Adding natural spaces to social indicators of intra-urban health inequalities among children: A case study from Berlin, Germany

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Session 1 – Thomas Claßen/Richard Mitchell

Introduction

- Urban green and blue spaces provide ecosystem services to city residents such as climate regulation (temperature reduction), recreation and environmental education (Haase et al. 2014, Kabisch et al. 2015).
- Natural areas are associated with public health improvements, such as increased physical activity, stress relief, improved motoric development & less obesity (Lee and Maheswaran 2011, Hartig et al. 2014, Sanders et al. 2015) and their availability might serve as a complementary health resource for vulnerable populations such as children.
- Good quality natural areas are, however, often unequally distributed within a city (Kabisch et al. 2016).

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Introduction

- Social and socioeconomic variables are already used as health determinates to identify specific urban areas of health inequality (e.g. see the tool URBAN HEART Urban Health Equity Assessment and Response Tool, WHO, 2010)

- Negative environmental determinants such as air pollution and noise have increasingly been recognized for their role in identifying distribution of health inequalities.

- So far, indicators of positive environmental resources are only rarely included among the existing health inequality indicators.

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Objectives

- Investigate the relationship between the spatial distribution of natural areas, such as green and blue spaces, and other known social health inequality indicators among children.

- Explore whether the distribution of urban natural areas demonstrates a spatial pattern that could be additionally used as indicator to identify health inequalities.

Session questions:

- What are the specific contributions of different urban open spaces (e.g. green, blue, grey spaces) to social wellbeing and health?
- Which causal relationships between green space availability, accessibility and health can be observed?

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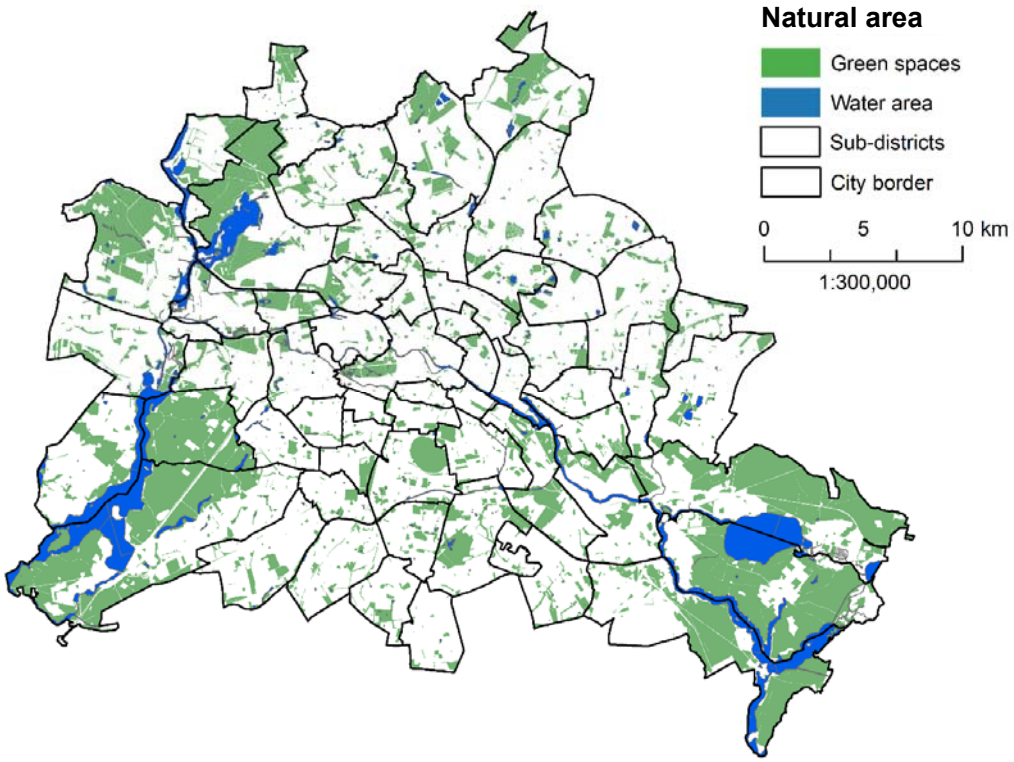
Methods – Case study Berlin



- data are based on the medical check-ups of children (5 to 6 years old) in 2013, prior to school enrollment (N=30,427)
- publicly available spatial data on an aggregated level of the 60 sub-districts
- health outcome and the social variables of the children and their families
- landuse variables as natural area indicator (green and blue spaces)

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Methods - data

Health-outcome variables	
Overweight (%)	Percentage of children overweight as defined by the Body-Mass-Index, BMI (thresholds are defined monthly by Kromeyer-Hausschild)
Deficits in viso-motoric development (%)	Percentage of children with impaired fine motor ability
Social variables	
Social status index	Median index (0-18) representing the status of parents based on school education, employment education and employment status: 0-8 low social status, 9-15 medium social status, 16-18 high social status
Single parent household (%)	Percentage of children living in single parent households
Non-German (%)	Percentage of children with background other than German
Complete measles immunization (%)	Percentage of children with at least two doses (considered complete) of measles vaccination
Social-environmental conditions of child care	
Kindergarten attendance (%)	Percentage of children enrolled in kindergarten for at least 2 years
Land use variables	
Natural area (%)	Percentage of green and water spaces in the sub-districts in relation to the total sub-district area. Green spaces include forest areas, urban green and parks, cemeteries and allotment gardens. Water spaces include all the water bodies such as lakes, rivers and canals.
Per capita natural area (m^2/inhabitant)	Natural space (m^2) / total number of inhabitants in the sub-district
Access natural areas (%)	Percentage of inhabitants living a maximum of 300 m distance away from a natural space (green space of min. 2 ha)

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Methods

- Correlation analyses to study any relations between the variables.
- Hierarchical regression modelling
- Factor analysis to identify a minimal set of health inequality indicators.
- Hierarchical cluster analysis to demonstrate spatial distribution of the indicators.

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Results – Correlation analysis

→ Correlations on a sub-district level were found between natural area, overweight and deficits in viso-motoric development.

Spearman correlation between health-outcome variables and health determinants.

Health determinants \ Health outcome	Overweight (%)	Deficits in viso-motoric development (%)
Social status index	**-.780****	**-.660****
Non-German (%)	**.809****	**.334****
Single parent household (%)	**.333****	**.415****
Kindergarten attendance (%)	**-.780****	**-.585****
Natural area (%)	-.149	**-.260***
Per capita natural area (m²/inhabitants)	**-.322****	-.209
Inhabitants with access to natural area (%)	.105	.116

Spearman correlation between social variables.

	Social status index	Non-German (%)	Single parent household (%)
Non-German (%)	**-.551****		
Single parent household (%)	**-.576****	.132	
Kindergarten attendance (%)	**.742****	**-.743****	**-.372****

→ Multi-collinearity

* p<0.5; ** p<0.01, significant correlations in bold

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Results – Factor analysis

Factors extracted by factor analysis using all the health determinant and health outcome variables.

	Factor			
	I	II	III	IV
	% of variance			
	48.97	16.84	9.67	6.57
Overweight (%)	.919			
Non-German (%)	.915			
Kindergarten attendance (%)	-.847			
Social status index	-.829			
Single parent household (%)		.907		
Deficits in viso-motoric development (%)		.648		
Natural area (%)			.924	
Per capita natural area (m²/inhabitant)			.866	
Access to natural area (%)			.633	
Complete measles immunization (%)				.821

→ Variables with the highest factor loading per factor: overweight, single-parent households, complete measles immunization, and natural space cover …

→ … are used for cluster analysis for spatial caracterisation of sub-district

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Results – Hierarchical multivariate regression

Table 1. Outputs of hierarchical multivariate regression models on influencing factors of children overweight (%).
Note: Significant coefficients in bold

	β_1 (Social index)	β_2 (non-German %)	β_3 (single parent household %)	β_4 (Kindergarten attendance %)	β_5 (Natural area %)	β_6 (Access natural area %)	β_7 (per capita natural area %)	R^2-adjusted (%)
Model 1	**-0.46**	**0.50**	-0.01	-0.06				84.6
p values	.000	.000	.908	.534				
Model 2	**-0.46**	**0.51**	0.00	-0.09	-0.15	-0.05	0.18	84.8
p values	.000	.000	.984	.358	.154	.431	.111	

Table 2. Outputs (Beta and p-values) of hierarchical multivariate regression models on influencing factors of children deficit in viso-motoric development (%).
Note: Significant coefficients in bold. **Change in R^2 is significant at 0.05.*

	β_1 (Social index)	β_2 (non-German %)	β_3 (single parent household %)	β_4 (Kindergarten attendance %)	β_5 (Natural area %)	β_6 (Access natural area %)	β_7 (per capita natural area %)	R^2-adjusted (%)
Model 1	**-0.46**	**-0.27**	0.18	**-0.36**				46.9
p values	.009	.093	.128	.043				
Model 2	**-0.42**	-0.18	**0.20**	**-0.35**	**-0.81**	0.11	**0.61**	62.5*
p values	.009	.241	.047	.026	.000	.272	.001	

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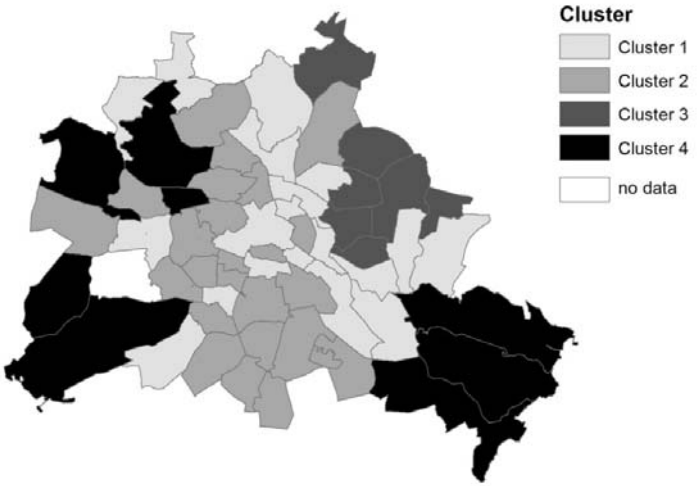
Results – Cluster analyis



- Sub-districts with a relatively large proportion of natural area cover also had low percentages of children being overweight or living in single parent households (Cluster 1 and 4).
- Sub-districts with lower percentage of natural area showed higher values of overweight and living in single parent householeds (Cluster 2 and 3)
- Sub-districts with indicators that correlated with higher social status had a comparatively low percentage of children with full measles immunization (Cluster 1)

Cluster	1	2	3	4	Total city
Variables	M (SD)	M (SD)	M (SD)	M (SD)	
Overweight (%)	5.79 (2.41)	11.48 (3.72)	8.41 (2.22)	7.58 (2.92)	8.76 (3.92)
Single parent hh (%)	19.48 (6.01)	23.48 (4.07)	39.89 (5.55)	23.68 (10.18)	24.17 (8.44)
Natural space (%)	20.21 (7.29)	15.16 (7.16)	15.30 (9.39)	55.54 (12.03)	22.28 (15.68)
Complete measles immunisation (%)	88.59 (4.49)	92.89 (2.13)	93.26 (1.56)	90.19 (4.14)	91.18 (3.83)
N	19	25	7	8	59

Values sign. above total city average

Values sign. below total city average

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Summary and conclusion

- Natural areas did show a clear spatial pattern that overlapped with social patterns, which reflects the need for further investigation of “green” inequality indicators, especially in other cities where green and blue spaces may be less abundant than in Berlin.
- However, the study was only partly conclusive regarding any causalities between natural area cover and health inequality
- Results are not conclusive as to whether natural area cover, natural area per capita, or accessibility of natural area is the most appropriate metric to use to indicate health and inequalities because their relationships to other indicators varied. → Further discussion about the adequacy of existing urban green or natural space indicators is needed
- The sub-district with the lowest rate of measles immunization was also the area with high social status with comparatively higher natural area cover → Berlin has been facing a severe outbreak of measles since 2014, which is at least partly explained by the increasing numbers of children in districts with higher social conditions who are not being vaccinated

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Thank you for the attention!

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