ORIGINAL RESEARCH

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Local Area Variation in Morbidity Among Low-Income, Older Adults in the United States

A Cross-sectional Study

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Background: Recent studies have reported that low-income adults living in more affluent areas of the United States have longer life expectancies. Less is known about the relationship between the affluence of a geographic area and morbidity of the low-income population.

Objective: To evaluate the association between the prevalence of chronic conditions among low-income, older adults and the economic affluence of a local area.

Design: Cross-sectional association study.

Setting: Medicare in 2015.

Participants: 6 363 097 Medicare beneficiaries aged 66 to 100 years with a history of low-income support under Medicare Part D.

Measurements: Adjusted prevalence of 48 chronic conditions was computed for 736 commuting zones (CZs). Factor analysis was used to assess spatial covariation of condition prevalence and to construct a composite condition prevalence index for each CZ. The association between morbidity and area affluence was measured by comparing the average of condition prevalence index across deciles of median CZ house values.

Results: The mean age of study participants was 77.7 years (SD, 8.2); 67% were women, and 61% were white. The crude prevalence of 48 chronic conditions ranged from 72.5 per 100 for hypertension to 0.6 per 100 for posttraumatic stress disorder. The prevalence of these 48 chronic conditions was highly spatially correlated. Composite condition prevalence was on average substantially lower in more affluent CZs.

Limitation: Low-income status measured on the basis of receipt of Medicare Part D low-income subsidies and not capturing persons not enrolled in Medicare Part D.

Conclusion: Low-income, older adults living in more affluent areas of the country are healthier, and areas with poor health in the low-income, older adult population tend to have a high prevalence of most chronic conditions.

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Geographic variation in mortality and morbidity and the association between socioeconomic status and health are both widely recognized (1–11). Researchers have found that there are substantial differences in life expectancy and in causes of death across U.S. geographic regions, even after accounting for differences in age, sex, and racial composition (12–24). A separate, large literature has reported differences in mortality and morbidity between different socioeconomic and demographic groups in the United States (13, 16, 22, 25–38). More recently, substantial differences in the income-longevity association were found across geographic locations (39, 40). Researchers have documented that adults with incomes in the first quartile of the income distribution living in more affluent areas of the United States have higher life expectancies (39). To our knowledge, limited evidence exists on the local area variation in morbidity stratified by income using clinical measures of diagnoses and large samples of the U.S. population.

Using 100% of Medicare administrative records, we aimed to assess the association between the prevalence of chronic conditions among low-income, older adults and the economic affluence of local areas in the United States. We used receipt of the low-income subsidy in the Medicare Part D pharmaceutical benefit as a measure of low income. We hypothesized that low-income, older adults living in more affluent areas of the country are healthier and that areas with poor health in the low-income, older adult population tend to have a high prevalence of most chronic conditions.

Methods

We conducted a cross-sectional association analysis using 100% of administrative Medicare records for 2015. The Institutional Review Board of the National Bureau of Economic Research approved this study. A total of 6.4 million older adults with a history of low-income support under the Medicare Part D prescription drug benefit for at least 1 month between 2006 and 2015 were included in the study. The Medicare Part D program, which enrolls more than 70% of all Medicare beneficiaries in the United States, provides cost sharing and premium subsidies for beneficiaries who have incomes less than 150% of the federal poverty line and modest countable assets (41, 42). More than 85% of low-income subsidy recipients are automatically enrolled into the program by the Centers for Medicare & Medicaid Services (CMS) (43).

Data Sources

Medicare administrative data for 2006 to 2015 were obtained from CMS. For the 58.3 million persons enrolled in Medicare in 2015, the Medicare Master Beneficiary Summary File (MBSF) provided information about age, sex, race, Social Security Administration (SSA) county code, Medicare Part D enrollment status, receipt of low-income support under Part D, and time

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of first diagnosis for 57 chronic conditions tracked by CMS. From the 2006 to 2014 MBSF, for each person in the data, we obtained the history of whether they received Part D low-income subsidies. The CMS and the Health Inequality Project (https://healthinequality.org/) provided the mapping of SSA county codes to Federal Information Processing Standards codes and in turn to commuting zone (CZ) codes, as well as information on median house prices in each CZ and whether each CZ intersected a metropolitan statistical area.

Sample

Persons were excluded from the study if they lived outside the United States, qualified for Medicare for reasons other than old age, or were younger than 66 years or older than 100 years in 2015. We further excluded beneficiaries without Part D enrollment because we were unable to identify low-income status. Finally, we excluded persons who did not receive any low-income subsidy under Part D during a period of 120 months from 2006 to 2015.

Local Area and Affluence

A "local area" was defined as a CZ, which is a group of counties. This grouping, developed by the U.S. Department of Agriculture, reflects commuting patterns between home and work in a local area. We chose this level of geographic aggregation because it reflects local economic and social activity ties rather than political boundaries. We used the 1990 CZ delineation, which split the United States into 741 CZs. Our analytic sample did not include 5 CZs in Alaska, restricting our analysis to 736 CZs. Affluence was measured using the median home value in the CZ. House prices incorporate both market and nonmarket (for example, air quality) characteristics of a local area and are an effective summary measure of an area's socioeconomic status (44). We ordered 736 CZs by increasing median house value and divided them into 10 equally sized groups, representing deciles of the median home value distribution. Within each group, we categorized CZs into urban and rural. A CZ was defined as urban if it intersected a metropolitan statistical area.

Outcomes

A person was recorded to have a chronic condition if the date when they first met CMS diagnosis criteria for this condition was indicated. The CMS diagnosis criteria are based on a combination of diagnostic and procedural codes. Indicators for 57 chronic conditions tracked by CMS were available. We excluded 9 conditions with prevalences less than 0.5 per 100 persons to ensure enough observations for each condition in each CZ.

Demographic Variables

To ensure sufficient sample size within each demographic cell, we discretized age into the following 5 disjoint intervals: aged 66 to 69, 70 to 74, 75 to 79, 80 to 84, and 85 or older. We created indicator variables for being female and white using sex and race records.

Statistical Analysis

Descriptive data for the whole sample are presented as counts, means, and SDs. Crude prevalence per 100 persons was computed for all 48 conditions in the full sample. Crude CZ-level prevalence was adjusted to account for differences in age, race, and sex across CZs. The adjustment was done using direct standardization (45). Twenty demographic cells were defined for standardization, using all combinations of indicators for 5 age intervals, female, and white. This adjustment method allowed for the relationship between prevalence and age to be CZ-specific and to vary flexibly by age and sex. The standard population distribution was computed empirically from the entire analytic sample.

We used factor analysis to assess the spatial covariation of condition prevalences and to aggregate 48 conditions into a composite CZ-level prevalence index. The share of variance explained by the first factor in the factor analysis was used as a measure of covariation across condition prevalences. The composite index was constructed in 2 steps. First, we computed a regression-based score for the first factor in our analysis (46, 47). This score is an optimally weighted linear combination of Z scores of condition prevalences in each CZ. Second, to improve interpretability, we rescaled the standardized CZ-level factor score to be an index with a mean of 100 and an SD of 10. The resulting local area chronic condition index (LACCI) for low-income, older adults can be interpreted in terms of percentage. For example, an LACCI of 150 would suggest that the CZ has a 50% higher composite prevalence of 48 examined conditions relative to an average CZ.

In addition to factor analysis, we used a graphical approach to illustrate the extent of spatial covariation of condition prevalence. We first identified the 100 most populous CZs and ordered them by increasing LACCI. We then created a matrix that, for each CZ in rows, recorded the adjusted prevalence of each condition in columns. We used a color scale from blue (low) to red (high) to code relatively higher prevalence of a condition across CZs. If the prevalence of all conditions was correlated within a CZ, we would expect that, for CZs with the lowest LACCI, the prevalence of most conditions should be relatively low and hence the share of "blue" cells should be high; conversely, for CZs with the highest LACCI, the prevalence of most conditions should be relatively high and thus so should the share of "red" cells.

Finally, we examined the association between LACCI and the deciles of the median home price distribution across CZs. We quantified the magnitude of the association by computing the mean LACCI within each decile separately for urban and rural CZs. We measured the precision of the association using a 2-sided *t* test that compared the mean LACCI in deciles 1 to 9 with the mean LACCI in decile 10, which had the highest median home values. A *P* value less than 0.050 was considered statistically significant.

We performed several sensitivity analyses. First, we repeated the analysis using multivariable logistic re-

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Table. Characteristics of Study Participants*

Characteristic	Value
Mean age (SD), *y*	77.7 (8.2)
Female, %	67
White, %	61
Mean duration received Part D low-income subsidy (SD), *mo*†	68.1 (41.3)

* Among 6 363 097 total participants.
† Measured over 120 mo between 2006 and 2015.

gression for demographic adjustment. Demographic adjusters were included as main effects for 5 age groups and as indicators for being female and white. We included separate indicators for women in each age group and for white women, which allowed age effects to vary by sex and for the sex effect to vary by race. Standard errors were clustered at the CZ level to account for the hierarchical structure of the data. The logistic regression included indicator variables for each CZ. Adjusted prevalence was predicted for each CZ at the mean of demographic groups in the full sample. Second, we repeated the analysis using direct standardization, adjusting for age and sex but not race. Third, we repeated the analyses on a subsample of persons who were reported to live in the same CZ between 2006 and 2015, thus restricting our analysis to those who did not move in the 10 years before our measurement. Fourth, we examined methods other than factor scores for aggregating 48 conditions into an LACCI, such as a linear combination of condition prevalence that uses national prevalence as weights, or a linear combination of standardized condition prevalence with equal weights. All analyses were performed using Stata for Unix 15.1/MP (StataCorp).

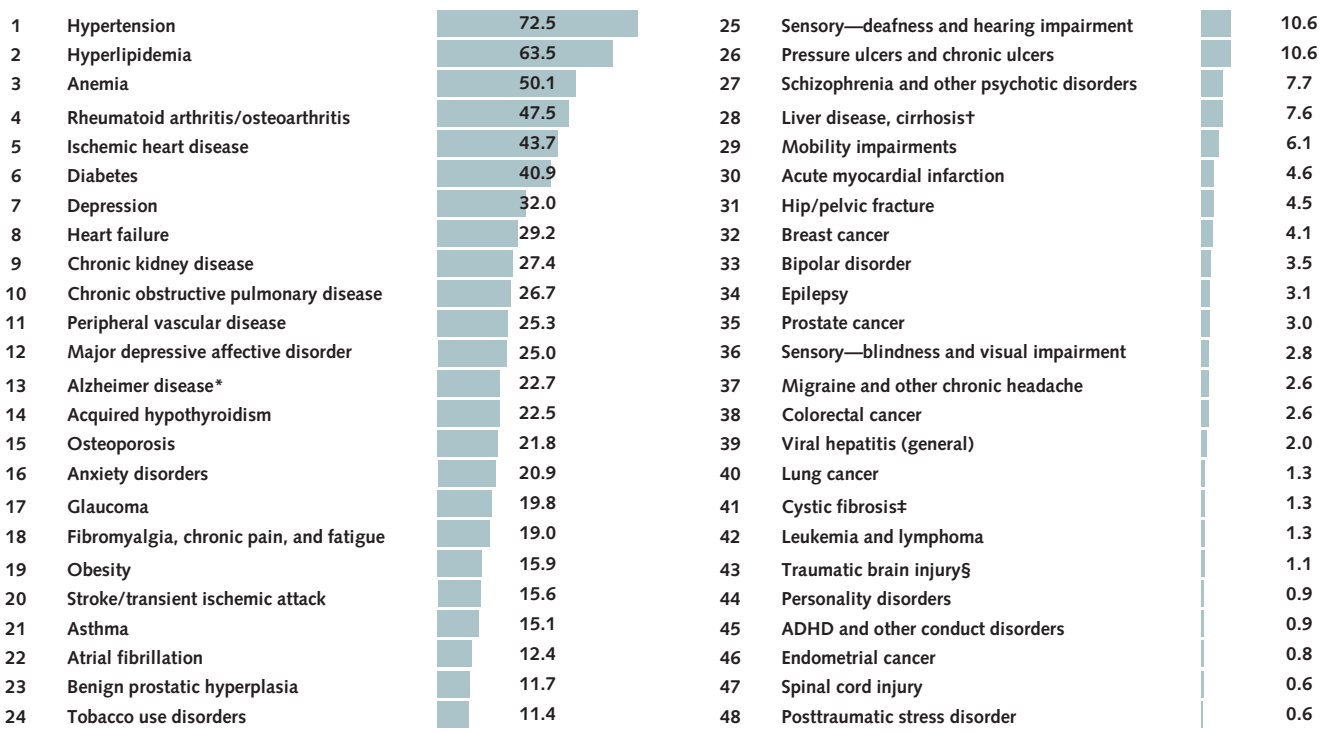
Role of the Funding Source

The funders had no role in the design or conduct of the study, analysis or interpretation of the data, or preparation of the manuscript.

RESULTS

We identified 40 387 209 adults in the 2015 MBSF aged between 66 and 100 years who resided in 1 of the 50 states and were eligible for Medicare because of old age. From these, we excluded 10 568 733 (26%) for whom it was not possible to define Part D low-income subsidy status because they either had other sources of prescription drug coverage or had no record of any coverage. We further excluded 13 226 (0.04%) adults for whom we were not able to match the recorded SSA

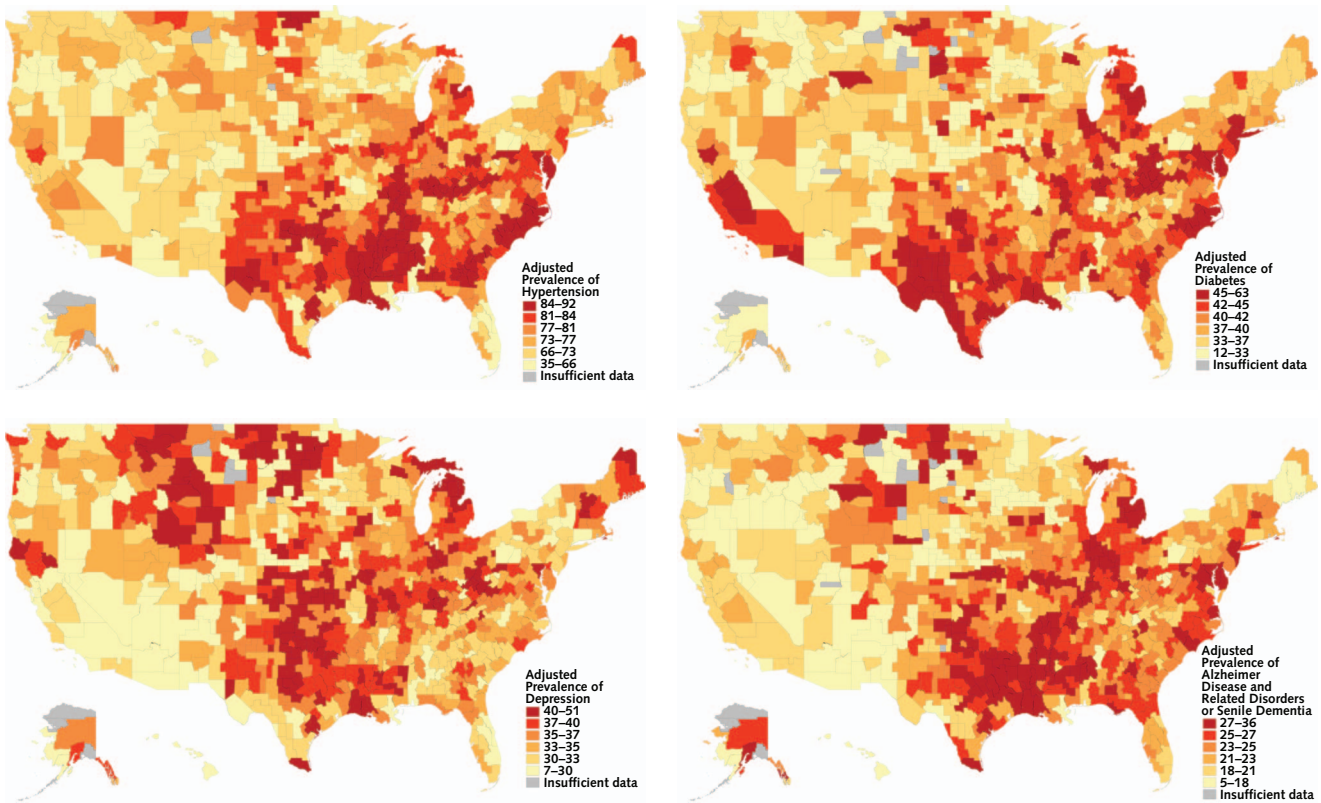
Figure 1. Crude prevalence of 48 chronic conditions in the study sample per 100 persons.



The study sample included 6 363 097 low-income, older adults observed in 2015. They were selected from the group of Medicare beneficiaries in 2015 according to the following criteria: aged 66–100 y, resided in 1 of the 50 U.S. states, were eligible for Medicare because of old age, had Medicare Part D prescription drug coverage, and were observed to have received ≥1 mo of low-income subsidy during a period of 120 mo from 2006–2015. ADHD = attention deficit–hyperactivity disorder.
* Includes related disorders and senile dementia.
† Includes other liver conditions, excluding hepatitis.
‡ Includes other metabolic developmental disorders.
§ Includes nonpsychotic mental disorders due to brain damage.

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Figure 2. Adjusted prevalence per 100 persons of hypertension, diabetes, depression, and Alzheimer disease in the study sample among persons aged 66–100 years with an income <150% of the FPL across 736 CZs.



Adjustment for age, sex, and race was done using direct standardization. The standardized population was the empirical distribution of 20 demographic categories in the full sample. Demographic categories included all permutations of indicators for female sex, white race, and 5 age intervals (66–69 y, 70–74 y, 75–79 y, 80–84 y, and ≥85 y). The study sample included low-income, older adults enrolled in Medicare as defined in the Table and Figure 1. CZ = commuting zone; FPL = federal poverty line.

county codes to Federal Information Processing Standards codes. From the remaining 29 805 250 adults, we selected 6 363 097 (21%) for the final analytic sample (**Appendix Figure**, available at Annals.org). These persons were observed to have received at least 1 month of low-income subsidy during a period of 120 months from 2006 to 2015.

The mean age of study participants was 77.7 years (SD, 8.2); 67% were women, and 61% were white (**Table**). They had received low-income Part D subsidies for a mean of 68.1 months (SD, 41.3). The crude prevalence of 48 chronic conditions ranged from 72.5 per 100 for hypertension to 0.6 per 100 for posttraumatic stress disorder (**Figure 1**). The 5 most prevalent conditions in addition to hypertension were hyperlipidemia, anemia, rheumatoid arthritis and osteoarthritis, ischemic heart disease, and diabetes. The adjusted prevalence of chronic conditions varied substantially across CZs. **Figure 2** illustrates the variation for 4 common conditions: hypertension, depression, diabetes, and Alzheimer disease and related dementias. The prevalence of hypertension was 75.0 per 100 in an average CZ, but ranged from 34.8 in the CZ around Bethel, Alaska, to 91.9 in the CZ around Lake Providence, Louisiana (SD, 10.0; interquartile range [IQR], 70.1 to 83.6). The prevalence of diabetes was 38.8 per 100 in an average CZ, but ranged from less than 12 in Alaska to 63.0 around Frederick, Oklahoma (SD, 7.6; IQR, 35.2 to 43.6). The prevalence of depression was 34.5 per 100 in an average CZ, but ranged from 7.2 around Bethel, Alaska, to 51.1 around Cody, Wyoming (SD, 5.7; IQR, 31.4 to 38.3). The prevalence of Alzheimer disease and related dementia was 22.4 per 100 in an average CZ, but ranged from 4.8 around Bethel, Alaska, to 36.3 around Madison, Indiana (SD, 4.5; IQR, 19.6 to 24.4).

The prevalence of 48 examined chronic conditions was highly spatially correlated, with the first factor in the factor analysis accounting for 66% of the observed variance, whereas the second factor contributed only 9% toward cumulative variance (**Appendix Table 1**, available at Annals.org). This finding was consistent with the hypothesized spatial pattern—that a CZ with a high prevalence of 1 condition had a high prevalence of most conditions. Loadings for the first factor supported this finding because the first factor was strongly correlated with the prevalence of most conditions (**Appendix Table 2**, available at Annals.org).

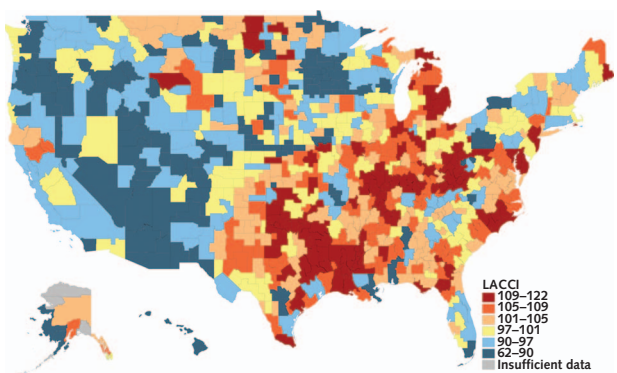
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The LACCI for low-income, older adults was created using regression-based factor scores. The LACCI varied substantially across the United States (**Figure 3**). The average LACCI was 100 (SD, 10) by construction. Among all 736 CZs considered in the analysis, the average LACCI ranged from 61.7 around Bethel, Alaska, to 122.3 around Sherman, Texas. The SD of the index was 10 by construction. The IQR was 94.4 to 106.9 across all 736 CZs. Among the 100 most populous CZs, the average LACCI was 98.1 and ranged from 73.8 around Tucson, Arizona, to 120.0 around Detroit, Michigan (SD, 9.2; IQR, 91.1 to 102.5). **Figure 4** illustrates the high degree of spatial covariation across condition prevalences in the 100 most populous CZs.

The LACCI in the low-income, older adult population was on average substantially lower in more affluent CZs, as measured by median home value (**Figure 5**; **Appendix Table 3**, available at Annals.org). This pattern was present in both urban and rural CZs and was almost perfectly monotone—the LACCI decreasing with higher home value deciles, except for the CZs in the first (lowest) decile of home values that had substantially lower LACCI than CZs in the second decile. Among urban CZs, LACCI in the second decile was 14.5 points higher (SD difference, 1.6 [95% CI, 5.5 to 23.6]; $P = 0.002$) than in the top decile (LACCI, 95.5). At each decile of home values, the LACCI of rural CZs on average were substantially lower. The difference was largest in the bottom deciles by 8.2 points ($P = 0.25$) and 8.5 points ($P = 0.048$) in the first- and second-lowest deciles, respectively. The difference in LACCI between urban and rural CZs was substantially less pronounced at the top of the home value distribution; the top decile had a statistically imprecise difference of 2.4 points ($P = 0.37$).

The main results remained qualitatively unchanged in our sensitivity analyses, which varied the method of demographic adjustment, the method of aggregation of conditions into an index, and the sample. The main differences were seen in models that either did not adjust for race or adjusted for race less flexibly than in the baseline specification. In these models, we saw a more monotone relationship between LACCI and deciles of home values (**Appendix Tables 4** to **6**, available at Annals.org), with no outliers in the first decile. Further, in these models we saw less difference in LACCI between urban and rural CZs. The general pattern of lower LACCI in more affluent CZs and the strong covariation of condition prevalences across CZs were seen in all sensitivity analyses.

Figure 3. LACCI for adults aged 66–100 years with an income <150% of the FPL across 736 CZs.



The LACCI was constructed as a regression-based factor score from factor analysis for the prevalence of 48 chronic conditions among low-income, older adults in 736 CZs. As a result, the LACCI measures the aggregate prevalence of chronic conditions among this population in each CZ. A higher LACCI implies a higher average prevalence of chronic conditions. The LACCI was standardized to have a mean of 100 (SD, 10) and can be interpreted as a percentage. For example, an LACCI of 150 in a given CZ would suggest that the CZ has a 50% higher composite prevalence of 48 examined conditions relative to the average CZ. The average CZ in the United States has an LACCI of 100. CZ = commuting zone; FPL = federal poverty line; LACCI = local area chronic condition index.

DISCUSSION

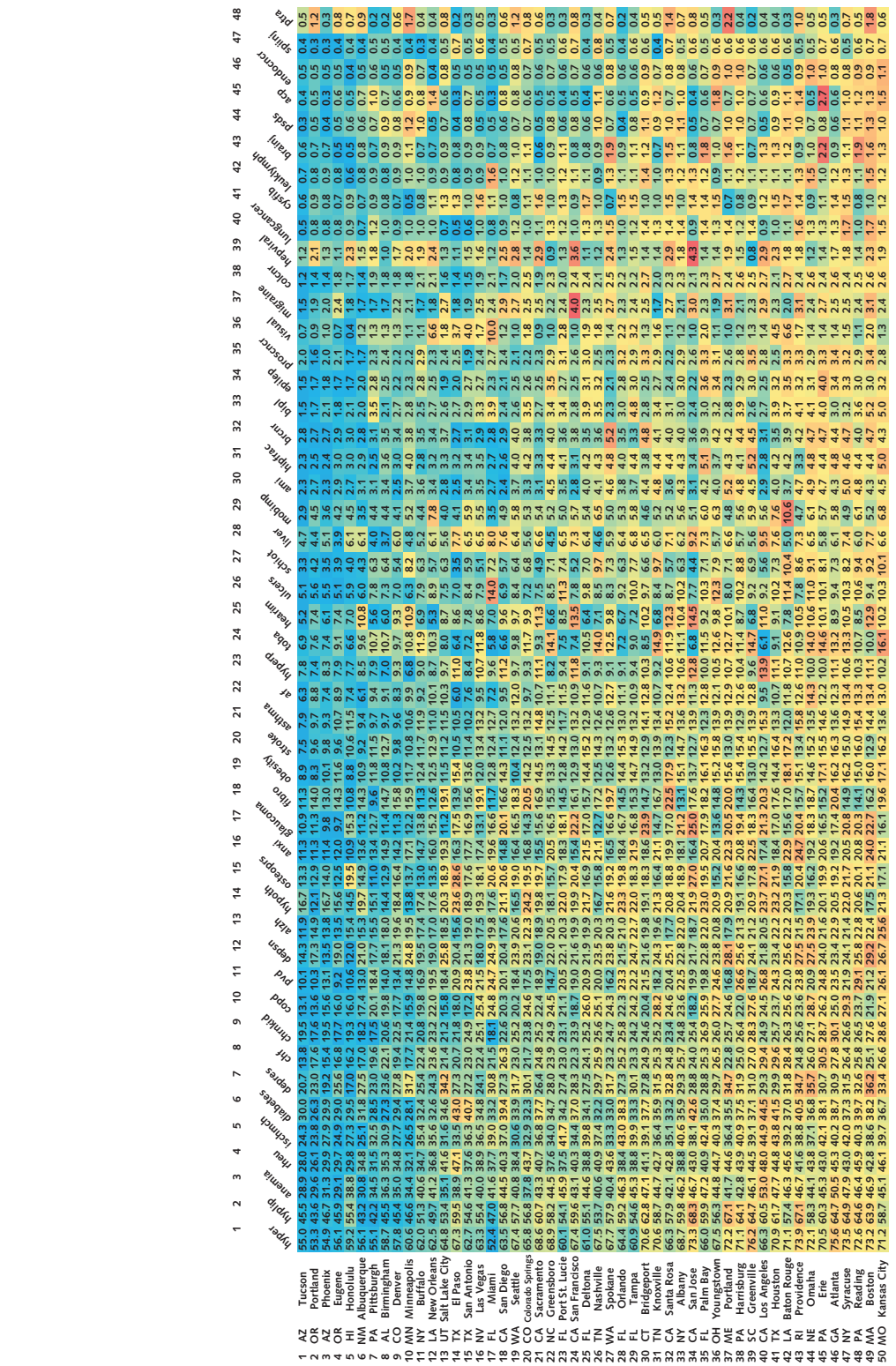
Our results suggest an important relationship between the socioeconomic environment of low-income, older adults and health. We found that low-income, older adults living in more affluent areas are healthier and that areas with poor health in the low-income, older adult population tend to have a high prevalence of most chronic conditions. These results are broadly consistent with the extensive literature on the social determinants of health (1, 8, 38, 48–51). Our study extends this research by providing measures of the prevalence of chronic conditions among low-income, older adults for a large national sample of the U.S. population. We used clinical rather than self-reported measures of diagnoses and reported this group's variation in morbidity across local areas of the country rather than nationally. We draw 3 key conclusions from our results.

First, the health of low-income, older adults in the United States varies substantially across local geographic regions, and this variation cannot be attributed to 1 specific disease or a narrow set of conditions. Local areas tend to be systematically healthy or unhealthy for this group. In unhealthy areas, the prevalence of most chronic conditions that we examined was high. This evidence suggests that any hypothesized causal pathway that aims to explain the geographic variation in health of the low-income population would need to explain the elevated prevalence of a broad spectrum of diseases in the same area.

Second, we found that low-income, older adults have better health in rural areas of the country. This difference is especially pronounced in less affluent CZs; in turn, the health of persons living in the most affluent CZs in rural and urban areas was found to be similar. Several mechanisms could explain this finding, including true differences in underlying health that could stem from more manual activity or higher disposable incomes, systematic underdiagnosis of chronic conditions in less affluent rural areas (52–54), or more similarity between urban and rural areas in more affluent

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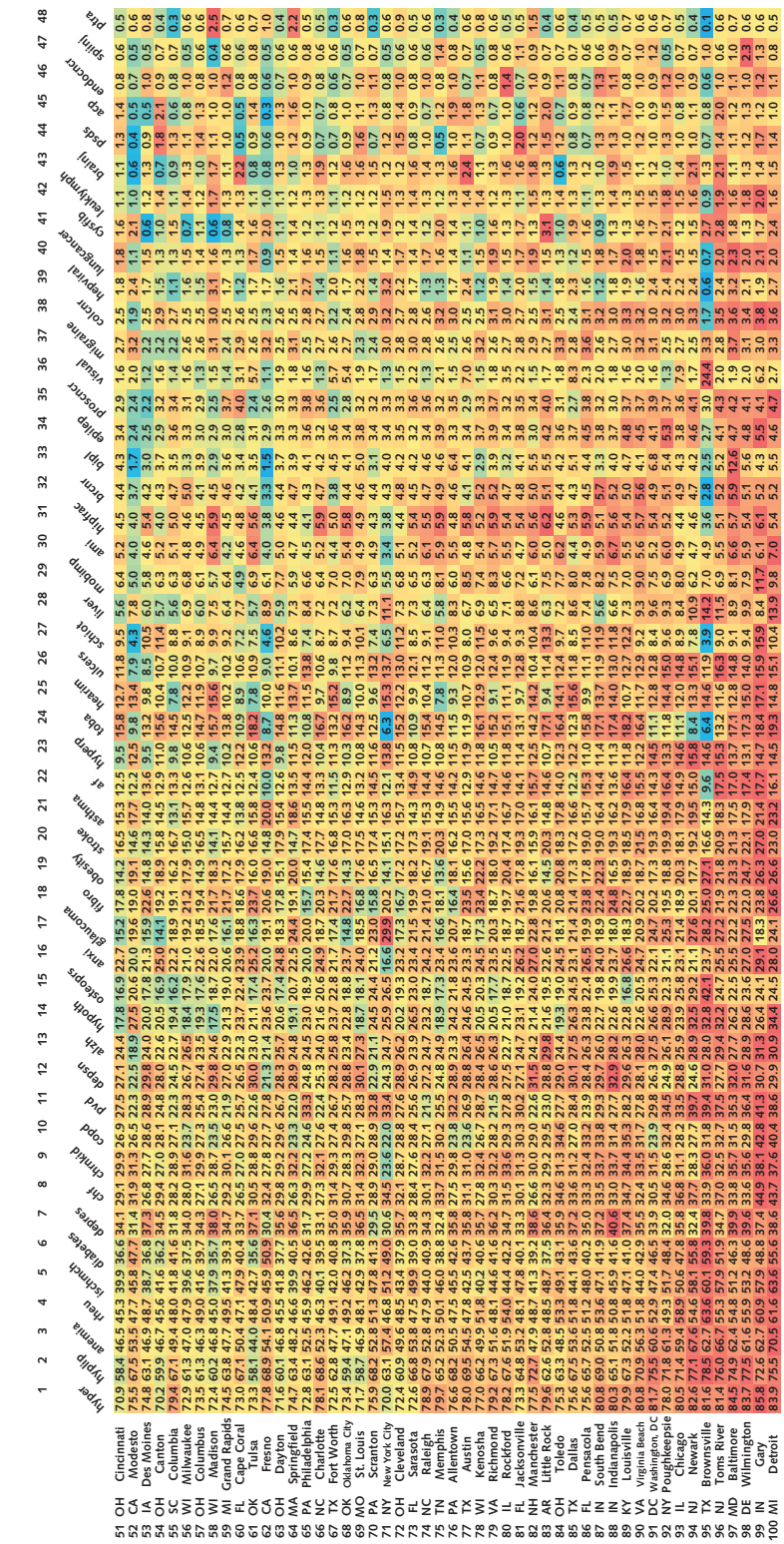
Figure 4. Spatial covariation of adjusted prevalence per 100 persons aged 66–100 years with an income <150% of the FPL of 48 chronic conditions in the 100 most populous CZs.



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Figure 4 –Continued.



Each cell of the matrix records age-, sex-, and race-adjusted prevalence of a chronic condition per 100 persons aged 66–100 years with an income <150% of the FPL. Rows represent CZs that are ordered from the lowest (at the top) to the highest (at the bottom) LACCI. The LACCI measures the aggregate prevalence of chronic conditions among low-income, older adults in each CZ. A higher LACCI implies a higher average prevalence of chronic conditions. Each column represents a chronic condition. The conditions are ordered by decreasing crude national prevalence from left to right, with the most prevalent condition presented first. The resulting order of conditions is the same as in Figure 1. Lower prevalence within a column is shaded blue, whereas higher prevalence is shaded with an increasing intensity of red. CZ = commuting zone; FPL = federal poverty level; LACCI = local area chronic condition index.

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parts of the country. More research is needed to understand these patterns.

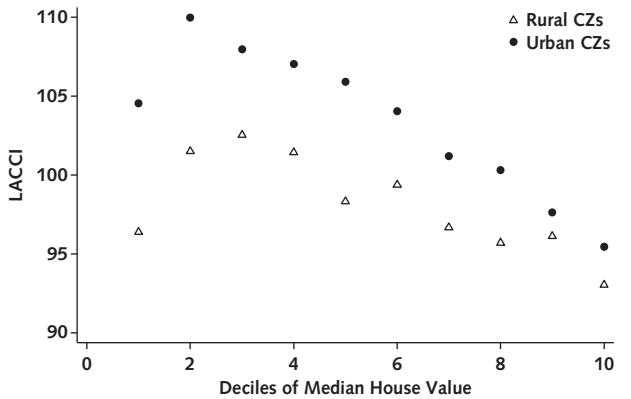
Finally, consistent with our original hypothesis, we found that more affluent local areas of the country have a lower prevalence of chronic conditions in the low-income, older adult population. Persons with the same low level of income are healthier in more affluent areas, even though their income is likely to have less purchasing power in these areas. Taken together, our findings support many hypotheses about the role of location on health outcomes as well as the "single-factor" determinant of health hypotheses (8, 48, 49, 55).

Our study has several limitations. We used receipt of low-income subsidies in Medicare Part D as a proxy for low-income status. This is a coarse measure of income that likely undercounts persons who are socioeconomically disadvantaged and restricts our analysis to those who have the Medicare Part D prescription drug benefit. We found that most chronic conditions are substantially more prevalent in our sample of low-income, older adults than in the overall Medicare population, as reported in CMS statistics (56). This is not surprising, as the prevalence of disease is known to be on average higher in poorer households. In addition, the CZ-level prevalences that we report adjust for geographic differences in demographic characteristics, contributing to the difference between our results and public reports. Our sample likely overstates the average prevalence relative to the full sample of low-income Medicare beneficiaries because we are more likely to capture the poorest households that are automatically enrolled in Medicare Part D. However, we could be undercounting nearly poor households that may have better health but are not enrolled in Medicare Part D or are not receiving low-income subsidies. Further, if in affluent areas healthier persons are more likely to enroll in Medicare Part D and to apply for low-income subsidies relative to less affluent areas, our results could reflect such differential sorting of persons into the study sample within a CZ in addition to actual differences in condition prevalence across CZs.

To measure the prevalence of chronic conditions, we relied on CMS Chronic Condition Warehouse indicators, which are constructed using diagnosis and procedures codes from Medicare claims. Thus, we can only measure formally diagnosed conditions. Further, regional differences in diagnostic intensity could lead us to under- or overestimate the prevalence of conditions in certain geographic areas (52–54). However, we believe that this bias is unlikely to substantively affect our results because differences in diagnostic practices would likely lead to overestimating the prevalence of conditions in more affluent areas that have more readily available health care options, whereas we found lower prevalence in these areas.

The CMS chronic condition indicators rely on Medicare fee-for-service claims, implying that persons whom CMS never observed in fee for service throughout their Medicare enrollment history may not have their chronic conditions captured in the data.

Figure 5. Association between LACCI for low-income, older adults and median house values in a CZ.



The plot records the average LACCI (on the *y*-axis) for each decile of CZ-level median house values (on the *x*-axis). The LACCI measures the aggregate prevalence of chronic conditions among low-income, older adults in each CZ. A higher LACCI implies a higher average prevalence of the chronic condition. The LACCI has a mean of 100 (SD, 10) and can be interpreted as a percentage relative to an average CZ that has an LACCI of 100. The association between disease burden and median house value in an area is shown separately for urban and rural CZs. A CZ was defined as urban if it intersected a metropolitan statistical area. CZ = commuting zone; LACCI = local area chronic condition index.

Selective migration of healthier persons to more affluent areas of the country could raise concerns about the interpretation of our results. We conducted a sensitivity analysis that restricted our sample to persons who lived in the same CZ during a period of 10 years before our measurement and found similar results. However, earlier selective migration of healthier persons to more affluent areas of the country could contribute to our findings. Hence, it is important to interpret our results as an association between health and location rather than a causal effect of location on health (57).

In conclusion, we found that the prevalence of chronic conditions in low-income, older adults varies substantially across local areas in the United States, that these adults living in more affluent areas of the country are healthier, and that areas with poor health in this population tend to have a high prevalence of many chronic conditions. These results suggest the likely importance of local location-based public health efforts that target the general health of the population rather than any specific conditions.

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Reproducible Research Statement: *Study protocol:* Not applicable. *Statistical code:* Available from Dr. Polyakova (e-mail, maria.polyakova@stanford.edu) and at http://web.stanford.edu/~mpolyak. *Data set:* Original data set not available due to data use agreement restrictions. Interested researchers can submit an application for a data use agreement at www.resdac.org. Data with CZ-level LACCI and adjusted chronic condition prevalences are available at http://web.stanford.edu/~mpolyak and in the **Supplement** (available at Annals.org).

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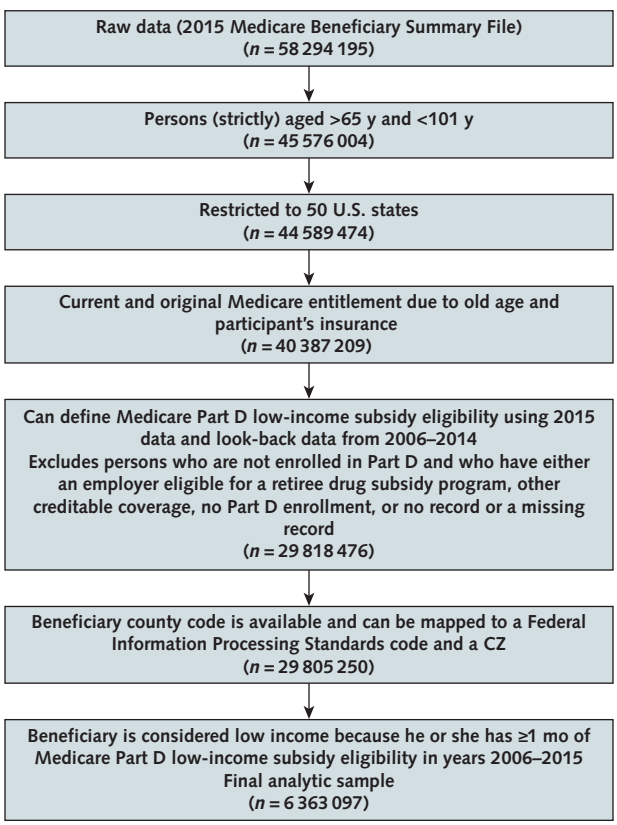
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Appendix Figure. Selection of study participants.



CZ = commuting zone.

Appendix Table 1. Factor Analysis of Spatial Covariation of Adjusted Prevalence Per 100 Persons of 48 Chronic Conditions in 736 CZs*

Factor	Eigenvalue	Share of Variance Explained, %
1	17.9	66
2	2.5	9
3	1.6	6
4	1.4	5
5	1.1	4
6	0.7	2
7	0.5	2
8	0.5	2
9	0.4	2
10	0.4	1

CZ = commuting zone.
* The results are shown for the first 10 factors only. Twenty-seven factors were retained in the model.

Appendix Table 2. Factor Loadings From the Factor Analysis of Spatial Covariation of Adjusted Prevalence Per 100 Persons of 48 Chronic Conditions in 736 CZs*

Condition	Factor Loadings	
	Factor 1	Factor 2
Anemia	0.90	−0.21
Hypertension	0.90	−0.17
Hyperlipidemia	0.88	−0.23
Rheumatoid arthritis	0.87	−0.15
Ischemic heart disease	0.86	−0.27
Chronic kidney disease	0.83	−0.04
Congestive heart failure	0.83	−0.11
Stroke	0.81	−0.08
Anxiety	0.81	0.11
Peripheral vascular disease	0.80	−0.21
Conditions with factor loading >|0.5|, *n*	29	0

CZ = commuting zone.
* Factor loadings are shown only for 10 conditions with the highest correlation with the first factor, but all 48 conditions were included in the model.

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Appendix Table 3. Association Between LACCI for Low-Income, Older Adults and Median House Values in a CZ: Based on Prevalence Adjusted for Age, Sex, and Race Using Direct Standardization Method

Measure	Deciles of Median House Value Distribution									
	1	2	3	4	5	6	7	8	9	10
Average LACCI in urban CZs	104.5	110.0	108.0	107.0	105.9	104.0	101.2	100.3	97.6	95.5
P value relative to 10th decile	0.16	0.002	<0.001	<0.001	<0.001	<0.001	0.003	0.008	0.27	NA
Average LACCI in rural CZs	96.4	101.5	102.5	101.4	98.3	99.4	96.7	95.7	96.1	93.0
P value relative to 10th decile	0.23	0.001	<0.001	0.003	0.059	0.011	0.21	0.45	0.32	NA
***P* value, urban vs. rural**	0.25	0.048	0.018	0.044	0.001	0.016	0.042	0.057	0.53	0.34
CZs, *n*										
Urban	3	6	13	21	35	33	56	54	54	50
Rural	71	68	60	53	38	41	18	19	20	23

CZ = commuting zone; LACCI = local area chronic condition index; NA = not applicable.

Appendix Table 4. Association Between LACCI for Low-Income, Older Adults and Median House Values in a CZ: Based on Prevalence Adjusted for Age and Sex Using Direct Standardization Method

Measure	Deciles of Median House Value Distribution									
	1	2	3	4	5	6	7	8	9	10
Average LACCI in urban CZs	103.7	107.3	106.3	105.0	104.4	101.7	98.7	98.3	94.6	90.9
P value relative to 10th decile	0.077	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.094	NA
Average LACCI in rural CZs	104.6	102.9	103.3	102.8	99.4	99.2	96.2	96.9	95.7	93.7
P value relative to 10th decile	<0.001	<0.001	<0.001	<0.001	0.041	0.036	0.35	0.26	0.44	NA
***P* value, urban vs. rural**	0.86	0.23	0.20	0.34	0.031	0.27	0.34	0.52	0.65	0.33
CZs, *n*										
Urban	3	6	13	21	35	33	56	54	54	50
Rural	71	68	60	53	38	41	18	19	20	23

CZ = commuting zone; LACCI = local area chronic condition index; NA = not applicable.

Appendix Table 5. Association Between LACCI for Low-Income, Older Adults and Median House Values in a CZ: Based on Prevalence Adjusted For Age, Sex, and Race Using Logistic Regression*

Measure	Deciles of Median House Value Distribution									
	1	2	3	4	5	6	7	8	9	10
Average LACCI in urban CZs	106.3	108.5	105.5	104.4	102.6	100.4	97.9	96.9	96.1	91.8
P value relative to 10th decile	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	0.030	0.075	NA
Average LACCI in rural CZs	105.6	103.0	104.7	100.4	99.5	98.6	95.8	98.2	94.0	93.1
P value relative to 10th decile	<0.001	<0.001	<0.001	0.026	0.074	0.124	0.40	0.115	0.81	NA
***P* value, urban vs. rural**	0.82	0.040	0.69	0.113	0.23	0.50	0.40	0.57	0.54	0.74
CZs, *n*										
Urban	6	10	18	25	31	45	47	44	50	48
Rural	56	52	43	37	30	17	15	17	12	13

CZ = commuting zone; LACCI = local area chronic condition index; NA = not applicable.
* The number of CZs is smaller than in direct standardization because the number of observations in some CZs was insufficient to estimate coefficients on the indicator variables for several CZs in the maximum likelihood procedure.

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Appendix Table 6. Association Between LACCI for Low-Income, Older Adults and Median House Values in a CZ: Based on Prevalence Adjusted for Age, Sex, and Race Using Direct Standardization Method on the Sample of Persons Who Did Not Move*

Measure	Deciles of Median House Value Distribution									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Average LACCI in urban CZs	103.3	110.8	107.9	106.9	106.3	104.1	101.8	100.5	99.0	97.0
P value relative to 10th decile	0.34	0.005	0.001	<0.001	<0.001	0.001	0.012	0.058	0.33	NA
Average LACCI in rural CZs	96.3	100.7	101.6	100.5	97.6	99.9	95.8	95.5	94.9	93.5
P value relative to 10th decile	0.29	0.005	0.001	0.016	0.16	0.011	0.44	0.58	0.66	NA
***P* value, urban vs. rural**	0.29	0.021	0.016	0.023	<0.001	0.024	0.007	0.039	0.097	0.21
CZs, *n*										
Urban	3	6	13	21	35	33	56	54	54	50
Rural	71	68	60	53	38	41	18	19	20	23

CZ = commuting zone; LACCI = local area chronic condition index; NA = not applicable.
* Persons were included in the sample if they were observed to have lived in the same CZ during the period of 10 y before 2015.

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