsafe are less likely to spend time outdoors and are consequently more likely to engage in ST. A recent international study has shown that spending a lot of time outside is one of the most consistent predictors of reduced ST in youth (Leblanc et al. 2015). Similarly, greater independent mobility is related to reduced ST (Stone et al. 2014). In addition, other studies have shown that greater independent mobility among young people is associated with higher perceived safety (Schoeppe et al. 2015; Veitch et al. 2006). This highlights the importance of creating safe places where young people are allowed to spent time outdoors. Among girls, a significant association between neighbourhood safety and ST was only observed in Germany, suggesting that safety issues are less important for girls. As highlighted before, a number of studies emphasise that boys are more likely to be allowed to spend time unsupervised outdoors and therefore safety issues may be more relevant for boys than girls, or boys may be more aware of safety concerns within their neighbourhood. This finding also underlines the need to address parental safety concerns so that girls are allowed to play outside more and be more independently mobile.

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

Strengths and limitations

The main strengths of this study are the comparisons across four European countries with large representative samples of youth and using a common methodological approach that is essential for providing a more robust evidence base. However, some limitations have to be considered when interpreting our findings. First, we present cross-sectional data so that we are not able to infer causality. Second, we used self-reports to assess MVPA, ST, and the social and physical environment. While most items have been shown to have acceptable validity and reliability, self-reports are prone to misclassification leading to biased effects. With respect to ST it has been shown that at least TV viewing is overestimated compared to a diary by 1 h per day in boys and 20 min per day in girls (Vereecken et al. 2006). However, self-reports of ST are limited in terms of quantifying valid estimates (Atkin et al. 2012). Therefore, we decided to use tertiles to rank adolescents as low, medium and high users of ST. This approach seems to be acceptable as it attenuates bias. Furthermore, we only used weekday patterns of ST as not in all countries data for weekend day was collected. While ST patterns differ between weekdays and weekend days (Bucksch et al. 2016) our findings are limited only to weekdays. Third, since we focused on perceived social and physical environmental correlates, it is possible that active adolescents are more aware of these features and may therefore be more likely to report about them. Lastly, we only adjusted for individual variables and may therefore have missed potential country-level confounders such as economic factors, social norms or climate.

Conclusion

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

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

Compliance with ethical standards

Conflict of interest The authors declare that they have conflicts of interest and study was in compliance with ethical standards.

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