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Relationship between the objectively-assessed neighborhood area and activity behavior in Swiss youth

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ABSTRACT

Background. Neighborhood attributes are modifiable determinants of physical activity (PA) and sedentary behavior (SB). We tested whether the objectively-assessed built and social environment was associated with PA and SB in Swiss youth and whether sex, age and the socioeconomic position (Swiss-SEP) modified such associations.

Methods. We combined data of 1742 youth (ages 4 to 17) from seven studies conducted within Switzerland between 2005–2010. All youth provided accelerometer data and a home address, which was linked to objective environmental data and the Swiss-SEP-index. Associations between neighborhood attributes and PA were analyzed by multivariable multilevel regression analyses.

Results. The extent of green areas and building density was positively associated with PA in the total sample ($p < 0.05$). Factors representing centrally located areas, and more schoolchildren living nearby tended to increase PA in secondary schoolchildren, boys and those from lower-ranked socioeconomic areas. In primary schoolchildren, the extent of green areas was positively associated with PA ($p = 0.05$). Associations between neighborhood attributes and PA were more pronounced in youth from low socioeconomic areas.

Conclusions. The results indicate that some associations between neighborhood attributes and PA differ by age, sex and socioeconomic area. This should be taken into account when planning interventions to increase childhood PA.

Introduction

There is great concern that physical activity (PA) levels of youth have decreased, while time spent in sedentary activities has increased over the last decades, necessitating public health action to promote active lifestyles and to prevent sedentary behavior. Ecological models postulate multiple environmental influences on PA such as the neighborhood environment (Sallis et al., 2006). A review of more than one hundred studies evaluating the relationship between neighborhood environment and youth PA (Ding et al., 2011) found that proximity to parks was the most consistent factor associated with PA in children. Several studies found that a high land-use mix and the presence of recreational facilities were positively associated with PA levels among adolescents. The same review concluded that objectively-measured environmental attributes were more consistently related to PA than reported environmental characteristics, possibly due to lower measurement errors (Ding et al., 2011). Yet most studies assessing the correlation of neighborhood attributes with PA or sedentary behavior (SB) used self-reported environmental data (Van Der Horst et al., 2007; Ding et al., 2011).

The vast majority of previous studies were conducted in North America or Australia (Ding et al., 2011; Davison and Lawson, 2006), where neighborhood attributes often differ from those in European settings, thereby limiting the generalizability of the findings. A Belgian study concluded that 'high-walkable' neighborhoods in the US might be considered 'low-walkable' neighborhoods by European standards

Abbreviations: BMI, body mass index; cpm, counts per minute; IPEN, International Physical Activity and Environment Network; ha, hectare; MVPA, moderate to vigorous physical activity; PA, physical activity; SB, sedentary behavior; SES, socioeconomic status; Swiss SEP, Swiss neighborhood index of socioeconomic position; TPA, total physical activity.

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(Van Dyck et al., 2009). Information from European youth primarily derives from Belgium where associations between objective neighborhood attributes and physical activity have been tested in adolescents. This study found significant associations between walkability and PA in low socioeconomic status (SES) neighborhoods but not in high SES neighborhoods (De Meester et al., 2012; De Meester et al., 2013a). Yet, information in younger age-groups is still scarce and patterns might differ by countries. An international comparison showed that significantly more Swiss than Belgian adolescents accumulated 60 min MVPA per day (Verloigne et al., 2012).

Assessing PA and SB represents a further challenge as self-reported PA and SB in children are of limited validity (Chinapaw et al., 2010; Bringolf-Isler et al., 2012). Thus, objective methods such as accelerometer measurements are recommended (Rowlands and Eston, 2007). Accelerometers are expensive and their use in population studies is time consuming, thus many accelerometer-based studies use only small sample sizes (Ferreira et al., 2007), thereby limiting their power for subgroup analyses. Yet, such analyses may be important for understanding whether the built environment has a differential impact on PA/SB for specific sub-groups (Ding et al., 2011; Boone-Heinonen and Gordon-Larsen, 2011).

We investigated in a large sample of 1742 Swiss youth (1) whether the objectively-assessed neighborhood was associated with accelerometer-based PA levels and SB of Swiss youth and (2) whether such associations were modified by sex, age or the socioeconomic position of the neighborhood.

Methods

Study population and setting

Data for Swiss students participating in seven studies (Brug et al., 2012; Zahner et al., 2006; Niederer et al., 2009; Bringolf-Isler et al., 2009; Genuneit et al., 2011; Von Mutius et al., 2006; Ikaö Bern et al., 2009) were extracted and compiled in a national database (Dössegger et al., 2013). The studies were conducted between 2005 and 2010 and used Actigraph accelerometers to assess PA. Two of the above studies were conducted in primary schools (Niederer et al., 2009; Von Mutius et al., 2006) two in secondary schools (Genuneit et al., 2011; Brug et al., 2012) and three in both (Zahner et al., 2006; Bringolf-Isler et al., 2009; Ikaö Bern et al., 2009). Two studies included primarily rural youth (Von Mutius et al., 2006; Genuneit et al., 2011) and two primarily urban ones (Brug et al., 2012; Niederer et al., 2009) whereas in the others, urban, suburban and rural youth were involved (Zahner et al., 2006; Bringolf-Isler et al., 2009; Ikaö Bern et al., 2009). To be included in this data pool, raw accelerometer data outputs, demographic information and an exact home address had to be available. The individual studies had been approved by the respective ethics committees. All participants or their parents gave written informed consent before participation.

Accelerometer measures

All included studies used Actigraph accelerometers, model AM7164, GT1M or GT3X. Accelerometers measure the acceleration of the body, integrating the measures continuously as "counts" over a predefined time period. Previous studies have shown that the measures of the vertical axis are comparable between the different models (John et al., 2010; Kozey et al., 2010). Nevertheless, in the present study, all of the analyses were adjusted for accelerometer model. All accelerometers were removed for water activities and except for one study not worn during sleeping hours. As the studies used different epoch lengths (15 to 60 s), all files were reintegrated into an epoch of 60 s using ActiLife 4.9 software. Data reduction was conducted using MeterPlus 4.2 software. Non-wearing time was defined as a period of 20 min of consecutive zero counts. Children were included in the study if they had accumulated ≥10 hour wearing time on at least two weekdays and one weekend day. Besides total PA (TPA) in counts per minutes (cpm), moderate to vigorous PA (MVPA) was calculated using age-dependent cut-offs (Freedson et al., 2005) and the cut-off for SB was set at 100 cpm (Trost et al., 2011).

Personal characteristics

Personal characteristics such as sex and age were obtained from questionnaires. Time of data collection was classified as summer (April to September) or winter (October to March).

Environmental data

Environmental data were individually linked to valid addresses. For all neighborhood attributes, different buffer sizes (near, median and distant buffer) were used because no reference sizes exist for European settings. The definitions of the neighborhood attributes, the buffer sizes and the respective descriptive statistics are presented in Table 1. The selection of the neighborhood attributes has been based on previous analyses (Ding et al., 2011; Bringolf-Isler et al., 2010; Frank et al., 2009). These variables were expected to provide information about walkability such as density (population and building), diversity (land use mix) and design (intersection density) (Ewing and Cervero, 2010). We further included greenness (green space and woods), traffic danger (main street density), access to peers (schoolchildren density) and the socioeconomic position of the neighborhood. Arc Map 10 (Esri, 2011) was used to calculate the main street density and the intersection density. Information about population density, building density, mixed land use and the number of schoolchildren living nearby was based on census data (Bundesamt Für Statistik, 2009b; Bundesamt Für Statistik, 2009a). The mixed land use score is a simplified version of a score proposed by IPEN-group (International PA and Environment Network) (Frank et al., 2009). Information on green spaces and wooded areas was based on land use statistics (Bundesamt Für Statistik, 2010). The socioeconomic status of each neighborhood was based on the Swiss neighborhood index of socioeconomic position (Swiss-SEP) (Panczak et al., 2012) The Swiss SEP was validated and has been related to health outcomes and all-cause mortality (Panczak et al., 2012).

Statistical analysis

All analyses were conducted with STATA 11.0 (Statacorp, 2007). Differences in the distribution of variables were analyzed using the Kruskal Wallis-test.

Spearman correlations and factor analyses were computed for all attributes of the near, median and distant neighborhood. To test the respective associations between cpm, MVPA and SB (dependent variables) and each of the environmental factors, multilevel regression models were computed, adjusting for sex, age, season, accelerometer model and study-cluster. MVPA and SB were additionally adjusted for wearing time. School was added as additional level (baseline model). Age was modeled using splines. The baseline regression models were then expanded to include all environmental attributes, unless they were highly ($r > 0.60$) correlated with each other (expanded model). If so, the variable with the highest factor load has been used. The significance value was set at $p < 0.05$ except for the testing of interactions ($p < 0.1$). For subgroup analyses, the fully adjusted regression models were also run stratified by age-group (primary schoolchildren aged 4 to 10 and secondary schoolchildren aged 11 to 17), sex and Swiss SEP-score-division (SEP score ≤5 and >5). Interactions of the association between neighborhood attributes and PA (age-group * neighborhood attributes, sex * neighborhood attributes, SEP-score-division * neighborhood attributes, study-cluster * neighborhood attributes) were tested using the likelihood ratio test.