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Examining the Lag Time Between State-Level Income Inequality and Individual Disabilities: A Multilevel Analysis

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State-level income inequality has been found to have an effect on individual health outcomes, even when controlled for important individual-level variables such as income, education, age, and gender. The effect of income inequality on health may not be immediate and may, in fact, have a substantial lag time between exposure to inequality and eventual health outcome. We used the 2006 American Community Survey to examine the association of state-level income inequality and 2 types of physical disabilities. We used 6 different lag times, ranging between 0 and 25 years, on the total sample and on those who resided in their state of birth. Income inequality in 1986 had the strongest correlation with 2006 disability levels. Odds ratios were consistently 10% higher for those born in the same state compared withthe total population. (*Am J Public Health.* 2008;98:2187–2190. doi:10.2105/AJPH.2008.134940)

In the United States, studies using multilevel statistical techniques have found a relation between state-level income inequality and individual health outcomes, including self-reported health[1,2] and limitations in activities of daily living (ADLs).[3] This relation remained even when important individual-level variables such as income, education, age, and gender, were controlled for in the analysis.

The majority of studies on the income inequality–health relation have used current measures of both inequality and health. The 3 proposed mechanisms through which income inequality could affect individual health are as follows: systematic underinvestment in a wide range of health and social infrastructure,[4,5] unfavorable social comparison,[6,7] and lower levels of social cohesion and social capital.[8] Each of these potential mechanisms suggests the effect of income inequality on health would not be immediate and may, in fact, have a substantial lag time between exposure to inequality and eventual health outcome.

A few multilevel studies that have examined the "lag effect" of income inequality on individual health outcomes[9–11] have suggested that self-reported health was more strongly associated with income inequality from 15 years previous than from shorter or longer time lags. There is a clear need for additional use of multilevel modeling to explore individual health outcomes other than self-reported health and to consider outcomes at time periods other than the late 1990s[10,12] and different sources of data. Furthermore, all of these studies were limited by potential misclassification of exposure because they did not control for movements between states during the lag time period.[9] Finally, these studies were based on the Current Population Survey,[13] which does not include individuals in nursing homes and other institutions, who represent a significant portion of the seriously ill in this country.

To address these concerns, we used multilevel analysis techniques to examine the association of state-level income inequality and 2 types of disabilities measured in 2006 using 6 different lag times ranging between 0 and 25 years. Disability is an excellent predictor of medical and social service need, and it greatly influences quality of life and productivity.[14]

METHODS

Data

The 2006 American Community Survey (ACS) was a representative nationwide survey of more than 3 million people from households and group quarters, including nursing homes.[13] It had a response rate of 97.5%.[15] The sample of ACS respondents we used included 1 973 766 people 25 years or older, 1 021 095 of whom currently lived in their state of birth.

Measures

Individual-level variables. Two disability indicators were used[1]: limitations in activities of daily living (ADLs; i.e., having had a physical, mental, or emotional condition lasting 6 months or more that made it difficult to "dress, bathe, or get around inside the home")[2] and functional limitations (i.e., having had a condition that substantially limits 1 or more basic physical activities such as walking, climbing stairs, reaching, lifting, or carrying).

There are conceptual differences between these 2 disability measures. Functional limitations are less likely to be improved through environmental modifications than are ADL limitations and are therefore less vulnerable to variations in household income.[16] For example, acquiring an environmental modification such as an elevator in one's home may result in a change in ADL limitations (e.g., difficulty getting around inside the home) but would not substantially alter the response to the ability to climb stairs, which is 1 of the functional limitations.

Demographic variables included gender, age, education, race/ethnicity, and marital status. The poverty index expresses total family income as a percentage of the federal poverty threshold for a household of the same size and composition. These poverty thresholds are determined and published by the US government.[17] The poverty index was divided into 6 categories.

State level variables. State income inequality was measured using the Gini coefficient for each state.[10] This coefficient ranges from 0 to 1, with 0 indicating complete equality of income distribution (e.g., everyone has the same income) and 1 indicating complete inequality (e.g., 1 person has all the income in the region).[18] In

TABLE 1—Sample Descriptive Information for Multilevel Analyses of State-Level Income Inequality and Individual Health Outcomes: American Community Survey, 2006

Variables	Total No. (%)	Born and Live in Same State, No. (%)
Total	1 973 766 (100)	1 021 095 (100)
Outcome variables		
ADL limitation	78 318 (4.0)	42 893 (4.2)
Functional limitations	263 971 (13.4)	145 721 (14.3)
Individual variables		
Gender (female)	1 044 579 (52.9)	541 013 (53.0)
Age, y		
25–34	330 218 (16.7)	175 297 (17.2)
35–44	409 948 (20.8)	208 303 (20.4)
45–54	451 355 (22.9)	237 169 (23.2)
55–64	358 450 (18.2)	182 879 (17.9)
65–74	225 143 (11.4)	114 321 (11.2)
75–84	149 912 (7.6)	78 102 (7.6)
≥85	48 740 (2.5)	25 024 (2.5)
Married/common law	1 274 125 (64.4)	640 260 (62.7)
Race		
White, non-Hispanic	1 495 098 (75.7)	844 923 (82.7)
Black, non-Hispanic	170 983 (8.7)	97 481 (9.5)
Other, non-Hispanic	116 171 (5.9)	26 461 (2.6)
Hispanic of any race	191 514 (9.7)	52 230 (5.1)
Education		
<9 y	112 292 (5.7)	42 908 (4.2)
9–12 y	173 765 (8.8)	96 404 (9.4)
High school graduate	587 953 (29.8)	356 707 (34.9)
Some college education	542 696 (27.5)	290 307 (28.4)
Undergraduate degree	346 325 (17.5)	155 198 (15.2)
Graduate degree	210 735 (10.7)	79 571 (7.8)
Family income, % of poverty threshold		
<100	176 986 (9.0)	92 588 (9.1)
100–199	306 127 (15.5)	159 679 (15.6)
200–299	325 987 (16.5)	176 393 (17.3)
300–399	293 433 (14.9)	160 964 (15.8)
400–499	236 461 (12.0)	128 764 (12.6)
≥500	634 772 (32.2)	302 707 (29.6)

Note. ADL = activities of daily living. Poverty threshold is defined by the US Census Bureau.[15]

keeping with previous studies,[9,10] the Gini coefficient was rescaled to range between 0 and 20 such that each unit corresponds to an increment of 0.05 on the original scale. State-level Gini coefficients published by US Census Bureau were used. The Gini coefficients for 2006 were based on the 2006 ACS,[19] and for 1981 to 2000, they were based on the Current Population Survey annual social and economic supplements.

Data Analysis

The multilevel modeling of the ACS participants nested within 51 regions (50 states and the District of Columbia, hereafter referred to as states) was achieved through the nonlinear logit link function within HLM5.02 software.[20] The analysis was repeated using the Gini coefficient measured at 0-, 5-, 10-, 15-, 20-, and 25-year lag times and controlled for individual's gender, age, race/ethnicity, marital status, education attainment, and adjusted personal income. In an attempt to adjust for population movement across states during the time period under study, the analyses were also conducted on survey participants who had been born in the same state.

RESULTS

Descriptive information on the sociodemographic factors used in this study are presented in Table 1. Means and standard deviations of the Gini coefficient and the odds ratios of having limitations in ADL or experiencing functional limitations for a 0.05 increase in state-level income inequality for the total population and for individuals who had been born in the same state are presented in Table 2. In general, the odds ratios (ORs) were at least 10% higher for those born in the same state than they were for the total population. This result reflects the different levels of exposure of the 2 populations. For individuals born in the same state, the odds of ADL limitations were almost constant at 5-, 10-, 15- and 25-year lag times and were higher at the 20-year lag time (OR=1.28; 95% confidence interval [CI]=1.17, 1.41).

Unlike the ORs of ADL limitations, the odds of having functional limitations increased steadily at 5-, 10-, 15- and 20-year lag times, were highest at the 20-year lag time, and dropped when using the 25-year lag time. This trend was evident for both the total population and the sample restricted to those born in the same state. However, all odds ratios for the latter sample were higher than those for the total population. With a lag time of 20 years, the odds of having functional limitations for individuals who had been born in the same state increased by 24% for every 0.05 increase in state-level income inequality (OR=1.24; 95% CI=1.14, 1.36).

DISCUSSION

With 1 exception, the largest odds ratios for both disability outcomes were for the state-level income inequality measured at the 20-year lag period (1986), which is slightly longer than the 15-year time lag proposed by previous multilevel studies on self-reported health.[9–11] It is not surprising that self-reported health would have a shorter latency period

TABLE 2—Logit Multilevel Analysis, Adjusted Odds Ratios (AORs) and 95% Confidence Intervals (CIs), for the Risk of Limitations in Activities of Daily Living (ADLs) and of Having Functional Limitations for a 0.05 Increase in Gini Coefficient: American Community Survey, 2006

		Total Sample (N = 1 973 766)		Born and Live in Same State (n = 1 021 095)	
Year	Gini Coefficient,[a] Mean (SD)	ADL, AOR (95% CI)	Functional Limitations, AOR (95% CI)	ADL, AOR (95% CI)	Functional Limitations, AOR (95% CI)
2006	0.449 (0.023)	1.17 (1.03, 1.34)	1.08 (0.95, 1.25)	1.29 (1.13, 1.47)	1.23 (1.06, 1.43)
2001	0.448 (0.032)	1.13 (1.03, 1.24)	1.04 (0.96, 1.14)	1.23 (1.13, 1.34)	1.14 (1.04, 1.25)
1996	0.438 (0.032)	1.11 (1.03, 1.20)	1.06 (0.97, 1.16)	1.21 (1.11, 1.32)	1.15 (1.05, 1.26)
1991	0.414 (0.026)	1.15 (1.04, 1.29)	1.11 (0.98, 1.26)	1.23 (1.11, 1.36)	1.20 (1.07, 1.36)
1986	0.415 (0.024)	1.19 (1.10, 1.28)	1.19 (1.09, 1.29)	1.28 (1.17, 1.41)	1.24 (1.14, 1.36)
1981	0.399 (0.024)	1.10 (0.98, 1.24)	1.12 (0.99, 1.27)	1.23 (1.10, 1.38)	1.17 (1.04, 1.32)

Note. Analyses adjusted for gender, age, marital status, race/ethnicity, family income, and education level.
[a]Gini coefficient ranges from 0 to 1, with 0 indicating complete equality of income distribution (e.g., everyone has the same income) and 1 indicating complete inequality (e.g., 1 person has all the income in the region).

than ADL and functional limitations. Longitudinal research indicates that poor self-reported health is a strong predictor of both morbidity and the development of functional limitations approximately a decade later.[21] Thus, one would expect that poorer self-reported health would often precede the development of functional limitations and the latter would precede the onset of ADL limitations. Research indicates that baseline functional limitations are associated with the development of ADL limitations 5 years later.[22] Future analyses of income inequality in long-term prospective studies would help clarify the trajectories of decline in health and development of functional limitations and ADL limitations.

The relation between income inequality and both disability outcomes was stronger for the sample restricted to those born in the state of current residence (persistent exposure group) than for the complete sample. This was true for the contemporaneous as well as for each of the lagged analyses. These findings are in keeping with the hypothesis that income inequality is causally associated with disability. If causal, the relation between income inequality and disability should be stronger among those with persistent exposure to income inequality than among those with less exposure. It is also possible that the prevalence of ADL limitations is higher in the subsample of those living in their state of birth because their health problems impede their interstate mobility.

In the complete sample, functional limitations were not significantly associated with 1991, 1996, 2001, or 2006 income inequality. By contrast, when the sample was restricted to those born in the state in which they currently resided, all analyses were significant. It is possible that previous studies that did not find a significant income inequality–health relation may have been hampered by inclusion of migrants with limited exposure to state-level income inequality. Future research should, if possible, adjust for interstate mobility.

Study limitations included the use of self-reported measures of health and of prevalence rather than incidence rates. If respondents had their disability for several years, their exposure time would be overestimated. In addition, the cross-sectional nature of the data precludes the determination of causal relation between income inequality and disability. Finally, the observed strong relation between 2006 income inequality and 2006 disability outcomes may be an artifact of the fact that all measures were derived from the same data source.

Despite these limitations, this study has several strengths not present in the previous studies examining lagged effects, such as the examination of ADL and functional limitations and the use of a large representative sample of institutionalized and noninstitutionalized individuals.

This study suggests that there is a 20-year lag time between income inequality and both ADL and functional limitation outcome. Furthermore, it suggests that the income inequality–health relation is strongest among those with the most persistent exposure—those who live in their state of birth in comparison to those who have moved between states. ■

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Contributors

T.M. Gadalla conducted the analysis and drafted the methods, results, and abstract. E. Fuller-Thomson drafted the introduction, discussion and abstract. Both authors helped to conceptualize ideas, interpret findings, and review drafts of the brief.

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Human Participant Protection

This study was conducted on a Public Use Microdata Set (PUMS) of the American Community Survey. All identifying information had previously been removed from the PUMS by the US Census Bureau and thus, ethics approval was not required.

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