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Access to urban green spaces and behavioural problems in children: Results from the GINIplus and LISAplus studies

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ABSTRACT

Aim: We investigated whether objectively measured access to urban green spaces is associated with behavioural problems in 10-year old children living in Munich and its surrounding areas.
Methods: Behavioural problems were assessed in the GINIplus and LISAplus 10-year follow-up between 2006 and 2009 using the Strengths and Difficulties Questionnaire. Access to green spaces was defined using the distance from a child's residence to the nearest urban green space. Associations between access to urban green spaces and behavioural problems were assessed using proportional odds and logistic regression models in 1932 children with complete exposure, outcome and covariate data.
Results: The distance between a child's residence and the nearest urban green space was positively associated with the odds of hyperactivity/inattention, especially among children with abnormal values compared to children with borderline or normal values (odds ratio (OR) = 1.20 (95% confidence interval (CI) = 1.01–1.42) per 500 m increase in distance). When stratified by sex, this association was only statistically significant among males. Children living further than 500 m away from urban green spaces had more overall behavioural problems than those living within 500 m of urban green spaces (proportional OR = 1.41 (95% CI = 1.06–1.87)). Behavioural problems were not associated with the distance to forests or with residential surrounding greenness.
Conclusion: Poor access to urban green spaces was associated with behavioural problems in 10-year old children. Results were most consistent with hyperactivity/inattention problems.

1. Introduction

Currently, more than half of the world's population lives in urban settings (United Nations, 2011). An increasing number of children grow up in cities and often have limited access to green spaces. The effects of urbanisation on the well-being of children have not been adequately investigated. Further insight into the effects of urban green space access on children's health is needed to inform efficient city planning and the development of effective health policies (Kyttä et al., 2012; Lee and Maheswaran, 2010).

Green spaces appear to have positive effects on human psychological health (Bowler et al., 2010; Lee and Maheswaran, 2010). However, with only a few exceptions, most studies examining associations between green spaces and mental health have been conducted among adults (Bowler et al., 2010; Lee and Maheswaran, 2010). Moreover, objective measurements of green space access have rarely been used in these studies (Annerstedt et al., 2012; Kyttä et al., 2012; Lee and Maheswaran, 2010; Stigsdotter et al., 2010).

Several hypotheses have been proposed to explain how green spaces may have a beneficial effect on mental health and well-being. There is mounting evidence supporting the restorative and stress reductive effects of green spaces (Fan et al., 2011). Better access to green spaces is also hypothesised to promote physical activity, which

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could ultimately lead to improved mental functioning (Fan et al., 2011; Lee and Maheswaran, 2010). Finally, green spaces might also improve psychological health by encouraging the development of social contacts (Maas et al., 2009).

We investigated whether objectively measured access to urban green spaces was associated with behavioural problems in 10-year old children living in Munich and its surrounding areas.

2. Materials and methods

2.1. Study population

The "German Infant Study on the Influence of Nutrition Intervention plus Environmental and Genetic Influences on Allergy Development" (GINIplus) study and the "Influence of Life-Style Factors on the Development of the Immune System and Allergies in East and West Germany plus the Influence of Traffic Emissions and Genetics" study (LISAplus) are ongoing population-based birth cohorts. Both cohorts have a similar study design and recruited healthy full-term neonates with a normal birth weight. GINIplus participants were recruited in the cities of Munich ($n = 2949$) and Wesel ($n = 3042$) between 1995 and 1998. This cohort consists of two study groups: one is an observation group and the second includes a nutritional intervention conducted during the first four months of life, in which a randomised, double-blind controlled trial compared the effect of three hydrolysed formulas versus cow's milk formula on allergy development. Newborns with a family history of allergy were selected for the intervention group. Participants with a negative family history or a positive family history but who declined to participate in the intervention trial were included in the observation group. LISAplus participants were recruited in the cities of Munich ($n = 1467$, but two participants withdrew their consent to participate), Leipzig ($n = 976$), Wesel ($n = 348$) and Bad Honnef ($n = 306$) between 1997 and 1999. The GINIplus and LISAplus studies were approved by the local ethics committees and informed consent was obtained from all parents of participants. More detailed descriptions of these cohorts have been published elsewhere (Heinrich et al., 2002; von Berg et al., 2003, 2013; Zutavern et al., 2006).

The current analyses are restricted to participants residing in the city of Munich and its surrounding areas from the time of recruitment until the 10-year follow-up ($n = 1700$ from GINIplus and $n = 940$ from LISAplus), as land use data at a high resolution was only available for this study centre. The analyses were also restricted to children for whom information on behavioural problems ($n = 1478$ from GINIplus and $n = 792$ from LISAplus) and other covariates ($n = 1303$ from GINIplus and $n = 742$ from LISAplus) was available. Children who reported living at their current address (at the 10-year follow-up) for less than one year were excluded ($n = 85$ from GINIplus and $n = 28$ from LISAplus). Thus, the final study population comprised 1932 participants ($n = 1218$ from GINIplus and $n = 714$ from LISAplus).

2.2. Access to urban green spaces

The following land use types were considered as urban green spaces: "Friedhof" (cemetery), "Gartenland" (garden), "Grünanlage" (park) and "Gärtnerei" (plant nursery). The shortest distance between each child's place of residence at 10 years of age and the nearest urban green space (in metres) was used as a surrogate for urban green space access. Data for these calculations were obtained from the local Bavarian land use dataset (vector with spatial resolution of <5 m) from the Bavarian Survey Office for the year 2008. The land use data covers the entire study territory (27,521.66 km^2), which includes two administrative regions of Bavaria state: Upper Bavaria and Swabia. Data management and calculations were performed in ArcGIS 10.1 Geographical Information System (GIS) (ESRI, Redlands, CA).

2.3. Behavioural problems

Behavioural problems in children were assessed using the German version of the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997; Woerner et al., 2004). Parents completed the SDQ on behalf of their child at the 10-year follow-up. The SDQ is an internationally disseminated and validated screening instrument used to identify behavioural problems in children and adolescents. In a recent review, the psychometric characteristics of the SDQ were reported to be strong (Stone et al., 2010). Good psychometric properties were also reported for the German version of the parent-reported SDQ in terms of reliability, based on internal consistency (Rothenberger et al., 2008; Woerner et al., 2004), and validity, based on the SDQ's ability to discriminate between clinical and community samples (Becker et al., 2004; Klasen et al., 2000).

The SDQ comprises five subscales for five items (25 items in total): emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems and prosocial behaviour. To score each item, a three-point scale ("not true", "somewhat true" and "certainly true") is used. Subscale scores and the total difficulties score were derived following the standard scoring instructions (http://www.sdqinfo.com/) and subsequently grouped into normal, borderline and abnormal categories, according to cut-off points recommended for a German population (Woerner et al., 2004). According to the standard scoring instructions, SDQ subscale scores were first prorated (mean substitution) when at most two out of five scale times were missing. Overall mental health was assessed by the total difficulties score, which was estimated by summing all subscale scores except for the prosocial behaviour score. As our study was focused on behavioural problems (i.e. difficulty subscales), the prosocial behaviour subscale (i.e. strength subscale) was not included in the analyses.

2.4. Covariates

Potential confounders were selected a priori, mainly based on our previous studies of behavioural problems in children (e.g., Tiesler et al., 2013). The following covariates were extracted from parent-completed questionnaires and considered in the current analyses: study (GINIplus observation group/GINIplus intervention group/LISAplus), sex (male/female), exact age at the 10-year follow-up (years), parental level of education (both parents with <10 years of school (low)/at least one parent with 10 years of school (medium)/at least one parent with >10 years of school (high), classified according to the German education system), age of mother at time of birth (≤30 years/>30–35 years/>35 years), single parent status at the 10-year follow-up (yes/no), time spent in front of a screen (<1 h per day in summer and ≤2 h per day in winter (low)/≥1 h per day in summer or >2 h per day in winter (high)) and time spent outdoors (≤4 h per day in summer and ≤2 h per day in winter (low)/>4 h per day in summer or >2 h per day in winter (high)).

2.5. Statistical analyses

Associations between access to urban green spaces and behavioural problems in children were assessed using proportional odds models. The proportional odds ratio (pOR) is a summary of odds ratios obtained from logistic regression models using incremental cut-points to dichotomise ordinal outcomes (Scott et al., 1997). Possible dichotomizations for the SDQ scales are (i) abnormal/borderline vs. normal and (ii) abnormal vs. borderline/normal. The assumption of homogeneity of the pOR over these two cut-points was tested with a score test. As proposed by Bender and Grouven (1998), when this assumption was violated in either crude or adjusted models, logistic regression models for the above-mentioned dichotomizations were applied and odds ratios (OR) are reported. Effects are reported per 500 m increase in the distance between a child's residence and the nearest urban green space.