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Neighborhood Cohesion is Associated with Reduced Risk of Stroke Mortality

Cari Jo Clark, Sc.D., Hongfei Guo, Ph.D., and Scott Lunos, M.S.

University of Minnesota

Neelum T. Aggarwal, M.D., Todd Beck, M.S., Denis A. Evans, M.D., and Carlos Mendes de Leon, Ph.D.

Rush University Medical Center

Susan A. Everson-Rose, Ph.D.

Abstract

Background and Purpose—Greater social cohesion is related to lower rates of coronary heart disease, but its relation to stroke risk is unstudied. This study examined whether neighborhood social cohesion was protective against stroke mortality and incidence.

Methods—Data come from 5,789 participants (60% female; 62% black; mean age, 74.7 years) in a longitudinal study of chronic diseases in the elderly. Stroke mortality, ascertained through 12/31/07, was verified via the National Death Index; 186 stroke deaths were identified in 11 years of follow-up. Stroke incidence was determined in a subset (N=3,816) with linkage to Medicare claims files; 701 first-ever strokes were identified. Cohesion was measured by 6 items assessing frequency of contact and social interactions with neighbors; items were z-scored and averaged. Individual scores were averaged across 82 census block groups, forming a neighborhood-level measure of social cohesion. Marginal Cox proportional hazard models tested the association of neighborhood-level cohesion with stroke mortality and incidence.

Results—Each one-point increase in cohesion related to a 53% reduced risk of stroke mortality (hazard ratio (HR)=0.47; 95% confidence interval (CI)=0.24, 0.90), adjusting for relevant covariates, including sociodemographics, known stroke risk factors and neighborhood-level socioeconomic status. A race x cohesion interaction ($p=0.04$) revealed cohesion was protective in whites (HR=0.34, 95% CI=0.17, 0.67) but not blacks (HR=1.17, 95% CI=0.35, 3.86). Cohesion was unrelated to stroke incidence ($p>0.5$).

Conclusion—Neighborhood-level social cohesion was independently protective against stroke mortality. Research is needed to further examine observed race differences and pathways by which cohesion is health-protective.

Keywords

Stroke; psychosocial; mortality; social conditions

University of Minnesota, 717 Delaware Street, SE, Ste 166, Minneapolis, MN 55414, Phone: 612.626.6876, Fax: 612.626.6782, saer@umn.edu.

Conflicts of Interest/Disclosures

The authors have no conflicts of interest to disclose.

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INTRODUCTION

Research on the impact of neighborhoods on health has grown dramatically over the past several years.(1) Most of this research has been on the relationship between the physical environment and poor health.(2) More recently, research on the relationship between the social environment and health has gained momentum, although most frequently related to mental health conditions,(2) with growing attention being paid to cardiovascular disease (CVD). However, the relationship between the social environment and stroke risk remains relatively unstudied.

Among the studies investigating neighborhood social environments and stroke risk, low socioeconomic status (SES) has been the most widely studied, with consistent evidence showing an inverse association.(3-8) Studies on the relationship between other measures of the social environment and stroke risk are sparse. Demographic measures of social isolation, such as percent living alone, have been associated with increased risk of stroke mortality.(8, 9) A country-level measure of volunteering has been shown to be inversely correlated with stroke mortality in a multi-country study, although the association was only of marginal significance.(10) These studies suggest that a lack of social cohesion may be detrimental to cardiovascular health and greater levels of social cohesion might be cardioprotective. To our knowledge, however, no study has directly examined the relationship between neighborhood level social cohesion and stroke mortality.

Therefore, this study was designed to examine the relationship between social cohesion at the neighborhood level and risk for stroke mortality in a cohort of older blacks and non-Hispanic whites, a subject population that may be particularly affected by their immediate environment due to the constriction of social space with age.(11) We hypothesized that greater neighborhood-level social cohesion would be protective against stroke mortality. Racial differences in the effect of the neighborhood social environment on health outcomes(12, 13) have been reported; therefore, we also examined potential racial differences in the relationship between social cohesion and stroke mortality.

MATERIALS AND METHODS

Population

This study utilizes data from the Chicago Health and Aging Project (CHAP), which is an ongoing, longitudinal, population-based study focused on the risk of Alzheimer's Disease and other chronic diseases of the elderly.(14) The baseline sample was drawn between 1993 and 1996 via a census of three adjacent neighborhoods in south Chicago, which represent 20 census tracts and 82 census block groups. These neighborhoods were chosen for the study because of their stability and the diversity of socioeconomic levels represented within the neighborhoods' two main racial groups, blacks and non-Hispanic whites. Residents aged 65 and older were eligible to participate, of whom 78.7% (n=6,158) agreed(14); this sample is considered the original cohort. Due to missing values on variables of interest, the analytic sample was 5,789. Questions assessing neighborhood conditions were added at the third cycle of data collection (2000-2002). These questions were asked of the surviving members of the CHAP original cohort and of a successive cohort of neighborhood residents who had become 65 years old since the baseline assessment and who were recruited to CHAP beginning in 2000 using information from the original census. We used the information on neighborhood cohesion from both the original and successive cohorts at cycle three to create our exposure variable (details below). The Institutional Review Board of Rush University Medical Center approved the study and all participants provided written, informed consent.

Measures

Outcomes—Information on vital status is obtained at each cycle of data collection and through annual phone contact with participants. Reported deaths are verified using the National Death Index (NDI). NDI started using ICD-10 codes in 1999; therefore, ICD-10 codes I60-I69 were used to classify stroke mortality occurring in 1999 and beyond; ICD-9 codes 430-438 were used for stroke deaths occurring prior to 1999. Mortality ascertainment in CHAP is complete through December 31, 2007; 84.1% of 3,910 total deaths have been verified via NDI and of these, 78.4% have known causes of death. Stroke deaths represented 8% of verified deaths with a known cause. The analytic sample includes 186 stroke deaths (120 female, 66 male; 85 whites, 101 blacks).

Stroke incidence was ascertained via linkage with Center for Medicaid and Medicare Services (CMS) claims files. CMS claims data were available through 12/31/2007 and linkages were attempted for all CHAP original cohort participants, with an 88.2% match rate. Incidence was defined as first hospitalization of stroke among those participants without a self-reported history of stroke at the initial CHAP baseline, with only occurrences among participants not actively in an HMO included in the count of events. CMS still uses ICD-9 codes so all hospitalizations coded with ICD-9 codes 430-438 were counted as stroke hospitalizations. Among 4,076 participants meeting these criteria and thus eligible for analyses of stroke incidence, 706 first-ever stroke events were identified. Due to missing data on our predictor or covariates, analyses of incident stroke were limited to 3,816 participants, among whom 701 first-ever strokes (403 female, 298 male, 338 whites, 363 blacks) occurred during follow-up.

Predictor

Neighborhood social cohesion was self-reported during the study's third cycle of data collection using a validated scale with 6 items: How often (often, sometimes, rarely, or never) in your neighborhood: 1) do you see neighbors and friends talking outside in the yard or on the street; 2) do you see neighbors taking care of each other, such as doing yard work, or watching children? 3) do you see neighbors watching out for each other, such as calling if they see a problem? How many neighbors: 1) do you know by name; 2) do you have a friendly talk with at least once a week; and 3) could you call on for assistance in doing something around your home or yard or to "borrow a cup of sugar" or some other small favor? Items were z-scored and averaged to form a total score at the individual level with higher scores indicating higher social cohesion. A neighborhood-level measure was constructed by averaging the individual scores at the census block-group (average respondents per block group = 71; range = 18-287). This scale has demonstrated construct validity and good internal consistency (reliability coefficient = 0.78) in a validation study. (15) Since the collection of data on neighborhood conditions began during the third cycle of data collection, it does not coincide with the baseline of the overall CHAP study. Therefore, to avoid potential problems of reverse causation, neighborhood ratings from individuals with a history of stroke up to and including cycle three were not included in the calculation of the exposure. Further, responses from participants in the successive cohort (n=1,680) were included in the calculation of the neighborhood-level measure so that the characterization of the neighborhood would be based on the largest number of residents available.

Participants in each block group were assigned the block group average. Because social cohesion represents a neighborhood level characteristic, its application to baseline does not pose a specific analytic problem, except to the degree that neighborhood characteristics may have changed between the mid 1990s and early 2000s and may no longer be valid indicators of each neighborhood. However, data collected during the third interview cycle attests, in part, to the stability of the neighborhoods. On average, study participants responding to the

third interview cycle reported that they had lived in the neighborhood on average 30 years (SD=17). Furthermore, a comparison of 1990 and 2000 census results characterizing the 20 census tracts that comprise these neighborhoods demonstrated very little change over time. On average across the 20 tracts, there was a 5% decrease in percent white, a 4% rise in percent black, a 1% rise in percent below the poverty line, a 4% decrease in persons aged 25 or older with less than a high school education, and no difference in percent owner occupied housing units and percent foreign born. Calculations of median percent change were similar (calculations made by the authors, available upon request). Due to the stability of the neighborhoods within the CHAP study, these neighborhood-level values were applied to participants at baseline; however, this approach precludes the use of individual level social cohesion measures since not all CHAP participants survived to cycle 3.

Covariates

Neighborhood socioeconomic status was created using census information on four indicators of the block group population: percent on public assistance, percent of households earning \$25,000 per year or less, percent with a college degree or higher, and percent of owner-occupied dwellings valued at \$200,000 or higher.(15) Z-scores of these measures were summed and averaged for each block group to create a neighborhood-level measure of SES. Cohesion scores were modeled continuously in the primary analyses, and categorically in approximate quartiles for a secondary analysis.

Social engagement was measured by four questions assessing participation in social and productive activities including: attending religious services, going to a museum, participation in activities or groups outside the home, and employment (none, part-time, and full-time). Despite the retirement age of the CHAP cohort, 11% reported either part- or full-time employment highlighting the importance of assessing employment as an activity in which a number of elders are engaged. As the variables were differently scaled, all were categorized into a 3-level scale (0, 1, or 2) per previous studies using these data;(16, 17) a score was created by summing across the items with higher total scores indicating higher social engagement(16, 17) (range 0-8).

Social network size was measured by three items derived from the Established Populations for Epidemiologic Studies of the Elderly Studies (EPESE)(18) that ask about the number of children, close relatives, and close friends seen at least once a month. Responses to the items were summed to create an overall measure of network size (range 0-81).(16, 17)

Basic demographic information was collected including: sex (male, female), age (self-reported birth date), education (number of years of schooling completed), and race (self-reported according to the 1990 U.S. Census categories: non-Hispanic white, Hispanic white, black, or other). Only 56 participants, less than 1% of the sample, were of other racial categories or Hispanic; therefore, these individuals were included with non-Hispanic whites in analyses.

Cigarette smoking was categorized as never, ever, and current. Physical activity was measured by participation in 9 physical activities during the past 2 weeks (e.g., walking, gardening, dancing) based on a modified set of questions from the 1985 Health Interview Survey.(19) Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Weight and height were measured using standardized methods appropriate for an elderly population.(20) BMI categories were defined as <18 kg/m²; 18.0-24.9 kg/m² (referent); 25.0-29.9 kg/m²; ≥30 kg/m².

Blood pressure was measured by two mercury sphygmomanometer readings in the seated position, following the protocols of the Hypertension Detection and Follow-Up Program.

(21) Presence of several chronic conditions (diabetes, heart attack, hypertension, cancer, hip fracture, and stroke) was measured through self-reported information using standard questions about physician-diagnosed diseases derived from EPESE.(22) Two composite chronic conditions variables were created representing a count (0,1,2) of cardiovascular conditions (heart attack and hypertension) and non-cardiovascular conditions (cancer and hip fracture). Self-reported history of physician-diagnosed stroke **and diabetes were** modeled as separate dichotomous variables.

Statistical Analysis—Descriptive statistics were used to summarize socio-demographic and health-related characteristics. Chi-square test and t-test analyses were conducted to compare the baseline characteristics between the high and low level of neighborhood cohesion groups. The multivariate Cox proportional hazards regression model based on a marginal approach was used to analyze the association between stroke mortality and neighborhood social cohesion controlling for relevant covariates. The variance-covariance matrix of the regression coefficients was estimated using a robust sandwich estimator that accounts for the correlation at the block-group level.(23) A race by neighborhood cohesion interaction was tested in the marginal Cox proportional hazard models and sensitivity analyses were conducted controlling for the additional covariates of individual level social network and social engagement which served as proxies for a measurement of individual level social cohesion. Due to significant missing values on the BMI variable, it was not included in the adjusted model listed above. A sensitivity analysis was conducted including BMI to ensure that the results were not altered by its omission in the adjusted model. SAS software version 9.2 (SAS Institute Inc, Cary, North Carolina) was used for all analyses. The statistical significance level used was 0.05.

RESULTS

Participant Characteristics

Table 1 provides socio-demographic and medical characteristics for the total sample and by level of neighborhood cohesion, high (above median) and low (below or at median). Study participants in low cohesive neighborhoods were slightly older, more likely to be female, more likely to be black, had lower education on average, engaged in less physical activity, were more likely to have a history of stroke, and marginally more likely to have a history of diabetes. However, they also were more likely to have never smoked than individuals in neighborhoods with high social cohesion. There were no differences in systolic blood pressure and presence of chronic conditions.

Neighborhood Cohesion and Stroke Mortality

Results of the adjusted marginal Cox regression models are presented in Table 2. Controlling for age, sex, education and race (Model 1), neighborhood social cohesion was significantly associated with reduced risk of stroke mortality [hazard ratio (HR)=0.47; 95% confidence interval (CI)=0.26, 0.86]. Further adjustment for systolic blood pressure, physical activity, smoking status, chronic conditions, history of stroke, and neighborhood level SES (Model 2) did not alter these results. An additional model (not shown) that excluded the 10.3% of subjects reporting a history of stroke also showed a strong, protective effect of cohesion [HR=0.35, 95% CI=0.18-0.70, p=0.0028]. Moreover, when examined in quartiles, a general trend toward greater protection was observed with higher levels of social cohesion [4th quartile: HR=0.66, 95% CI=0.47,0.94; 3rd quartile: HR=0.67, 95% CI=0.46,1.00; 2nd quartile: HR=0.73, 95% CI=0.51,1.04; 1st quartile: reference].

Controlling for the additional covariates of individual level social network, social engagement, and BMI did not attenuate the association between neighborhood-level

cohesion and stroke mortality. In these models individual social network size and social engagement were not significantly related to stroke mortality [HR (95% CI) = 0.99 (0.96-1.02) for network size and 0.96 (0.86-1.07) for engagement].

The interaction between neighborhood social cohesion and race was significant (p-value = 0.04). In race-stratified models adjusted for age, sex, and education, the protective effect of neighborhood social cohesion was evident for whites [HR=0.34, 95% CI=0.17, 0.67] but not blacks [HR=1.17, 95% CI=0.35, 3.86]. Further adjustment for stroke risk factors revealed a similar pattern [whites: HR=0.32, 95% CI=0.14, 0.70; blacks: HR=1.39, 95% CI=0.40, 4.84].

Neighborhood Cohesion and Stroke Incidence

Among the subset of participants for whom hospitalization data were available via linkage with CMS claims files, each 1-point higher cohesion score was associated with a 13% reduction in incidence of first-ever stroke in a multivariable adjusted Cox model (model 2 covariates), but this association was non-significant [HR=0.87, 95% CI=0.58-1.32]. There was no evidence of a race x cohesion interaction (p=0.13) for stroke incidence.

DISCUSSION

In this population-based cohort of older adults, greater neighborhood-level social cohesion was associated with significantly reduced risk of stroke mortality but not incident stroke. The association with stroke mortality was independent of known stroke risk factors and neighborhood-level SES, and was not attenuated by the control for individual-level measures of social network and engagement. Findings suggest that aspects of the neighborhood social environment may affect stroke risk among older adults, a demographic group in which neighborhood effects may be particularly salient.(11)

The observed protective effect of neighborhood cohesion on stroke mortality is consistent with previous studies. Neighborhood-level cohesion has been linked to heart disease,(24) all cause mortality,(25) self-rated health,(26, 27) smoking,(28) physical activity,(29, 30) hypertension,(31) and measures of mental health.(26, 32) The findings of this study are also consistent with the overlapping literature on the health effects of social capital.(33-35) However, we failed to find a significant association between neighborhood cohesion and incident stroke in our cohort. The reason for this pattern of mixed findings is unclear; one possibility is that neighborhood conditions deemed cohesive may be more related to rapid access to acute care, thereby reducing mortality, but less related to onset of stroke. Social support and access to services have been theorized as potential mechanisms linking neighborhood conditions and individual health (36) and recent longitudinal research has found a significant protective relationship between social support and stroke mortality but not stroke incidence(37) offering a credible explanation for why cohesion may be related to stroke mortality but not incidence. In this study, the size of one's social network was not a mediator of the relationship. However, a much more robust measurement of social support is needed to examine it as a potential pathway. An important area for future research will be to investigate potential pathways by which neighborhood cohesion can protect health.

The protective effect of cohesion on stroke mortality did not extend to older blacks in this cohort. We did not observe a similar interaction between race and cohesion with respect to first-ever strokes. Blacks reported lower neighborhood social cohesion than whites, but the reasons for the observed racial differences in the effect of cohesion on stroke mortality are not clear. The literature on race/ethnicity differences in the health-protective effects of neighborhood cohesion is mixed. While similar beneficial effects of neighborhood social cohesion on hypertension risk have been reported across racial and ethnic categories,(31)

other studies have found that neighborhood cohesion is only related to poor mental health(13) and cardiovascular mortality(12) among whites. Further research is warranted to examine the mixed pattern of black-white differences such as those observed here.

The results of this study must be tempered by its limitations. We relied on participants' own perceptions of the neighborhood social climate and aggregated them to the census block level, potentially conflating neighborhood conditions and individual perceptions. The fact that the effect of neighborhood social cohesion on stroke mortality did not change when we controlled for individual measures that are related to social cohesion, i.e., social network and social engagement, suggests that the social cohesion measure captured a phenomena distinct from individual level attributes. However, despite being theoretically-based, and having demonstrated good construct validity and internal reliability in previous research, the neighborhood-level measure of social cohesion also demonstrated poor agreement among residents in the same neighborhood.(15) This is not uncommon among neighborhood level measures(15, 38) and may be caused by incongruity between neighborhood perceptions and block group boundaries, spatial correlation among the neighborhoods, or genuine differences among individuals living in the same block group.(15) The fact that the aggregated measure operated as expected, even when related individual measures were controlled for and despite potentially low correlation among individuals in the same block group, supports its usage as a viable neighborhood level construct. Nevertheless, more research is needed to examine reasons for such low correlation and a more direct control of individual level perceptions of social cohesion would strengthen the results. In addition, the generalizability of the study's findings may be limited to black and white elders residing in stable, urban neighborhoods. Further research on a broader range of ages, race/ethnicities, and locations is needed.

SUMMARY

This study found that neighborhood level social cohesion was protective against stroke mortality but not stroke incidence in a cohort of older adults. Moreover, the benefits of cohesion on mortality risk were evident among whites but not blacks. Given the importance of neighborhood environments to older individuals and that fact that the population is rapidly aging, the characteristics of neighborhoods are and will continue to be of relevance to public health policies.

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Table 1

Sample Characteristics (N=5,789)

	Total	High Neighborhood Cohesion (N=2,879)	Low Neighborhood Cohesion (N=2,910)	P- value [†]
Age, mean±sd	74.72 ± 6.99	74.35 ± 6.58	75.10 ± 7.36	<0.0001
Female, %	60.37	57.9	62.82	0.0001
Black, %	61.88	51.41	72.23	<0.0001
Education, mean±sd	11.77 ± 3.71	12.22 ± 3.57	11.33 ± 3.80	<0.0001
Systolic blood pressure, mean±sd	139.36 ± 20.30	139.17 ± 19.93	139.55 ± 20.67	0.4664
Smoking status, %				0.0438
Never smoke	46.31	44.74	47.87	
Ever smoke	38.87	40.33	37.42	
Current smoke	14.82	14.94	14.71	
Physical activity, mean±sd	3.31 ± 5.51	3.65 ± 5.72	2.96 ± 5.27	<0.0001
Diabetes, %	7.65	7.02	8.28	0.0702
CV chronic conditions, %				0.3297
0	48.83	48	49.66	
1	43	43.42	42.58	
2	8.17	8.58	7.77	
non-CV chronic conditions, %				0.1388
0	78.01	76.97	79.04	
1	21.3	22.37	20.24	
2	0.69	0.66	0.72	
History of stroke, %	10.33	9.41	11.24	0.0226

[†]T-test for continuous variables and chi-square test for categorical variables.

Table 2

Adjusted Marginal Cox Regression Models Predicting Stroke Mortality

	Model 1	Model 2
	Hazard Ratio (95% CI)	Hazard Ratio (95% CI)
Neighborhood cohesion	0.47 (0.26, 0.86)	0.47 (0.24, 0.90)
Age	1.08 (1.06, 1.10)	1.08 (1.06, 1.10)
Male sex	1.10 (0.82, 1.47)	1.16 (0.85, 1.58)
Education	0.94 (0.90, 0.97)	0.94 (0.91, 0.98)
Black race	0.69 (0.50, 0.94)	0.58 (0.36, 0.93)
Systolic blood pressure		1.01 (1.00, 1.01)
Physical activity		0.99 (0.95, 1.03)
Smoking status		
Never smoke		1.00
Ever smoke		1.08 (0.78, 1.49)
Current smoke		1.46 (0.94, 2.26)
Diabetes		1.51 (0.99, 2.31)
Chronic conditions, cardiovascular		
0		1.00
1		1.29 (0.92, 1.80)
2		2.37 (1.52, 3.72)
Chronic conditions, non-cardiovascular		
0		1.00
1		0.78 (0.56, 1.09)
2		2.95 (1.43, 6.05)
History of stroke		2.93 (2.09, 4.11)
Neighborhood socioeconomic status		0.97 (0.75, 1.26)

Note: N = 5789, number of events=186.