How relevant are district characteristics in explaining subjective health in Germany? – A multilevel analysis

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Abstract

This study was the first multilevel analysis to investigate the possible impact of macro-level factors on individual self-rated health over and above individual characteristics across Germany. This is especially interesting against the background of German history and the persistent disparity between Eastern and Western Germany. In this paper, the 439 German administrative districts, called Landkreise, provided the macro-level characteristics for this study. Altogether, 5516 individuals in 437 districts were included from data collected between 2005 and 2007.

Our results show a significant association between the district unemployment rate and subjective health. The impact remains significant after adjusting for individual variables, including individual employment status. Furthermore, a significant association was found between subjective health and the degree of rurality, the proportion of elderly inhabitants and the proportion of foreigners. However, the variance of these was zero.

In conclusion, our findings indicate an independent association between the unemployment rate of districts and individual self-rated health. Area mechanisms identified for other countries seem to exist in Germany, too, beyond the well-known differences between the Federal Republic of Germany and the German Democratic Republic that still influences individual health outcomes.

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Introduction

The relationship between health and area structures has been a topic of interest for many epidemiologists and sociologists for decades. The majority of literature on the influence of the contextual effects on health shows that neighborhoods have effects on a range of health-related outcomes (Pickett & Pearl, 2001). Examples for affected outcomes are subjective health (Agyemang et al., 2007; Cummins, Stafford, Macintyre, Marmot, & Ellaway, 2005; Humphreys & Carr-Hill, 1991; Jones & Duncan, 1995; Malmström, Sundquist, & Johansson, 1999; Reijneveld, 1998; Stafford, Cummins, Macintyre, Ellaway, & Marmot, 2005), long-term illness (Humphreys & Carr-Hill, 1991; Shoults, Congdon, & Curtis, 1996), coronary heart diseases (Diez-Roux et al., 1997; Sundquist, Malmström, & Johansson, 1999) and mental health (Fagg et al., 2008; Peterson, Tsai, Petterson, & Litaker, 2009; Reijneveld & Schene, 1998; Stafford & Marmot, 2003). Likewise, several multilevel studies have examined mortality rate as the dependent variable in conjunction with neighborhood characteristics (van Hooijdonk, Droomers, Deerenberg, Mackenbach, & Kunst, 2008; Jaffe, Eisenbach, Neumark, & Manor, 2005; Martikainen, Kauppinen, & Valkonen, 2003).

Even though there are multilevel analyses from many different countries, no nationwide analysis exists for Germany. However, such an analysis is particularly important considering Germany's history: nearly 20 years ago, Germany was reunified but social and economic differences still exist at the individual and regional level between Eastern and Western Germany.

Until now, only a few analyses have dealt with area effects on health in parts of Germany. For example, Wolf (2002) investigated outdoor air pollution and chronic diseases within quarters in Cologne. He found weak but consistent effects. Koller and Mielck (2009) examined overweight, participation in health check-ups and vaccination among children living in Munich. Another study focusing on health outcomes by Breckenkamp, Mielck, and Razum (2007) examined cardiovascular diseases in six geographic regions and concluded that these were not associated to any large extent with income inequality. Selected Bavarian districts were studied by...
Kemptner et al. (2008), who found that the proportion of higher educated persons at the district level was significantly associated with self-rated health.

As only a few multilevel analyses concerning health outcomes in Germany have been conducted, the aim of this study was to investigate whether, after controlling for individual variation, there is also significant variation at the district level concerning subjective health. In doing so, different models including different combinations of variables were calculated on a nationwide base.

Our main focus was the variable “district unemployment rate,” which was significantly associated with health in an ecological study by Queste (2007) conducted in Germany. Mechanisms behind the potential association between health and district unemployment rate could be psychosocial (stress, frustration and isolation, which may have an impact on entire neighborhoods) as well as economic (Cassel, 1976; Kawachi & Kennedy, 1997; Marmot & Wilkinson, 2001; Wilkinson, 2000). Infrastructural problems may arise if a region is economically weak and cannot invest in buildings or provide adequate social structure (Lynch et al., 2001; Lynch, Smith, Kaplan, & House, 2000; Voigtlander, Berg-Beckhoff, & Razum, 2008). The degeneration of the physical environment could influence inhabitants’ well being directly or indirectly (Wen, Browning, & Cagney, 2003).

To cover a wide range of potential factors, we chose variables from very different fields. Aside from unemployment rate, we included more compositional variables (van Lenthe, 2006), such as the proportion of inhabitants aged 65 and older, to investigate associations between the health and sociodemographic as well as socioeconomic composition of the districts. Furthermore, we included rurality as a contextual variable. Potential associations between the district variables and health may be attributable to both economic and psychosocial mechanisms. These results may be the first indication that further detailed analyses are warranted.

Methods

Data

Data for this study were collected from two independent sources: for districts and for individuals living in these districts. The information on districts was from the INKAR (Indikatoren, Karten und Graphiken zur Raum- und Stadtentwicklung; engl. Indicators, Maps and Graphics for Spatial and Urban Development: The Federal Office of Building and Regional Planning) 2007 dataset, which includes social and ecological indicators from 2006.

Germany is organized into 439 administrative districts. The range of the number of inhabitants per district is large (Hannover with 1,129,201 inhabitants to district Lüchow-Dannenberg with 50,465 inhabitants). Each district has self-contained organizational structures, which provide the link between municipalities and the German states. Elections also take place at this level, which demonstrates the impact of the districts at the individual and community level. Districts are responsible for community health, schools and communal family politics. In addition, they are responsible for local public transport, rescue as well as civil and fire protection. Therefore, districts are relevant for organizational structures that may impact individual health.

Individual data were obtained from the cross-sectional German Telephone Health Survey 2006, conducted by the Robert Koch-Institute in Berlin, the central federal institution responsible for disease control and prevention. Data collection took place between October 2005 and March 2006. The Health Survey is a representative, telephone-based survey among German adults. The sample was drawn using the Gabler–Häder-Design (Gabler & Häder, 1997). Selection of the interviewed household member was organized via the last-birthday-method. Overall, the dataset contains 5542 individuals who live in Germany, have a good command of German and are at least 18 years old. Participants were interviewed using a standardized questionnaire. The response rate was 56%.

Dependent variable

The predefined outcome variable was self-rated health. The information about subjective health is considered to be a valid measure for predicting mortality and objective morbidity (Idler & Benyamini, 1997; Malmström et al., 1999). It was measured using a five-point Likert scale (“very poor”, “poor”, “fair”, “good” or “very good”). Subjective health was coded as a binary variable as suggested by Malmström et al. (1999) and Kemptner et al. (2008) for the purposes of logistic multilevel analyses. Therefore, persons rating their health very good or good were combined into one category (1 = good self-rated health) and persons reporting fair, poor or very poor health were coded as the reference category (0 = poor self-rated health).

This dichotomization was chosen for two reasons. First, the number of individuals reporting poor health was too few (3.6% “poor”, 0.8% “very poor”) to perform reliable analyses. Second, the self-rated, objective health summary disease scores of persons in the middle category (“fair”) were, on average, nearer to those with poor subjective health than to persons with good subjective health. Therefore, we grouped individuals with “very poor”, “poor” and “fair” health and compared them to individuals with “good” and “very good” self-rated health.

Independent variables

District variables

The district variables were selected according to their presumed relevance. Most of the chosen variables were also used in analyses by Kemptner et al. (2008).

The representation of health care coverage at the district level was taken as the number of physicians per 100,000 inhabitants. Another variable included was rurality, which describes the proportion of municipalities with a population density of less than 150 persons per km². By means of this indicator, rural areas can be distinguished from urban areas. Higher values of this variable indicate more rural and sparsely populated districts.

To represent sociodemographic aspects, two variables were chosen. The first characterized the proportion of inhabitants aged 65 and older. It provides an indication of the number of retired persons and is therefore an indicator of specific infrastructural demand, such as elderly care. The second sociodemographic variable chosen was the proportion of foreigners living in the district.

To adjust for districts’ economic situations, the unemployment rate and proportion of persons with higher education entrance qualifications were included. The unemployment rate provided information about the labor market and job situation. The proportion of persons with a university entrance diploma reflects the regional qualification potential.

Aside from these economic variables, the gross domestic product (GDP), a measure of wealth per inhabitant, was also included.

Individual variables

The following individual-level independent variables were used to adjust for potential confounding: gender, age (18–25 years; 26–35; 36–45; 46–55; 56–65; 66 and older), and BMI (body mass index), based on the WHO (2008) classifications (<18.5; 18.5–25; ≥25). In addition, we included some variables as indicators of individual health risk and health behavior to further control for...
individual health risk factors: Smoking behavior was divided into smokers (including both regular smokers and occasional smokers), past smokers and non-smokers as suggested by the Federal Centre of Health Education (Latza et al., 2005). The variable alcohol consumption was categorized as high or moderate consumption and low or no consumption. From the survey question regarding daily portions of fruits and vegetables, the consumption of at least three portions per day were defined as “moderate/high” following the definition of Kemptner et al. (2008). Two or fewer portions were categorized as “no/low consumption”. Physical activity was measured as the number of hours of sport activities per week. Persons engaging in more than 1 h/week were contrasted with persons doing less than 1 h of sports activities (Kemptner et al., 2008).

To control for individual socioeconomic circumstances, four other variables were included. The first one was the Winkler-Index, an established and previously validated German measure of social class. The index is based on education (school education and vocational education), income and occupational situation, each with a seven-point scale (Winkler & Stolzenberg, 1999). The Winkler-Index is calculated by summing the three indices. Index values ranged from three to 21 and were grouped into three classes: lower class (three to eight points), middle class (nine to 14 points) and higher class (15–21 points). Married persons were compared to persons living apart from their partner, singles, divorcees and widows/widowers (reference category). Migrants were defined as foreign nationals as well as resettled or displaced persons. We also considered an index of perceived “quality of residence”, which was created from the three variables from the health survey. Each variable was assigned a value of one to three and summed to produce an index score with a range between three and nine. After calculating the median (4) and mean (4.28), a dummy variable was created: scores of three and four, considered to be average or better quality of residence, were contrasted with scores of five and higher, which represented a quality of residence worse than average.

Analyses

Data on individuals were linked with data on district characteristics using the district code number. We used multilevel models to assess individual and district influences on self-rated health among the 5516 individuals (Level 1) nested within the 437 districts (Level 2). On average, there were 12.6 individuals per district; the proportion of areas with less than ten individuals was 53.7%. As the relationship between macro-level variables and micro-level outcomes was the main focus of our analyses, the number of individuals per district was relatively less important (Hox, 1998; Snijders, 2005). For example, previous work has suggested that overall power to detect associations of interest is greater when the number of macro-units is higher, even though the number of individuals within a unit may be relatively few (Bell, Ferron, & Kromrey, 2008; Snijders, 2005; Snijders & Bosker, 1999).

In our analyses, for example, we had a relatively large number of macro-units (n = 437).

We created a series of nested multilevel models. In the first, only district-level variables were included. Subsequently, several models containing the individual-level variables were added and removed for each district variable. To cover different aspects, a socioeconomic model, a lifestyle model, an anthropometric model, a residence quality model and a best AIC/BIC model were calculated for each district variable. All calculated models were run as logistic random-intercept models. Analyses were performed with MLwiN 2.02 using a first order linearization with MQL as the estimation type. A two-tailed p-value < 0.05 was considered to be statistically significant.

The multilevel equation is as follows:

\[
\text{logit}(\pi_{ij}) = \beta_{0ij} + \beta_{1j}x_{ij} + \beta_{2j}x_{j}
\]

\[
\beta_{0ij} = \beta_0 + u_{0ij}
\]

In supplemental analyses, the robustness of our results was tested using three other variables. First, we included an index of objective health to test our subjective health variable. This was a sum score of diseases and health problems, reported by the respondents to be diagnosed by a physician. Second, to control for area influences between Eastern and Western Germany, we included an East-West dummy variable. Third, we considered individual employment measure, which was also part of the Winkler-Index. Due to filtering errors, the employment status was not exactly measured for all cases. Therefore, this variable was only used to adjust for confounding in selected analyses.

Results

Substantial differences existed between the districts with respect to chosen variables (Table 1). The range of the indicators was often very broad (e.g. the area unemployment rates varied from 3.7% to 27.6%, Fig. 1).

The logistic random-intercept models revealed significant associations for unemployment rate, rurality, the proportion of inhabitants aged 65 and older and the proportion of foreigners living in the district (Table 2). After adjusting for individual-level characteristics, significant associations with subjective health remained. Those with good subjective health were found to be living in urban areas with lower unemployment rates, a lower proportion of inhabitants aged 65 and older and a higher proportion of foreigners. With the exception of the unemployment rate, the variance explained by other district-level characteristics was very low. We observed no significant associations between the number of physicians per 100,000 inhabitants, the proportion of persons with higher education and the GDP with subjective health.

In supplemental analyses, we further tested the association of the district-level unemployment rate with subjective health by including individual employment status as a control variable. We also introduced a second geographical variable in the form of an East-West-indicator, a dummy variable distinguishing between Eastern and Western Germany. We did this against the background of German history because there are still differences in many political, social, economic and health-related outcomes between East and Western Germans (Razum, Altenhoner, Breckenkamp, & Voigtlander, 2008). In both models, the association of unemployment rate remained significant. Moreover, we observed that the East-West-indicator itself was also associated with subjective health: Western Germans have higher odds of rating their health as being good or very good.

Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of physiciansa</td>
<td>69.0</td>
<td>393.0</td>
<td>166.60</td>
<td>140.00</td>
</tr>
<tr>
<td>Rurality</td>
<td>0.0</td>
<td>100.0</td>
<td>17.45</td>
<td>4.70</td>
</tr>
<tr>
<td>Inhabitants aged 65b</td>
<td>13.8</td>
<td>25.3</td>
<td>19.15</td>
<td>18.90</td>
</tr>
<tr>
<td>Proportion of foreignesc</td>
<td>0.7</td>
<td>26.0</td>
<td>9.25</td>
<td>8.50</td>
</tr>
<tr>
<td>Unemployment ratec</td>
<td>3.7</td>
<td>27.6</td>
<td>12.06</td>
<td>11.00</td>
</tr>
<tr>
<td>Proportion of personsd</td>
<td>0.0</td>
<td>52.7</td>
<td>24.92</td>
<td>25.30</td>
</tr>
<tr>
<td>GDP with higher educations</td>
<td>12.2</td>
<td>83.4</td>
<td>28.12</td>
<td>24.40</td>
</tr>
</tbody>
</table>

a per 100,000 inhabitants. 
b in %. 
c in 1000 € per inhabitant.
Fig. 1. Unemployment rates in Germany at district level, 2006
Table 2

<table>
<thead>
<tr>
<th>District variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
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</thead>
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<tr>
<td>Unemployment rate</td>
<td>0.965***</td>
<td>0.966***</td>
<td>0.971***</td>
<td>0.976**</td>
<td>0.966***</td>
<td>0.982*</td>
</tr>
<tr>
<td></td>
<td>[0.952–0.978]</td>
<td>[0.953–0.980]</td>
<td>[0.958–0.985]</td>
<td>[0.961–0.992]</td>
<td>[0.953–0.979]</td>
<td>[0.966–0.997]</td>
</tr>
<tr>
<td>ICC</td>
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<td>0.006</td>
<td>0.009</td>
<td>0.014</td>
<td>0.013</td>
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<tr>
<td>Rurality</td>
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<td>0.002</td>
<td>0.003</td>
<td>0.004</td>
<td>0.004*</td>
<td>0.004</td>
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<tr>
<td></td>
<td>0.997**</td>
<td>0.998</td>
<td>0.997**</td>
<td>0.996</td>
<td>0.996**</td>
<td>0.997</td>
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<tr>
<td></td>
<td>[0.995–0.999]</td>
<td>[0.996–1.000]</td>
<td>[0.995–0.999]</td>
<td>[0.992–1.000]</td>
<td>[0.994–0.998]</td>
<td>[0.993–1.001]</td>
</tr>
<tr>
<td>Inhabitants aged 65+</td>
<td>0.947**</td>
<td>0.958*</td>
<td>0.960*</td>
<td>0.963</td>
<td>0.948**</td>
<td>0.957</td>
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<td></td>
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<td>[0.916–0.982]</td>
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<td>0.000</td>
<td>0.000</td>
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<td>0.000</td>
</tr>
<tr>
<td>Proportion of foreigners</td>
<td>1.023***</td>
<td>1.015*</td>
<td>1.120***</td>
<td>1.020**</td>
<td>1.026**</td>
<td>1.017*</td>
</tr>
<tr>
<td></td>
<td>[1.011–1.035]</td>
<td>[1.003–1.027]</td>
<td>[1.008–1.032]</td>
<td>[1.006–1.034]</td>
<td>[1.014–1.039]</td>
<td>[1.003–1.031]</td>
</tr>
<tr>
<td>ICC</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
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<tr>
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<td>5389</td>
<td>5431</td>
<td>5432</td>
<td>5499</td>
<td>5301</td>
</tr>
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<td>N_2</td>
<td>437</td>
<td>437</td>
<td>437</td>
<td>437</td>
<td>437</td>
<td>437</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05.
Model 1: only context variable included.
Model 2: socioeconomic model including social class and marital status.
Model 3: lifestyle model including alcohol consumption, smoking, physical activity and consumption of fruits and vegetables.
Model 4: anthropometric model including gender, age and bmi.
Model 5: residence quality model including the individual living quality.
Model 6: “best fit” model including age, bmi, individual living quality, alcohol consumption, smoking and social class.

Discussion

Living in areas with a higher unemployment rate, a higher degree of rurality, a greater proportion of elderly persons, and a lower proportion of foreigners was associated with increased odds of poorer self-reported health, after adjusting for several individual variables including the employment status of the respondent. This multilevel analysis is the first to examine the relationship between district-level characteristics on individual subjective health ratings across Germany.

Our results concerning the unemployment rate were consistent with the results from an ecological study done in Germany by Queste (2007). The possible mechanisms behind this result could be stress and frustration stemming from a high district unemployment rate. High unemployment rates can lead to distrust, delinquency and violence. This, together or in parts, can have a negative impact on the health of all inhabitants of this area independent of individual employment status (Kawachi & Kennedy, 1997; Marmot & Wilkinson, 2001; Wilkinson, 2000).

Poorer health in rural districts may be attributable to lower levels of infrastructure (Voigtlander et al., 2008). Even though air pollution may be lower and recreational value higher in rural areas, many people may be “trapped” in their village or town, which can be detrimental to health. For example, older persons may be isolated (Cassel, 1976) and not able to reach their physician or participate in social and cultural events.

Areas with more people aged 65 years and older were also associated with poorer health. An explanation for this may be psychosocial (Marmot & Wilkinson, 2001). In regions with many elderly inhabitants, residents are quite often confronted with death and morbidity, compared to regions with fewer elderly inhabitants. This may influence both physical and mental health.

Our analyses found a positive association between the proportion of foreigners per district and health. It may be that areas with more foreigners are more culturally rich and life is more vibrant. This may translate into an overall sense of good health. As this is a new finding, this association deserves future evaluation.

Despite the uniqueness of this study, we acknowledge several limitations in the interpretation of our results. First, the cross-sectional design of the Health Survey does not allow us to establish causal relationships between the variables tested. Second, the response rate might also raise concerns about external generalizability. However, a rate higher than 50% has been considered acceptable in previous work using telephone surveys (Curtin, Presser, & Singer, 2005), especially when obtained through a random digit dialing protocol. Moreover, we tested sensitivity of our results to weighting by age and gender (results not shown) and observed no differences to the third decimal place with the unweighted analyses. Furthermore, due to filtering errors in the CATI system, the current individual employment status was not directly measured in some cases. Therefore, we used the variable dealing with individual unemployment during the last two years. A third potential limitation relates to the usefulness of districts as a unit of study. As previously stated, the number of people per district varied widely across Germany from 50,000 to over a million of people. While districts are unlikely to represent communities or social units, a representative, nationwide survey using smaller geographic units (e.g., those based on postal codes, telephone area codes or geographically defined neighborhoods) has not yet been conducted. Nonetheless, we feel that the results generated from our analysis provide useful insights into the relationship of contextual and compositional characteristics on self-reported health in Germany. Possibly related to the size of the clustering unit (Merlo, Chaix, Yang, Lynch, & Rastam, 2005), we observed that the estimated variance of many district-level characteristics was quite low. We do not interpret this observation as evidence, however, that district-level characteristics are irrelevant to health, as the odds ratios achieved statistical significance in several instances. Fifth, we...
acknowledge the possibility of a missing variable bias even though variable selection was guided by previous work. Sixth, some may question an analysis based primarily on subjective rather than objective measures of health. Previous work demonstrates, however, that subjective measures of health serve as valid indicators of objective health (Malmström et al., 1999) and correlate to a significant extent with more objective measures of health (Idler & Benyamini, 1997). For testing purposes, we included in our models an index of objective health. The association between unemployment rate and subjective health remained significant.

With this Germany-wide analysis we were able to explain variance in subjective health reported at the individual-level with a contextual variable. These important results justify replication in other national samples in the future. As the next step, an examination of the underlying mechanisms may help to further explain why the factor unemployment rate is associated with individual self-rated health. Additionally, more spatial analyses in Germany are needed. Future studies of this kind may be useful in guiding the development of area-specific prevention and intervention programmes.

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