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Social Deprivation and Secondhand Smoke Exposure Among Urban Male Residents: A Nationwide Study of China

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Abstract

Introduction

Social deprivation is a known determinant of health and related behaviors. Many studies have linked socioeconomic status to secondhand smoke (SHS) exposure. However, no studies have examined the relationship between social deprivation and SHS exposure. This study examined whether social deprivation has any independent effect on SHS exposure at both individual and regional levels among Chinese residents.

Methods

A cross-sectional multistage sampling design was utilized to interview subjects from 6 selected cities in China. A standardized questionnaire was used to tap demographic characteristics, social deprivation and SHS exposure. Multilevel logistic regression models were used to assess the association between social deprivation and SHS exposure.

Results

5,782 valid questionnaires were collected in this study. Of 2,930 non-smokers, the SHS exposure prevalence was 21.9% (95% CI 19.5, 24.30). Multilevel logistic regression showed a negative association between family income, regional GDP and SHS exposure, and positive associations between social deprivation and SHS exposure, respectively.

Conclusions

Findings support the central proposition that social deprivation influences SHS exposure messages. Our research underscores the importance of reducing health inequality in controlling SHS exposure.

Implications

The information from this study should be helpful when considering effective SHS exposure control policies and interventions among urban residents in China. Targeted interventions for SHS exposure should help reduce health inequities across social class. With this in mind, SHS exposure control for socially deprived groups should be paid attention.

Introduction

Secondhand smoke (SHS), also known as passive smoke, is formed from the burning of cigarettes and other tobacco products, and also from smoke exhaled by smokers. The World Health Organization (WHO) has estimated approximately one-third of adults and 40% of children worldwide were exposed to SHS (World Health Organization, 2008). The International Labor Organization estimates at least 200,000 workers die each year due to exposure to SHS (Takala, 2002). Studies found SHS was very common in households, workplaces and public places (Yang et al., 2015; Ye et al., 2014) in China. According to the 2018 *China Global Adult Tobacco Survey* conducted by Chinese Center for Disease Control and Prevention, 50.9% of adults were exposed to SHS in the workplace, 12.9% on public transportation and 73.3% in restaurant. *China Global Youth Tobacco Survey* in 2014 showed that 58.2% of youth (ages 13-15) are exposed to SHS in outdoor public places, 57.2% in indoor public places, 44.4% at home and 37.9% on public transports. Several studies have linked exposure to SHS to a number of health consequences in non-smokers, including lung cancer, heart disease, and asthma in children (World Health Organization, 2008; US Department of Health and Human Services, 2006).

Many studies found that individuals with low socioeconomic status (SES) have high SHS exposure prevalence (Gan, Mannino, and Jemal, 2015; Bonevski, Paul, Jones, Bisquera, and Regan, 2014; Nazar, Lee, Arora & Millett, 2016). Thus, SHS exposure may be a characteristic of social disadvantaged groups. The fundamental cause theory of health argues that health outcomes develop out of a series of intermediators, such as health behaviors, environmental pollution, risks of injury and harms. Behind these intermediators, people can mobilize their flexible resources to avoid the harmful intermediators and promote the beneficial ones (Link and Phelan, 1995, 2010). Lacking the full set of resources to change the intermediators, socially deprived individuals are thus unable to achieve desirable health outcomes. More importantly, the distribution of these flexible resources, such as schooling, housing, institutional investment, money and connections, are often unequally distributed in a society and subjected to zero-sum competition. The limited total size of flexible resources and their uneven distribution blocks socially deprived individuals from useful health information and healthcare resources. As a research concept, social deprivation factors into a broad network of correlated factors that contribute to

social exclusion; they may include poverty, poor education, inconvenient accommodation, minority status and low socioeconomic status. Personal social standing is a powerful determinant of the amount and quality of personal health beliefs and behaviors, which mitigate the impact of health problems. With fewer available material resources (e.g., money) and symbolic resources (e.g., education and prestige), a person of lower status is likely more severely challenged to avoid risky health behaviors. Those with fewer resources have fewer opportunities, less extensive social networks, less personal freedom, more unsafe working conditions, and less confidence in addressing a health threat (Markwicket, Ansari, Sullivan, Parsons, and McNeil, 2014). Due to subordination in a ranked hierarchy of status and commodities, socially deprived individuals also tend to have less perceived power to control their lives and more suppressed self-efficacy in achieving goals, which in turn heighten risks of developing mood disorders and other mental illness (Yang, Hu and Schieman,2019). The negative impact of a power differential has even been documented among non-human primates. Although speculation, these same consequences may apply to humans in disadvantaged social positions (Yang, 2016).

Social deprivation is a known determinant of health and related risk behaviors. It is now well established that social deprivation is associated with multiple diseases (Siegrist and Marmo, 2006; Struthers, Anderson, Donnan, and Macdonald, 2000; Romeri, Baker and Griffiths, 2006), and it has been commonly reported in the health literature. People who live in more socially deprived areas have a greater prevalence of behavioral questions than counterparts in less socially deprived areas (Adams, Howard, Tucker, Appleton and Taylor, 2009; Ocaña-Riola et al,, 2008; Chivu and Reidpath, 2010). Smoking is a group behavior in China, and many studies have shown individuals with lower SES or in a socially deprived group may have excess tendency to smoke (Barbeau, Krieger and Soobader, 2004; Hiscock, Bauld, Amos, Fidler and Munafo, 2012). This, it is possible they also have excess SHS exposure. However, the contradictory phenomenon that separates the social experience of smoking in China from that in the West is the fact that cigarette smoking in China is typically associated with greater social standing and connections (Yang, 2020; Yang and Hendley, 2018). This cultural peculiarity confounds the assumption that SHS is also associated with social deprivation—even though our theoretical framework is based on fundamental cause theory, with social deprivation implicated in SHS.

Given the absence of published studies, there is a need to investigate social deprivation's influence on SHS exposure. This study will yield new information on understanding how social deprivation influences SHS exposure, and on the importance of reducing health problems though preventing SHS exposure among socially disadvantaged groups. This is particularly germane to China whose residents have relatively high exposure to SHS in their home, workplaces and public venues compared to residents in other countries (Yang, Jiang, Barnett, Peng, and Yu, 2015).

Methods

Study Area and Participants

This was an observational cross-sectional, multilevel study with a multi-staged cluster sampling design. Six cities were selected from across China and differentiated by regional location. Within each city two residential districts were randomly selected from the main urban zones, and four communities were randomly selected within each district. Within each community the family household registration list was used to randomly sample households. The sample was limited to males aged 15 years and older who had resided in these cities for at least 1 year (Yang, Zhu, Barnett, Zhang, and Jiang, 2019). Finally, one respondent, whose birth date was closest to date of contact, was selected from each household to be surveyed if there were two or more male residents. Further details are documented elsewhere (Yang, Zhu, Barnett, Zhang, and Jiang, 2019).

Data Collection

A self-administered questionnaire was scheduled once an individual was identified and agreed to participate in the survey. All responses were anonymous, and each respondent was afforded an opportunity to seek clarification about survey questions. The same survey protocol was used across the six cities to assure homogeneity of interview and data collection. The survey was administered privately to participants in their home or a designated quiet place, such as a backyard or community park. Surveys were conducted on Saturdays, Sundays, or during the evening or at other times when the participants were available. The survey was conducted between June and October July 2016. The study was approved by the ethics committee of Zhejiang University. Verbal consent was obtained from all respondents following verbal instruction from an investigator. Respondents received a gift worth 10 *yuan* in RMB after questionnaire completion (Yang, Zhu, Barnett, Zhang, and Jiang, 2019).

Variable Definition and Measurement

Dependent variable

SHS exposure was assessed through self-report. We defined SHS exposure as non-smokers who reported daily exposure to SHS for at least 15 minutes per day (Centers for Disease Control and Prevention, 2015; Yang et al., 2015). SHS was the dependent variable in this study and was coded dichotomously as 1 = exposure and 0 = non-exposure.

Independent variable

As commonly conceived, social deprivation indicators include overcrowding, not owning a car, and familial unemployment (Carstairs and Morris, 1990; Stansfeld et al., 2004). In this study, our social deprivation variable comprised these three elements, with overcrowding being defined as family housing space per capita of less than 10 square feet. Survey responses to related questions were coded dichotomously as 0= Yes and 1 = No. The extent of their presence differentiates the degree of social deprivation, with values ranging from zero to 3.

Covariates

Individual-level independent variables

Sociodemographic characteristics include age, gender, ethnicity, educational level, occupation and family income. Family income was obtained by asking respondents to report average income per person in the household in the prior year. Educational attainment and family income may differentially reflect social deprivation.

District in city-level independent variables

The extent to which people are exposed to SHS also reflects district-level characteristics. A key variable in this study was district economic status, and it was measured as per capita gross domestic product (GDP), and differentiated as <70,000, 70,000–99,999, and 100,000+ *yuan.* The data were obtained from official local government websites, such as the GDP for each district in Hangzhou

(http://www.yhtj.gov.cn/upload/file/20170125/6362094967627151571192686.doc).

Data analysis

All data were entered into a database using Microsoft Excel. The dataset was then imported into SAS (9.3 version) for the statistical analyses. Descriptive statistics were calculated for SHS exposure prevalence. Series unadjusted logistic models were built for each primary predictor. The multilevel logistic regression model used the SAS NLMIXED procedure to determine associations between social deprivation and SHS exposure (Grilli and Pratesi, 2004; Yang, Jiang, Barnett, Peng, and Yu, 2015). We constructed several models for the multilevel logistic regression analyses. The first was the 'null' model, a two-level model (individual and district) with random intercepts. The constant was the sole predictor in accounting for cross-district variation in SHS exposure. In this base model, we entered all demographic variables to form model 1 (demographic model), as fixed main effects, to evaluate the impact of demographics on SHS exposure. In this demographic model, we entered family income and the three key elements of social deprivation to form model 2 (family economic-social deprivation model), added district per capita GDP and three key elements of social deprivation to form model 3 (regional economic-social deprivation model), and then added family income and total social deprivation to form model 4 (family economic-total social deprivation model), regional income and total social deprivation to form model 5 (regional economic-total social deprivation model), respectively. SAS 9.3 was applied to run the complex survey data analysis procedure, using community as the clustering unit in order to account for within-clustering correlation.

All analyses were weighted. Weights included (1) sampling weights, as the inverse of the probability of selection, calculated at city and district-levels, and then multiplied together; (2) Nonresponse weights comprised household and individual aspects; (3) Post-stratification weights were calculated using age (< 25, 25–34, 35–44, 45–54, and 55 years and older), based on estimated distributions of these characteristics from a national survey (National Bureau of Statistics, 2017). The final overall weights were computed as the product of the prior three sets of weights.

Results

A total of 6,500 individuals was identified as potential participants for this study, of whom 6,010 (93.9%) were contacted and agreed to participate in the survey. Of the 6,010 surveys collected, 5,782 (96.2%) were complete and valid questionnaires. Of the respondents, 2,930 were non-smokers, and were thus included in this study. Of the sample, 25.4% were younger than 25 years of age, and 23.5% were 55 years and older; most (95.1%) were Han nationality; 47.6% had high school or less education; approximately 4.8% were divorced or widowers; many worked in operations, were students, or worked in commerce and service occupations (Table 1).

SHS exposure prevalence varied across age, education, occupation, family and regional income, and degree of social deprivation (Table 1). The results of the multi-level analysis indicated age, occupation, family and regional income, and social deprivation were significantly associated with exposure (Table 2).

Model 1 showed SHS exposure was significantly associated with age and occupation—SHS exposure prevalence was lower in the 35-44 age group (OR: 0.63) and retirees (OR: 0.43), and students (OR: 0.33) than among referents. Model 2 showed individuals with 60,000 *yuan* or more family income had less SHS exposure (OR: 0.81). Model 3 showed individuals in areas with per capita GDP of 100,000 *yuan* and higher also had less SHS exposure (OR: 0.69). Compared to the referent, individuals in no-car households had excess SHS exposure prevalence—the OR was 1.17 in Model 2 and 1.19 in Model 3. Those in overcrowded households had excess SHS exposure prevalence—the OR was 1.47 in Model 2 and 1.38 in Model 3, as did those in households with an unemployed person—the OR was 1.30 in Model 2 and 1.16 in Model 3 (Table 2). Compared to the reference group, individuals with social deprivation scores of 2 and 3 had significantly greater SHS exposure prevalence than those with a score of zero—respective ORs were 1.26 and 1.52 in Model 4, and 1.24 and 1.30 in Model 5.

Discussion

This study is the first to examine the association between social deprivation and SHS exposure. We found a SHS exposure prevalence of 21.9% (95 % CI 19.5, 24.30) among non-smokers, affirming the fact that SHS exposure among nonsmokers is common in China. Socioeconomic inequalities are generally associated with SHS exposure and health problems. This study provided additional evidence that those living in poorer households and districts had higher SHS exposure rates than those who did not, as consistent with findings from previous Chinese research (Yang et al., 2015). Lower economic attainment means fewer educational opportunities, less health awareness, fewer social networks and less safe work environments (Cottrell & McKenzie, 2011). This constellation of factors may make people more exposed to SHS (Yang, Jiang, Barnett, Peng, and Yu, 2015). Lower socioeconomic status may reflect social deprivation. Study findings support our proposition that social deprivation contributes to SHS exposure.

We found three indicators of social deprivation in subject households: 29.5% (95%CI: 22.3%, 36.7%) of respondents lived in housing with an unemployed member, 5.1% (95%CI: 3.0%,7.9%) were in overcrowded housing, and 56.7% (95%CI: 47.2%, 66.1%) had no family car ownership. Of all households, 36.6% (95%CI: 23.9%, 40.7%) had none of the three elements, 45.6% (95%CI: 43.7%, 47.5%) had one, 19.7% (95%CI: 8.4%, 30.9%) two, and the residual, 2.1% (95%CI: 1.1%, 3.2%), had all three.

Addressing a gap in the literature, this study found evidence of a significant association between social deprivation and aforementioned three elements, and SHS exposure. Understanding the nature of this association is now crucial in order to reduce the amplifying effect that social deprivation has upon SHS exposure, which aligns with other health problems (Siegrist and Marmo, 2006; Struthers, Anderson, Donnan and Macdonald, 2000; Adams, Howard, Tucker, Appleton and Taylor, 2009; Ocaña-Riola et al, 2008). The association may be explained by both risky situation exposures and individual resources and behaviors. Individuals with lower SES or in a socially deprived group may be more likely to smoke (Barbeau, Krieger, and Soobader, 2004; Hiscock, Bauld, Amos, Fidler and Munafo, 2012), and face excess exposure to SHS situations. At the same time, individuals with a socially disadvantaged status tend to lack health awareness, vigilance towards harmful effects of second-hand smoke, and a behavioral mitigation strategy against second-hand smoke (Yang et al., 2015; Hiscock, Bauld, Amos , Fidler and Munafo, 2012), and thus have a higher prevalence of SHS exposure.

Our research indicates exposure to secondhand smoke among socially deprived groups is a serious public health problem. Targeted interventions will help reduce health inequities across social class. While society is changing rapidly, it manifests great social inequality and anomie (Yang, Wu Zhang , Cottrell and , Rockett, 2012), which in turn exacerbate health inequality. As Nobel Laureate economist Angus Deaton stated: “When inequality is the handmaiden of progress, we make a serious mistake if we look only at average progress. But the story is one of both growth and inequality, not just income, but health too” (Deaton, 2015). Health inequality should be treated as an important social issue. Health inequality was found to exist among individuals of levels of SES and family

economic status in China (Hu, 2015). In 2016, the central government issued the “Healthy China 2030” Planning Outline, which attached great importance to health inequality.

This study calls for attention to health problems among the disadvantaged. There is an urgent need to address SHS exposure among them in national and local health-sector policies and programs. Public education campaigns needto promote greater awareness of the negative consequences of SHS exposure. Educational efforts especially need to target vulnerable people, with some public awareness campaigns including television, mobile phone media, internet and billboards. Equally important is the implementation of environmental smoking restriction strategies. According to the World Health Organization, smokefree policies are the most effective way to reduce exposure to tobacco smoke in public venues (World Health Organization, 2014). There is a tendency for these policies to focus on venues with more favorable conditions for easy implementation of smokefree measures, such as government offices, hotels, hospitals, schools and public transport. However, this focus ignores the health right of vast numbers of highly vulnerable people to breathe fresh air. Although two five-year plans for Basic Public Service System have been issued in China, none of them covers regulations on SHS control to protect the socially deprived group. Smokefree policies should also cover venues where these people are concentrated, such as construction sites, small factories and ‘sweatshops’.

Limitations

The study has strengths and limitations. It is the first study to examine the influence of social deprivation upon exposure to SHS in China or elsewhere in the world. The cross-sectional study design is an important limitation. Therefore, a causal link between social deprivation and SHS exposure cannot be established. However, we employed a multilevel study design, both individual and regional, and our findings met several criteria for inferring causality, which include the strength of some associations, their consistency, and biological plausibility. Regardless, it is implausible that SHS exposure leads to social deprivation. Longitudinal follow up will provide an opportunity to further evaluate this association.

Conclusions

This study provides new information about the influence of social deprivation on exposure to SHS among urban male residents in China. This information may facilitate understanding of the high SHS exposure prevalence among socially disadvantaged groups in China. Our results highlight the need to control secondhand smoke and SHS exposure, in order to protect the health of socially and economically vulnerable populations.

Declarations

- Ethics approval and consent to participate

This study was approved by the Ethics Committee at the Medical Center, Zhejiang University, and verbal consent was obtained from all participants prior to data collection.

- Consent for publication

All authors are consent for publication

Not applicable.

- Availability of data and materials

The survey was conducted between June and October 2016. The datasets analyzed during the current study are available from the corresponding author on reasonable request.

- Competing interests

The authors declare that they have no competing interests.

- Funding

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- Authors' contributions

TY and WH conceived the study design, conceptualized the ideas, and supervised the data management and analyses. YY,SP, LY and XY conducted the data collection. TY and YY wrote the preliminary draft, while XY and IR revised and edited the manuscript. All authors reviewed earlier drafts and approved the final version.

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Tables

Table 1. Demographic characteristics of the sample and secondhand smoking (SHS) exposure prevalence.

Group	N	% of sample	SHS exposure prevalence	Adjusted OR
Individual level				
Age (years)				
<25	618	25.4	17.9	1.00
25-34	697	19.7	20.0	1.18(1.02,1.34)*
35-44	618	15.9	22.8	1.37(0.91,2.07)
45-54	526	15.4	29.8	1.97(0.96,4.03)
55+	471	23.5	22.2	1.33(0.78,2.25)
Ethnicity				
Han	2772	95.1	22.1	1.00
Minority	158	4.9	19.3	0.83(0.53,1.32)
Education				
Elementary school or less	198	10.4	24.7	1.00
Junior high school	462	18.2	28.3	1.21(1.05,1.39)
High school	709	19.0	25.7	1.06(0.84,1.33)
Junior college	670	19.1	22.6	0.89(0.55,1.45)
College or more	891	33.4	15.0	0.52(0.37,0.71)**
Marital status				
Never married	1110	38.1	18.0	1.00
Married	1706	57.1	24.3	1.45(0.90,2.36)
Divorced	52	1.8	31.9	2.11(0.59.7.52)
Widowed	62	3.0	17.5	0.96(0.50.1.86)
Occupation				
Manager or clerk	393	10.2	22.9	1.00
Professional	376	12.1	23.0	1.00(0.74,1.63)
Commerce and service	537	16.0	27.9	1.30(1.04,1.63)*
Operations	668	20.7	25.5	1.16(0.87,1.56)
Retiree	270	11.2	16.3	0.66(0.52,0.84)**
Student	443	19.2	10.8	0.41(0.31,0.54)**
Unemployed	90	3.0	30.9	1.52*1.13,2.05)**
Other	161	67	29.2	1.39(0.89,2.15)
Household income per capita (Yuan)				
<20,000	775	28.8	22.7	1.00
20,000-39,999	805	27.6	24.5	1.11(0.97,1.27)
40,000-59,999	546	16.2	20.5	0.88(0.61,1.27)
60,000+	804	27.4	19.3	0.82(0.74,0.90)**
Social deprivation elements				

Own car				
Yes	1432	43.3	19.4	1.00
No	1498	56.7	23.8	1.27(1.14,1.42)**
Housing area(m^2)				
10+	2769	94.9	21.5	1.00
<10	161	5.1	30.1	1.58(1.39,1.79)**
Household unemployment				
No	2049	70.5	21.0	1.00
Yes	881	29.5	24.2	1.20(1.07,1.35)**
Social deprivation(score)				
0	1072	36.6	19.3	1.00
1	1254	45.6	21.1	1.12(1.02,1.39)*
2	526	19.7	27.7	1.27(1.15,1.39)**
3	78	2.1	25.3	1.42(1.08,1.87)*
Regional level				
District GDP (Yuan)				
<70,000	640	8.7	26.4	1.00
70,000-99,999	1020	34.0	24.6	0.92(0.78,1.09)
100,000+	1270	59.4	19.6	0.68(0.54,0.87)**

Table 2. Multivariable analysis of secondhand smoking (SHS) exposure prevalence.

Group	Null model	Demographic model (Model 1)	Family Economic-Social deprivation element model (Model 2)	Regional Economic-Social deprivation element model (Model 3)	Family Economic-Social deprivation model (Model 4)	Regional Economic-Social deprivation model (Model 5)
Individual level						
Age (years)						
<25		1.00	1.00	1.00	1.00	1.00
25-34		0.82(0.65,1.03)	0.57(0.43,0.76)**	0.56(0.42,0.74)**	0.54(0.42,0.78)**	0.55(0.43,0.70)**
35-44		0.63(0.42,.93)*	0.62(0.49,0.77)**	0.57(0.47,0.68)**	0.61(0.49,0.76)**	0.58(0.49,0.69)**
45-54		0.88(0.47,1.63)	0.85(0.56,1.31)	0.79(0.53,1.19)	0.85(0.61,1.20)	0.81(0.53,1.21)
55+		0.75(0.48,1.18)	0.74(0.62,0.87)**	0.69(0.59,0.81)**	0.71(0.62,0.82)**	0.71(0.60,0.84)**
Occupation						
Manager or clerk		1.00	1.00	1.00	1.00	1.00
Professional		0.81(0.54,1.22)	0.88(0.43,1.16)	0.96(0.72,1.29)	0.94(0.71,1.26)	0.96(0.71,1.30)
Commerce and service		1.00(0.83,1.19)	1.16(0.92,1.47)	1.19(0.96,1.46)	1.17(0.95,1.45)	1.17(0.95,1.46)
Operations		1.08(0.82,1.08)	1.13(0.92,1.38)	1.05(0.91,1.21)	1.03(0.81,1.30)	1.04(0.91,1.18)
Retiree		0.43(0.31,0.59)**	0.60(0.42,0.88)**	0.59(0.46,0.77)	0.59(0.47,0.74)**	0.59(0.46,0.77)**
Student		0.33(0.19,0.58)**	0.27(0.21,0.35)	0.25(0.19,0.33)**	0.26(0.20,0.35)**	0.24(0.19,0.32)**
Unemployed		0.94(0.70,1.26)	1.20(0.89,1.60)	1.23(0.97,1.57)	1.02(0.87,1.22)	1.23(0.95,1.59)
Other		0.89(0.67,1.19)	1.26(0.87,1.83)	1.19(0.90,1.56)	1.29(1.02,1.66)*	1.16(0.86,1.54)
Household income per capita (Yuan)						
<20,000			1.00		1.00	
20,000-39,999			1.12(0.98,1.22)		1.13(0.98,1.23)	
40,000-59,999			0.89(0.66,1.21)		0.87(0.65,1.22)	
60,000+			0.81(0.59,0.94)*		0.83(0.58,0.97)*	
Social deprivation elements						
Own car						
Yes			1.00	1.00		
No			1.17(0.97,1.41)	1.19(1.06,1.36)**		
Housing space (m^2)						
10+			1.00	1.00		
<10			1.47(1.29,1.66)**	1.38(1.03,1.55)**		
Household unemployment						
No			1.00	1.00		
Yes			1.30(1.04,1.46)*	1.16(1.02,1.34)*		

Social deprivation(score)						
0					1.00	1.00
1					1.06(0.91,1.22)	1.09(0.96,1.24)
2					1.26(1.07,1.49)**	1.24(1.09,1.41)**
3					1.52(1.28,1.81)**	1.30(1.11,1.76)**
Per capita (GDP) in district (Yuan)						
<70,000				1.00		1.00
70,000-99,999				0.94(0.79,1.12)		0.93(0.78,1.10)
100,000+				0.69(0.57,0.81)**		0.68(0.57,0.80)**
Fixed parameters	4.16**	3.20**	2.33*	1.86	2.17*	1.94
Random parameters between districts	3.06**	3.01**	1.88	1.91	2.06*	2.22*

*p < 0.05, **p, 0.01