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The German Environmental Survey for Children (GerES IV): Reference values and distributions for time-location patterns of German children

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ABSTRACT

Children's time-location patterns are important determinants of environmental exposure and other health-relevant factors. Building on data of the German Environmental Survey for Children (GerES IV), our study aimed at deriving reference values and distributions for time-location patterns of 3–14-year-old German children. We also investigated if GerES IV data are appropriate for evaluating associations with children's health determinants by linking them to data of the National Health Interview and Examination Survey for Children and Adolescents (KiGGS).

Parents reported on the time their children usually spend at home, in other indoor environments, and outdoors. This information was characterized by statistical parameters, which were also calculated for different strata concerning socio-demography and the residential environment. Consequently, group differences were evaluated by *t*-tests and univariate ANOVA. Reference distributions were fitted to the time-location data by a Maximum Likelihood approach to make them also useable in probabilistic exposure modeling. Finally, associations between data on the children's physical activity as well as body weight and their outdoor time were investigated by bivariate correlation analysis and cross tabulation.

On daily average, German children spend 15 h and 31 min at home, 4 h and 46 min in other indoor environments, and 3 h and 43 min outdoors. Time spent at home and outdoors decreases with age while time spent in other indoor environments increases. Differences in time-location patterns were also observed for the socio-economic status (SES) and immigration status. E.g., children with a high SES spend 24 min less outdoors than low SES children. Immigrants spend on daily average 20 min more at home and 15 min less outdoors than non-immigrant children. Outdoor time was associated with parameters of the residential environment like the building development. Children living in 1- or 2-family houses spend more time outdoors than children living in building blocks (3 h 48 min vs. 3 h 29 min). Physical activity correlates with outdoor time. For children with diminished age-specific outdoor time, a higher prevalence of obesity was observed (odds ratio: 3.2, 95% CI: 1.5–7.1).

GerES IV provides a compilation of current time-location reference values and distributions on German children. This data hint to substantial differences in time-location patterns within the population to be considered in environmental health risk assessment.

Introduction

Children's health is well known to be particularly vulnerable to various environmental stressors, such as noxious chemicals in food, air pollutants, UV radiation, and noise (Tamburlini et al., 2002; Landrigan et al., 2004). The health relevance of these environmental stressors is generally associated with the dose of exposure, e.g. the inhaled amount of particulate matter or the experienced noise level. As the presence of environmental stressors varies substantially between different environments (Frumkin, 2005), children's time-location patterns are important determinants of their health-relevant exposures: The time usually spent indoors, as well as outdoors, influences, i.a., the exposure to various airborne contaminants (Hubal et al., 2000).

Children's time-location patterns are, moreover, associated with other determining factors of health: Time children spend outdoors

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is known to be positively correlated with their physical activity (Sallis et al., 2000). Veitch et al. (2006) proposed time children spend outdoors as a proxy for physical activity. Recent studies by McBrien et al. (2008) suggest that outdoor time may protect children from developing myopia. It also has been hypothesized that lack of vitamin D in children may partly be due to insufficient outdoor time, but no profound epidemiological evidence has been presented so far (Ali et al., 2009; Elizondo-Montemayor et al., 2010).

Several studies conclude that children's time-location patterns have changed in the last decades. The literature on this issue however is not entirely consistent: several authors reported an increase of indoor activities such as watching television and playing computer games and decreasing outdoor activities like walking or biking to school or organized sports (Dollman et al., 2005; Ham et al., 2008; Hofferth, 2009). In contrast, other studies observed an increase in children's organized activities while sedentary activities like watching television have decreased (Sturm, 2005).

Against this background, sound and up-to-date information on children's time-location patterns is essential for risk assessment and management aiming at improving health outcomes. As opposed to other countries (e.g. Leech et al., 2002) recent data on German children's time-location patterns are scarce. Therefore, data on the time German children usually spend in different locations have been obtained within the framework of the German Environmental Survey for Children (GerES IV).

Building on these data the main objective of our study was to generate comprehensive statistical reference values on the time-location patterns for Germany's children population. Children's time-location patterns are potentially influenced by age, gender, season and day-type, socio-economic and immigration status, and parameters of the residential environment. To give initial indications of current differences within the population and enable differentiated risk assessment, the reference values were stratified by these factors. For risk assessment problems of high complexity the interindividual variability in time-location patterns might often be required at a level of detail that is beyond a set of reference values. As these problems are usually solved by means of probabilistic exposure modeling, the study also aimed at fitting reference distribution functions to the GerES IV data that reflect the variation within the population to a maximum degree.

Taking physical activity and overweight as examples, we also investigated whether GerES IV data are appropriate for evaluating associations between children's health determinants and their time-location patterns. For this, we linked GerES IV data to data of the National Health Interview and Examination Survey for Children and Adolescents (KiGGS) on an individual basis.

Methods

Survey design

The German Environmental Survey (GerES) is a representative cross-sectional study on the German children and adult population. The main goals of GerES are to analyze and document the extent, distribution and determinants of exposure to environmental pollutants. Hitherto GerES has been carried out four times since the mid-1980s, including up to 5000 participants per survey. GerES IV was performed from 2003 to 2006 and focused exclusively on children. A total of 1790 children aged 3–14 years from 150 German sampling locations participated in this survey. GerES IV is a module of KiGGS, conducted by the Robert Koch Institute, and the GerES IV data were obtained on a random sub-sample of all KiGGS participants. Thus, environmental data could be linked to health-related data on an individual basis. Because of this close co-operation, a profound set of health data is available for all GerES IV participants (Kurth et al., 2008; Schulz et al., 2007).

Questionnaire data

In GerES IV standardized face-to-face interviews were performed with older children and all parents. Interviews as well as data and quality management were carried out by the Robert Koch Institute (Dölle et al., 2007).

Specific composite indices, representing the socio-economic status (SES) and the immigration status of children participating in KiGGS and GerES IV, were derived from data of self-administered questionnaires, to be used as essential stratifying variables in statistical evaluation (Lange et al., 2007; Schenk et al., 2007).

Time-location data

As part of the interview, parents of all GerES IV participants were asked about the average time in minutes their children spend at home, differentiating between weekdays and weekend. Both amounts of time were separately obtained for winter and summer. The same set of questions was asked for the time usually being spent outdoors. The remaining time completing the 1440 min per day was defined as being spent in other indoor environments, e.g. at school or relative's residences. Obtaining these data was based on a parental recall of the child's activities within the last typical week. The interviewers were instructed to individually support this recall by asking for the child's common activities and corresponding locations. The interviewers also cross-checked the reported durations with other interview items such as the time the child usually spends in his or her room. Moreover, they assisted in summing-up the different amounts of time and converting them to minutes per day. Regular stays in other residences, e.g. in children of divorced parents or families owning weekend homes, were also considered for validating time-location data recording.

Data on the residential environment

A basic classification of the residential environment the GerES IV participants lived in was derived from the sampling location's community size. The GKBIK10 scheme was used for categorizing the community size according to the number of inhabitants and extent of commuting into ten groups (Aschpurwis + Behrens GmbH, 2001; Behrens, 2005). In order to better detect differences due to community size, the GKBIK10 classes were unevenly combined to three strata: GKBIK10 classes 1 and 2 were defined as the first stratum (less than 5000 inhabitants), GKBIK classes 3 to 8 were defined as the second stratum (at least 5000–less than 500,000 inhabitants), and GKBIK10 classes 9 and 10 were defined as the third stratum (at least 500,000 inhabitants).

For collecting more specific information at the neighborhood level, the GerES IV interviewers characterized the residential environment of each child's home on-site. The interviewers categorized, i.a., the type of the residential area (degree of urbanization) and the surrounding building development. For evaluating the interviewer ratings of the type of building development, one- and two-family houses were combined into one stratum, as they represent comparable building types. The resulting three-level variable yields a sufficient sample size for statistical analyses in each level.

Data on the children's physical activity

In the KiGGS study, children of at least 11 years of age were asked about their physical activity behavior and the average hours of leisure time per week they are involved in strenuous physical activity. In contrast, regular physical activity of children up to 10 years of age was only evaluated by parental report. In order to have a uniform variable on physical activity across all age groups, the parental assessment of their children's usual outdoor activity (up