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RESEARCH REPORT

Housing and health in Germany

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Study objectives: To examine the association between housing tenure and self rated health, controlling for socioeconomic measures and testing the mediating effects of physical features of the home, pollution in the local environment, and relationships with neighbours.

Design: Cross sectional panel study with people nested within households. Analyses were performed using multilevel methods.

Setting: Population based sample in Germany.

Participants: People aged 16 or older were interviewed in the 1999 wave of the socio-economic panel study (n = 14 055) and nested within households (n = 7381).

Main results: 44.0% of the population lived in homes that they owned. In bivariate analyses, women, people who live in apartment buildings, reside near cities, live in crowded homes, have homes in need of renovation, report higher pollution, and have distant contact with neighbours are more likely to live in rented homes. In multilevel analyses, renting a home was found to be associated with poor self rated health (OR 1.48, 95% CI 1.31 to 1.68). This relation persisted after controlling for education and income and was partially mediated by the need for household renovation, the perception of air and noise pollution in the local area, and distant relationship with neighbours, all of which were significantly associated with self rated health.

Conclusions: This study provides evidence that home ownership is significantly associated with self rated health in Germany, and this relation may be, in part, mediated by physical and social features of home and neighbourhood.

Housing tenure, as an indicator of socioeconomic position, has been linked to mortality,^{1–3} coronary heart disease,⁴ self assessed health,^{5–7} and mental health^{6–9} in the United Kingdom as well as mortality in Sweden,¹⁰ and the rates of specific cancers in Italy.¹¹ Using housing tenure as an indicator of socioeconomic position, however, does not necessarily answer the question as to what living or working conditions are affected that, in turn, have an impact on health.^{12–14} Researchers have thus turned to investigate physical and psychosocial dimensions of the home, and more generally, of the neighbourhood in which the home is situated.^{7–9 15–16} Mould, dampness, and crowding may be more common in rented homes and poorer households^{17–19}; air and noise pollution may be more likely in their neighbourhood^{20–21}; people may feel a lower sense of control over their surroundings²²; and social relationships, cohesion, and capital in the neighbourhood may be more strained.²³ Each of these factors may have an adverse affect on health.

The aim of this paper is to investigate the association between housing tenure and health in Germany by using a large scale, population based sample and to test potential mechanisms that may mediate any relation between housing tenure and health. Numerous measures of socioeconomic position are controlled for to highlight the relations among the measures and the independent effects of housing tenure. To our knowledge, home ownership has not been tested with regard to health in a large scale sample in Germany.

As the meaning of home, rates of home ownership, and housing prices vary between countries, so too might the way housing relates to health. Germany has one of the lowest rates of home ownership in advanced industrialised countries²⁴ and a housing market that has seen declining prices in real terms.²⁵ Surveys show that the desire to own a home is widespread in Germany, especially among families with young children.²⁶ Thus, Germany represents an important

case study in understanding the complexity of the relation between housing tenure and health.

METHODS

The socio-economic panel study (SOEP) is a longitudinal survey of the German population that began in 1984 and was enlarged to include the re-united East Germany in 1990.²⁷ This report uses the 16th wave from 1999 because, in this year, multiple questions concerning the home and neighbourhood environments were included in the survey.

Sampling was performed through a regionally clustered, multistage design. Within a private household, every member aged 16 and older was asked to participate. People were followed up even if they moved to another location and started a new household (though not outside the country), and all variables used in this study represent the most current household. In addition to the personal interviews, a single household member was asked to complete an additional survey about general household and neighbourhood items. Continuity of the sample between waves and response rates within waves have remained high.²⁷ All people who were interviewed in 1999 and who had the health outcome variable were included (n = 14 055).

Outcome measure

Self rated health, which has been shown to be a reliable indicator of overall health status²⁸ and predictive of mortality in Germany,²⁹ was assessed with a single item answered on a five point Likert scale. Responses were dichotomised with “not so good” and “bad” indicating poor health.

Demographic features

Age was divided into four groups as based on the sample distribution, and sex was controlled for in the study. As foreigners living in Germany were oversampled in the survey and because their housing situation has been shown to be

different from German born persons,³⁰ immigrant status was included.

Socioeconomic variables

Home ownership was divided into owner and renters (including those who rent privately and from state subsidised plans). Education was assessed through years of schooling needed to attain their current degree, and these years were classified into three groups based on the educational system. A measure for relative household poverty was constructed as follows: firstly, the total monthly household income (in DM, after tax deduction and national insurance contributions) was divided by the number of household members (with the first household member having a weight of 1.0 and each additional member with a weight of 0.8) and, secondly, relative poverty was defined as those households having an income less than 50% of the sample's mean.

Household features

To assess the physical household environment, household representatives were asked: "How would you characterise the condition of the house in which you live?" Households were dichotomised into homes in need of renovation (partial to complete) compared with those not in need of renovation. Household crowding was defined by the number of persons in the household divided by the number of rooms. Households were then dichotomised into a low crowding group (two thirds of the households) compared with a high crowding.

Housing type was defined as either a single or double family house (either detached or as part of a row) compared with a building with three or more apartments. A dummy variable was also created if the person lived alone or with other people. This is used here as a crude measure of social ties within the home.³¹

Neighbourhood indicators

Neighbourhood indicators were selected in order to describe the physical and social environment. As living in a rural or urban environment may intersect with these findings, distance to nearest city (in km) was asked. According to the distribution in our sample, distance from city centre was classified as less than compared with greater than 25 km. Each household representative was asked the extent to which they were affected by noise and air pollution (graded on a five point Likert scale). As these two items were highly correlated (0.714, $p < 0.000$), they were summed and then dichotomised into a high pollution (one third of households) compared with low. With regard to the social neighbourhood environment, the household representative was asked how close was their relationship to their neighbours (answered on a five point Likert scale ranging from "very close" to "almost no contact"). Being distant with neighbours was defined as "not close" and "almost no contact".

Whether the respondent lived in the former East or West Germany was also included as a control variable in the study as housing conditions between the two regions have been shown to vary.³²

Statistical analysis

To explore how health as well as home ownership varied between the different variables, cross tabulations with χ^2 statistics were used.

Because bivariate and single level logistic analyses do not account for the fact that people within households will be more alike than people from different households, the analyses are likely to underestimate standard errors. Therefore, multilevel statistical methods were used with individuals nested within households. In the following

equation, the outcome Π_{ij} for the i th individual in the j th household is explained by the fixed intercept B_0 and the m fixed effects or predictor variables:

$$\Pi_{ij} = B_0X_0 + B_1X_{1ijk} + B_2X_{2ijk} + \dots + B_mX_{mijk} + (u + e)$$

The individual error term is represented by e which in binary analyses is confined to 1, and u represents the level 2 (household) error term.³³⁻³⁴ Analyses were conducted using MLwiN version 1.1³⁵ with second order penalised quasilielihood (PQL) used to estimate coefficients and standard errors.³⁶ As self rated health may be conceptualised as a continuum, a "latent variable approach" is used to estimate the household variance partition coefficient.³⁷ This coefficient is used to show the relative importance of the household level variation.

RESULTS

The nested structure of the dataset shows 14 055 people living in 7381 homes. Between one and six people reside in a home, and in 23.4% of homes, people live alone. The sample is almost equally divided between men (48.3%) and women (51.7%). The age distribution is as follows: 31.4% are less than 35 years old, 30.3% are between 35 and 49 years old, 23.6% are between 50 and 64, and 14.7% are 65 or older. People who were foreign born comprise 15.9% of the sample. With years of schooling, 18.8% having nine or fewer years, 51.5% having between 9 and 12 years, and 29.7% having 12 or more. Of the sample, 16.3% (2293 people) describe themselves as being in "not so good" or "bad" health.

Table 1 shows the distributions of the household and neighbourhood indicators. Of the participants, 44.0% live in their own homes and 11.1% live in relative poverty. About half (48.3%) live in buildings with three or more apartments.

Bivariate analyses by home ownership (shown in table 2) show the clustering and distribution across the study population. In relation to the socioeconomic indicators, people who live in poverty and those who have less than or equal to nine years of schooling have higher percentages who rent their homes. Those foreign born have a higher percentage who rent their homes than people who are German born. Younger people, women, people living alone, and those who live in apartment buildings, near cities, have crowded homes and homes in need of renovation, report high pollution, and distant contact with neighbours all have a higher percentage who rent their homes than the respective reference groups.

Turning to the multivariate analyses, the null model shows significant variation at the household level with respect to self rated health (see table 3). The variance partition coefficient is reduced to 25.6% with the inclusion of demographic features, and further reduced to 24.0% with the addition of housing tenure, education, and poverty.

In model 2, which includes demographic information, it is found that age, sex, and immigrant status are all related to the likelihood of reporting "not so good" or "poor" self rated health. In model 3, every variable is tested individually in a model containing demographic information. Household crowding, years spent in your own home, and whether a person resided in the East or the West were all non-significant. People who rented homes had an odds ratio of 1.48 (CI 1.31 to 1.68). In the model that included years of education, immigrant status was no longer significant. Socioeconomic indicators were added simultaneously to an equation containing demographic information in model 4. The effect of housing tenure is only slightly reduced (OR 1.46, CI 1.29 to 1.66). To further test this association, relative

Table 1 Household and neighbourhood characteristics of the 1999 wave of the German socio-economic panel study, grouped by the number of people and households

Indicator	Individuals n = 14055 (%)	Households n = 7381 (%)
Ownership status		
Home owner	6179 (44.0)	2901 (39.3)
Home renter	7876 (56.0)	4480 (60.7)
Poverty status		
Not in relative poverty	11938 (88.9)	6303 (89.7)
Relative poverty	1485 (11.1)	724 (10.3)
Housing type		
1 or 2 family home	7161 (51.7)	3458 (47.7)
3 or more apartments	6681 (48.3)	3796 (52.3)
Need for housing renovation		
No renovation needed	9155 (65.1)	4769 (64.9)
Renovation needed	4847 (34.5)	2580 (35.1)
Household crowding		
Not crowded	8429 (61.2)	4738 (65.8)
Crowded	5333 (38.8)	2468 (34.2)
Living situation		
Lives with others	12331 (87.7)	5657 (76.6)
Lives alone	1724 (12.3)	1724 (23.4)
Distance to nearest city		
Near to city	9005 (64.5)	4806 (65.6)
Distant from city	4948 (35.5)	2520 (34.4)
Pollution in neighbourhood		
Low pollution	10024 (71.7)	5253 (71.6)
High pollution	3953 (28.3)	2084 (28.4)
Relationship with neighbours		
Close with neighbours	10659 (74.4)	5884 (89.8)
Distant with neighbours	3289 (23.6)	669 (10.2)

poverty was replaced with household equivalent income categorised into quartiles and then tertiles (not shown). Home ownership remained a significant factor.

In model 5, remaining household and neighbourhood variables were added. Only those variables which reached significance in model 3 were included. Here the type of house, whether a person lives alone, and the distance to the city centre were not significantly associated with the health outcome. Housing tenure did remain significant and again decreased with these additional factors (OR 1.23, CI 1.04 to 1.46). Renovation and relative poverty were the significant household factors. Perceptions of pollution and relationships with neighbours were the two neighbourhood factors that remained significant in the final model.

DISCUSSION

The study supports the argument that after controlling for multiple measures of socioeconomic position, housing tenure is associated with self rated health in Germany. This contrasts with results from two previous studies, which found that home ownership was not significantly related to self rated health, depression, or functional limitations in Germany; however, these studies had smaller samples restricted to elderly populations.^{38 39} This study further found that the association between housing tenure and health may be mediated by elements of the physical and social environments in the home and surrounding community.

Though home ownership is related to higher levels of education and lower levels of poverty, controlling for education and poverty in multilevel analyses did not eliminate housing tenure's association with health. Furthermore, home ownership in this study is unlikely to just reflect occupation status. In a subgroup analysis of 7150 full time employed people (not shown), it was found that by including occupational prestige (with low status defined as people in the sample with the lowest third on the Treiman scale)⁴⁰ along with education and income, renting your own home remained significantly associated with poor self rated health, though the association was further decreased (OR

1.35, CI 1.13 to 1.60). Thus, home ownership is different from many commonly used measures of socioeconomic position with respect to self rated health.

Moreover, controlling for income, education, and occupation may underestimate the relations between home ownership and health because it does not consider indirect effects, that is, how home ownership may operate through these factors.⁴¹ Home ownership represents a comparatively stable investment that may generate income through appreciation, tax benefits, or other forms of government subsidies.^{24 26} Home owners may live in areas with better school systems or employment opportunities.⁴² Though these indirect effects seem to be small in the model that simultaneously controlled for all three factors, the life stage of the respondent needs to be taken into account. Access to schools, for example, has a very different meaning for someone who is school age compared with an older person. This study also did not control for household assets, savings, insecure home ownership,⁴³ or unemployment,⁴⁴ all of which may be important in further elucidating the relation between housing tenure, socioeconomic position, and health.

Though housing tenure may be related to health through similar mechanisms proposed for socioeconomic position (such as engaging in unhealthy behaviours, low levels of social support, and low access to medical care⁴⁵), this study directs us to features of the home and neighbourhood environment. Psychosocial features may be one link between housing tenure and health. Home has been postulated to be a site of attachment, familiarity, and identity,^{46 47} and it has also been argued to be a site of ontological security where control can be exercised.⁴⁸ Greater attachment and an increased sense of security may accompany owning your own home. Research that has instrumentalised these factors and tested their associations with respect to housing tenure and to health have been rare.^{15 22 49}

Physical housing conditions may also help to explain the association between housing tenure and health. Worse physical features of the home—need for renovation and crowding—were both related to home renting. The need for

Table 2 Bivariate analyses showing the number and percentage of people who lived in rented homes during the 1999 wave of the German socio-economic panel study grouped by sociodemographic, household, and neighbourhood characteristics

Characteristic	Number (14055)	Percentage renters (56%)
Age		
<35 years old	4268	67.1
35 to 49	4126	51.1
50 to 64	3202	50.0
65 or older	1999	52.7
Sex		
Male	6791	54.9*
Female	7264	57.1
Nation of origin		
German born	11821	52.1
Foreign born	2233	76.8
Schooling		
≥12 years of education	4002	52.3
10 to 11.5	6956	54.3
≤9	2536	67.1
Poverty status		
Not in relative poverty	11938	54.7
Lives in relative poverty	1465	68.9
Housing type		
1 or 2 family house	7161	26.6
3+ apartments	6681	87.4
Need for housing renovation		
No renovation needed	9155	48.0
Renovation needed	4847	71.2
Household crowding		
Not crowd	8429	44.5
Crowded	5333	74.6
Living situation		
Lives with others	12331	52.9
Lives alone	1724	78.4
Distance to nearest city		
Near to city	9005	61.5
Far from city	4948	46.2
Pollution in neighbourhood		
Low pollution	10024	52.2
High pollution	3953	65.6
Relationship with neighbours		
Close with neighbours	10659	50.2
Distant with neighbours	3289	75.1
West or East Germany		
West Germany	10239	55.0
East Germany	3816	58.9

*Significant at 0.05 level by χ^2 test. All other values are significant at 0.001 level.

renovation was further associated with worse self rated health. The need for household renovation is a broad category that may include such aspects as mould and dampness. As it does not adequately delineate among the various factors, more explicit questions and quantitative measures are important in future studies. Furthermore, renters may have less control over renovations and, thus, may have responded to the survey question differently. Crowding was not associated with self rated health, which may reflect the fact that diseases are less likely to be of infectious origin in contemporary Western societies. Crowding was defined relative to the sample distribution, and it may be the case that either a subjective sense of crowding or an absolute “over-crowded” level may be more important for health.

Mechanisms that link home ownership and health must also situate the home in the surrounding neighbourhood. Rented homes tend to be clustered together, creating areas of lower socioeconomic status. Neighbourhoods have been postulated to affect health through the physical, social, and service environment.^{13 14 41} In terms of the physical environment, living in a rented home was more common closer to cities and in areas where pollution was high. Pollution was associated with self rated health and decreased the magnitude of the association between home ownership and health. This is consistent with past studies that report air and noise

pollution are more likely to be found among poorer areas and that they negatively affect health in Germany.^{20 21}

The social environment of the neighbourhood may also mediate the effects of housing tenure. This study found that home owners were more likely to report that they were close with their neighbours and this was related to better self rated health. One reason for this may be that home owners in the sample tended to reside in their homes for longer periods of time (analyses not shown) and they may feel more committed to the neighbourhood. These may allow for community networks and social ties to develop^{42 50} and have a beneficial effect on health. This study supports previous evidence from Germany that found that individual level indicators of social capital (reciprocity and civic trust) were correlated with housing satisfaction among the elderly population in Germany and that these were significantly associated with self rated health (submitted data). Though the service environment (such as access to healthy groceries and recreational facilities) was not included in our study, it may also mediate the relation between home ownership and health.

The use of multilevel methods in this study strengthens the validity of the results. Because people from the same household are not assumed to be independent in multilevel modelling, it allowed for the inclusion of the cases within a household while still obtaining unbiased coefficients and

Table 3 Multilevel logistic models of household level and individual level variables in the 1999 wave of the German socio-economic panel study: examining the impact on poor self-rated health

	Model 1—null model		Model 2—demographic characteristics entered simultaneously		Model 3—each variable added separately into an equation containing demographic characteristics		Model 4—all socioeconomic characteristics entered simultaneously		Model 5—all significant factors from Model 3 and 4 entered simultaneously	
	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
Age										
<35 years old			1.0		†		1.0		1.0	
35 to 49			2.50	(2.07 to 3.02)			2.64	(2.16 to 3.22)	2.72	(2.22 to 3.34)
50 to 64			6.44	(5.38 to 7.72)			6.88	(5.67 to 8.33)	7.05	(5.78 to 8.59)
65 or older			12.55	(10.40 to 15.15)			12.31	(10.06 to 15.06)	12.53	(10.14 to 15.48)
Sex										
Male			1.0		†		1.0		1.0	
Female			1.38	(1.244 to 1.54)			1.26	(1.12 to 1.41)	1.26	(1.13 to 1.42)
Nation of origin										
German born			1.0		†		1.0		—	
Foreign born			1.30	(1.11 to 1.52)			0.97	(0.82 to 1.15)	—	
Ownership status										
Home owner					1.0		1.0		1.0	
Renter					1.48	(1.31 to 1.68)	1.46	(1.29 to 1.66)	1.23	(1.04 to 1.46)
Schooling										
≥12 years of education					1.0		1.0		1.0	
10 to 11.5					1.29	(1.10 to 1.52)	1.26	(1.07 to 1.48)	1.25	(1.06 to 1.48)
≤9					1.90	(1.57 to 2.31)	1.75	(1.43 to 2.13)	1.72	(1.41 to 2.09)
Poverty status										
Not in relative poverty					1.0		1.0		1.0	
Relative poverty					1.77	(1.45 to 2.15)	1.64	(1.35 to 2.00)	1.61	(1.31 to 1.96)
Housing type										
1 or 2 family home					1.0		1.0		1.0	
3 or more apartments					1.32	(1.17 to 1.49)			1.06	(0.90 to 1.25)
Need for renovation					1.0				1.0	
No renovation needed					1.36	(1.20 to 1.53)			1.16	(1.02 to 1.33)
Renovation needed										
Household crowding					1.0				—	
Not crowded					1.10	(0.96 to 1.27)				
Crowded										
Housing situation										
Lives with others					1.0				1.0	
Lives alone					1.25	(1.06 to 1.47)			1.12	(0.94 to 1.33)
Distance to nearest city										
Near to city					1.0				1.0	
Far from city					0.87	(0.77 to 0.99)			0.93	(0.81 to 1.06)
Pollution in neighbourhood										
Low pollution					1.0				1.0	
High pollution					1.48	(1.31 to 1.69)			1.38	(1.21 to 1.58)
Relationship with neighbours										
Close with neighbours					1.0				1.0	
Distant with neighbours					1.35	(1.17 to 1.55)			1.20	(1.03 to 1.40)
West or East Germany										
West Germany					1.0				—	
East Germany					0.97	(0.85 to 1.12)			—	
Intercept*			-2.227	(0.036)						
Random†			2.446	(0.143)	†		-3.897	(0.118)	-4.044	(0.128)
Variance partition coefficient			0.424		†		1.041	(0.099)	1.045	(0.101)
Cases in homes			14055	7381	†		0.240		0.241	
							12880	6984	12472	6748

*Shows β coefficient and standard errors; †represents household level variation and standard errors; ‡each of the indicators was added to a model containing age, sex, and immigrant status. Thus these three variables along with the intercept and random component change with each indicator and are not included in the table; —, excluded from analysis because variables did not reach significance in model 3.

standard errors.³³ Multilevel statistics also provide a framework in which housing variables may be defined at the appropriate level. It showed that household level variation (42.6% in the null model) is high, thus highlighting the importance of investigating and developing interventions at the household level. Residual variation (24.1% in the final model) indicates that unmeasured factors at the household level, including a better assessment of the psychosocial and physical environments, require further elaboration.

With few people per household, it is difficult to use multilevel models to specify a very extensive random portion, and thus all variables were entered as fixed effects. As this was one of the first studies examining home ownership and health in Germany, interaction terms were not explored. Future studies should examine these interaction terms to better investigate how the associations are changed by sex, age, race, immigration status, whether the person resides in East or West Germany, and income inequality in the neighbourhood.^{13 40 51} The fact that women were more likely to report worse health, even after controlling for socio-demographic indicators is consistent with previous studies and in need of further investigation.⁵²

Additional limitations need to be discussed. Firstly, because multilevel statistics were used, each person was given the same weight, and the results are therefore not nationally representative. Secondly, as this study is cross sectional, it is subject to the problem of common method variance, and no causal inference can be drawn as to the association between housing tenures and self rated health. Furthermore, the health measure was obtained through self report rather than objective measures or events and other potential health confounders, including mental illness, were not included. Depression, for example, may bias not only the reported health status but also perceptions of home and the local environment. The fact that self reported health was highly correlated with being legally disabled (0.353, $p < 0.000$) and depression (0.513, $p < 0.000$) lends further credence to its importance as an indicator of overall health. These limitations call for a prospective study design that uses objective measures of health.

Thirdly, as household and neighbourhood level variables were assessed by a single household representative, they do not account for varying opinions that may exist between members of the same household. In addition, the head of household may have felt pressured to make the home and neighbourhood seem better (so as to appear as a good provider). Fourthly, obtaining objective measures of the home and environment, on such features as dampness, pollution, and local amenities are also important in future studies.

Advantages of this study include its use of a large scale, population based sample to explore how home ownership is related to self rated health, controlling for multiple socio-economic confounders and investigating numerous potential mediators. The use of multilevel methods further allows for the correct specifications and estimations. Rather than simply implementing policies to encourage home ownership, further exploration is needed to better understand how the physical and psychosocial environments in the home and the surrounding neighbourhood may affect health.

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THE JECH GALLERY

Inequalities in health are often only a matter of yards apart

In urban India fortunate middle class areas may have water closet latrines such as these. Meanwhile, slum dwellers living yards away may depend on the roadside or any nearby piece of waste land for defecation. Sanitation remains a top priority for global health.

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