Journal of Studies in Social Sciences
ISSN 2201-4624
Volume 12, Number 2, 2015, 198-218

A Multilevel Analysis of Mobility Disability in the United States Population: Educational Advantage Diminishes as Race-Ethnicity Poverty Gap Increases

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Abstract: Until now, they idea that economic inequalities affect health outcomes remains of interest and a topic under debated. If disability can be considered an adequate indicator of health and an acceptable argument could be made that educational attainment is partially affected by "life changes", then investigating how educational attainment correlates with the likelihood of being "disable" and how it varies by level of social inequality in residential area may be of interest for research on health disparities. Microdata from the American Community Survey (ACS) 2009-2011 is used in a hierarchical logistic model that accounts for various person-level factors and differences in race-ethnicity poverty gap at the Public Use Microdata Area (PUMA) level. After nesting a total of 3,752,372 observations over 2,055 PUMAs, results indicate that risk for mobility disability decreases with educational attainment and that this protective effect decreases as the race-ethnicity poverty gap in the PUMA increases. Because unjust and avoidable health disparities should be mitigated, future work should continue on the topic.

KEY WORDS: inequality; disability; education; ACS; PUMS;

INTRODUCTION

Because maintaining the ability to live independently is central to daily living, any physiological impairment that threatens a person's ability to live independently has the potential to affect quality of life. For example, being unable to walk or shop for groceries without assistance ("mobility disability") may affect person's quality of life by limiting their choices. Studying how person- and place-level factors are associated with mobility disability is important for research on human development.

Agency and Structure

Some of the literature on health focuses on how the individual can help mitigate the onset of mobility disability by maintaining a physically active lifestyle and healthy eating habits. These views have the ability to empower individuals with information but simultaneously burden them with the realization that their health is their responsibility. This is a partially false view as individuals' agency is not the *only* factor affecting their health: social structures can influence health outcomes (Geronimus, 1991; Benson, 2014). Highlighting the power of agency (i.e., ability to choose) is valuable but may be incomplete because a person's health is influenced by more than his/her genetics or behaviors. Previous work has provided some evidence that both the social and physical environments have the ability to exert an influence on health outcomes (Filho 2013). This means that a person's environment (e.g., safety from crime at place of residence) may be as important as their agency (e.g., maintaining low-fat diet).

Why should public health professionals care if the attributes of the environment have the potential to affect health outcomes? Unlike clinicians who typically deal with one person at a time, public health researchers study populations to understand patterns of disease(s). A clinician may be prudent to frame health as being primarily influenced by a person's agency (i.e., "free will"). From such a view, the patient is given tools and the responsibility to manage their health. For those of us who study the health of the population, focusing on the alleged 'free will' of the agent seems less practical. If the formation of disease occurs through non-random patterns, a fundamental assumption in most health research, then we must ask: Can social structures affect the environments shown to affect the health outcomes of individuals?

If evidence emerges that social structures (e.g., federal government) have the ability to affect both social (e.g., safety from crime) and physical (e.g., sidewalk availability) aspects of the environment, then we could ask: If social structures can affect the environment, and the latter can exert an influence on health outcomes, is it possible that social systems have the potential to affect the health of individuals above and beyond their personal characteristics? If the answer is yes, and there is some evidence supporting this response (Wilkinson 2006), then public health researchers must continue to explore how social structures play a role in health outcomes.

In particular, we must ask if social structures that affect a person's environment are unbiased systems where people from diverse backgrounds are treated equally. Even more complex is the idea that individuals are distributed over the environment along detectable patterns: primarily as a function of their ability to choose where they reside. In this paper, a literature informed assumption (Feagin 2006) that social systems are systematically influenced by racial-ethnic discriminatory practices is made. From this postulate, the following argument is made: because the systematic and unjust discrimination of individuals through biased social systems has the ability to influence a person's health through their environment; there are modifiable mobility disability risks which can be intervene upon. Because a person's health may be affected by both their agency and the social structure they inhabit, their ability to guard from risk associated with developing mobility disability can influenced by both personal volition and forces beyond a person's control (i.e., social structure).

The idea that a person's health is partially influence by factors beyond their control (e.g., access to the good education that improves life chances) seems obvious to some and deeply controversial to others. If a person is empowered with the belief that everything about their health is within their control, she or he may then be prone to adapt beneficial health behaviors. If a person is excused from maintaining a healthy lifestyle by the idea that their health is primarily affected by forces beyond their control, then they may be more likely to abandon participation in healthy lifestyles. Either of these extreme positions is convenient because of their binary nature—comparing two views in the process of deciding which to adapt is less mentally taxing that making complex contrasts. Although the use of these forms of cognitive heuristics can be influence by environmental factors (Liu et al., 2012) they are useful in decision making (Gigerenzer et al., 2011).

Unfortunately, a more certain truth may be found in a view that embraces an understanding that both agency and structure play a role in health outcomes. For example, eating habits may be influence by personal decisions and self-control as well as: genetics, social traditions within families, food outlets within reach, governmental policies affecting prices, and a long list of other events that include political unrest in distant nations. Such a view is mentally taxing relative to simply adopting either the "agency only matters" or the "structure rules your world" view.

Social Stratification

Social stratification (interchangeably refer to as social inequality) refers to how individuals are distributed into different social status groups and how valued resources (e.g., political or economic power) are most concentrated amongst the 'top tier' social status groups (McLeod, 2013). Socioeconomic inequality is a product of social stratification: those privileged into top tier stratums have greater access to economic sources than those in the bottom tiers (Massey, 2007). Publications have discussed how social inequalities affect infectious diseases (Farmer, 1996). If social stratification has the ability to affect the formation and mitigation of mobility disability, the accounting for place-level measures of social inequality may be important. For example, the quality of the build environment and safety of your place of residence (items related to social inequality) can play a role in the formation of mobility disability (e.g., by mediating physical activity participation)(Farmer, 1996).

Until now, there are no publications that investigated how the socioeconomic gap between majority and minority racial-ethnic groups (a "place" level measure) affect the risks associated with mobility disability (e.g., having difficulty with walking)—a non-communicable disease. The term "gap" is important here because it assumes a potential exists for mobility disability to be affected (e.g., created or aggravated) by the size in the gap between the advantaged-racial-ethnic-majority group and the disadvantaged-racial-ethnic-minority group (Montague, 1996). The core argument being that the unequal distribution of social, economic, and political resources is more important for health related outcomes (Gardner 2000). An assumption validated by relatively consistent findings that both wealth and impoverishment have the ability to affects health (Wilkinson 2006).

An important question arises in the literature gap: Can place-level measures on the socioeconomic gap between majority and minority racial-ethnic groups help explain person-level mobility disability? Research on how social stratification affects health has been ongoing for many decades and has primarily focused on the effects of the social environment on mental health (Dahl 2006; Filho 2013; Fone 2013). A recent longitudinal study with a sample from Santiago, Chile found evidence that disability is most likely to occur for those with lower socioeconomic status (Fuentes-Garcia, 2013). Multilevel analyses on income inequality and health outcomes have been undertaken (Dahl 2006).

The specific aim of this paper is to adopt the complex view that both agency and structure matter with regards to mobility disability. In doing so, the paper investigates how person- and place-level attributes are associated with mobility disability. The study merges epidemiological and sociological perspectives to show risk for mobility disability varies as a function of micro- and macro-level *markers of social stratification*. In theory, characteristic of the person (P), environment (E), and their interaction (PE) could explain why risk for adverse health systematically differs between groups of people. Under the assumption that mobility disability is not distributed randomly, risk for ambulatory disability could vary as a function of person, environment, and their interaction:

$$Mobility\ Disability = \int (P, E, PE)$$

Accordingly, the project models risk for mobility disability by: person factors (educational attainment); measures of the residential environment (race-ethnicity poverty gap); and their cross-level interaction in a multi-level model.

METHODS

Data

The analytic sample derives from the Public Use Microdata Sample (PUMS) 3-year (2009-2011) files from the American Community Survey (ACS). The ACS is a nationally representative survey administered by the US Census Bureau and plays a key role in determining how hundreds of billions of dollars in federal and state funds are distributed [4]. The ACS PUMS gathers responses on "difficulty" to perform the following tasks: hearing; vision; cognitive; self-care; ambulatory; and independent living. This study uses the last two items to determined "mobility disability" (discussed below). Even though ACS difficulty items may have some ambiguity in their meaning, these items are used to inform on the health of the US population.

Sample

Individuals aged 45 and over who are Non-Latino-White, Non-Latino-Black, or Mexican (categories discussed below) make up the analytic sample. Out of a possible 9,142,619 people (ranging from age 0 to 95) in the microdata and within the mainland US, this study uses 3,752,372 study subjects (i.e., person-level units) in the multilevel model analysis. The 9,142,619 people are only used to create area-level measures (discussed below). ACS PUMS data can only be geographically reference to Public Use

Microdata Areas (PUMAs)—discussed below. The 3,752,372 person-level units are "nested" over a total of 2,055 PUMAs.

Disability

The ACS evaluates "disability" by asking individuals to report on their difficulty with six different items association with functional impairment. Two disability (label used by US Census Bureau) variables are used to identify mobility disability. The first is "ambulatory difficulty," where survey respondents were asked: "Does this person have serious difficulty walking or climbing stairs?" "Independent living difficulty" was assessed by asking survey participants: "because of a physical, mental, or emotional condition, does this person have difficulty doing errands alone such as visiting a doctor's office or shopping?" If a person reports or is allocated as responding with a yes to either of these questions, he/she is said to have "mobility disability"—roughly defined here as having difficulty with physical movements because of a physical, mental, or emotional condition (a definition born from available variables in data). These measures of mobility disability are very limited.

The data do not allow an exploration of why a person is coded as having a difficulty with one of these items. For example, a person who is unable to walk may be treated the same as someone who may occasionally have some discomfort in walking. Hence, the use of the mobility disability term is motivated by the need to help the flow of the paper and to relate the topic to existing publications on health topics. However, great care should be taken to compare results from this study to others where mobility disability is measured differently. Please note that in comparison to other health related studies that use small numbers of person-level units, this study uses millions of individuals (n=3,752,372). In this regard, the findings may be considered amongst the most generalizable to the US population.

Educational Attainment

Educational attainment is the primary person-level exposure of interest and the outcome variable in the multilevel logistic model. Educational attainment was assessed in ACS using the following 24 categories: (1) No schooling completed;(2) Nursery school, preschool; (3) Kindergarten; (4) Grade 1; (5) Grade 2; (6) Grade 3; (7) Grade 4; (8) Grade 5; (9) Grade 6; (10) Grade 7; (11) Grade 8; (12) Grade 9; (13) Grade 10; (14) Grade 11; (15) 12th grade - no diploma; (16) Regular high school diploma; (17) GED or alternative credential; (18) Some college, but less than 1 year; (19) 1 or more years of college credit, no degree; (20) Associate's degree; (21) Bachelor's degree; (22) Master's degree; (23) Professional degree beyond a bachelor's degree; and (24) Doctorate degree. Note that although educational attainment is treated as a continuous exposure in the models, the outcome is made up of "categories" of formal educational attainment.

Person-Level Covariates

The model controls for age, sex, race, and nativity. Age is control for as a continuous variable, sex as a binary (female vs male), and nativity as a binary (US-born vs foreign-born). Both race and ethnicity variables are used to create the following groups: Non-Latino-Whites; Non-Latino-Blacks; and Mexican-Latinos. Details on race and ethnicity are made widely available online by the US Census Bureau only. The "race-ethnicity" coding scheme being used here provides succinct (i.e., guided by population size) groups—which account for almost 9 in every 10 people in the general US population. Historically and in the US, Non-Latino-Whites have been the "majority" group—the racial-ethnic group with the most control over political, social, and economic resources. In stark contrast, the ancestors of modern day Non-Latino-Blacks arrived to the US in large numbers after suffering forced migration. Their large forced migration was largely made up by Non-Latino-Blacks who were slaves to Non-Latino-Whites.

Mexican-Latinos have resided in what is now considered the US long before the arrival of Non-Latino-Whites (i.e., before the colonization of North America by Europeans). However, after the arrival of Non-Latino-Whites, Mexican-Latinos were forced into the lower socioeconomic and social echelons of US society. Because both Non-Latino-Blacks and Mexican-Latinos have historically been a "minority group" in the US, they are seen as racial-ethnic groups who in general control less political, social, and economic resources than Non-Latino-Whites.

Public Use Microdata Area

To insure survey participants' identity are protected, the US Census Bureau releases large public use microdata files which only permit users to geographically locate respondents to PUMAS. The geographical anatomy of PUMA polygons have been discussed at length elsewhere (Siordia & Wunneburger, 2013, Siordia & Fox, 2013). The geometrical properties of PUMAs are primarily decided by population density: PUMAs must have at least 100,000 people or more. The boundaries of PUMA polygons only respect the borders of US states (Siordia & Fox, 2013). In this paper, a multilevel analysis is used under the assumption that the place of residence has the ability to exert an influence on person-level mobility disability. In particular, a presupposition is made that the Race-Ethnic-Poverty Gap (REP-Gap), discussed below, is a meaningful measure (i.e., has the ability to affect a person's health) of economic disparity between dominant and minority racial-ethnic groups.

Map 1 shows the PUMAs and state boundaries in the continental US. Please note that in more conceptual terms, the multilevel model being used predict intercepts and slopes by using a total of 2,055 regressions to estimate the average intercept and slope of the person-level statistical relationships for the 3,752,372 people in the analytic sample. The average number of individuals per PUMA (i.e., nesting unit) is 1,826 (standard deviation=774) and the PUMA with the least number of people-units has 72 survey participants and the PUMA with the most has 7,064 people. Maps 2 (Los Angeles, California) and 3 (New York, New York) provide a 'zoomed-in' view on the geographical characteristics of PUMAs in heavily populated areas.

Race-Ethnicity Poverty Gap (REP-Gap)

REP-Gap is a measure of the poverty gap between Non-Latino-Whites and minorities—all other individuals in the population which include Non-Latino-Blacks, Mexican-Latinos, and others. REP-Gap is calculated by using individual's poverty score: the complete sample in the ACS PUMS file is used to determine the number of Non-Latino-Whites "in-poverty" (i.e., poverty ratio $\leq$ 150) and the number of all other individuals below the 150 poverty ration (i.e., in-poverty) (Siordia , 2014).

A total of 9,142,619 unweighted people from the microdata (6,306,210 Non-Latino-Whites and 2,836,409 minorities) are used to compute poverty prevalence for the two groups by PUMA. Poverty prevalence is computed by weighting the observations with the PWGTP (Siordia & Vi, 2012) variable: Non-Latino-Whites represent a total of 196,186,216 individuals in the US population and 34,634,694 (18%) of them are in-poverty; minorities represent a total of 110,971,481 people in the US population and 40,155,316 (37%) of them are in-poverty; when combined, they approximate the 2007-2011 US mainland population estimated by the microdata to be 307,157,697.

Because Non-Latino-Whites have a national in-poverty rate of 0.18 and Minorities one of 0.37, the national level, the REP-Gap is 0.19 (i.e., 0.37-0.18=0.19)—which indicates that on average, Non-Latino-Whites have less of their group in poverty than the minority group. These are mainland estimates. For the analysis, the REP-Gap estimates are produced for each of the 2,055 PUMAs using the following equation:

$$REPGap_j = (NonLatinoWhitesInPoverty_j - MinoritiesInPoverty_j)$$

Where $REPGap_j$ is the poverty gap between Non-Latino-Whites and Minorities at j^th^ PUMA, $NonLatinoWhitesInPoverty_j$ is the percent of Non-Latino-Whites in-poverty at j^th^ PUMA, and where $MinoritiesInPoverty_j$ is the percent of Minorities in-poverty at j^th^

PUMA. Positive REP-Gap numbers indicate there is more poverty in the Minority group, zero and numbers close to zero indicate the two groups have similar poverty prevalence, and negative numbers indicate there is more poverty in the Non-Latino-White group.

Map 1 shows the distribution of REP-Gap in the continental US, while Maps 2 and 3 show the REP-Gap distribution in Los Angeles and New York. From the 2,055 PUMAs, only 50 (2%) of them have a negative (≤ -0.01) REP-Gap value: this means that in 98% of all the areas under investigation, there is more poverty in the Minority group than in the Non-Latino-White group. A total of 186 (9%) have a positive REP-Gap number greater than or equal to 3: will be referred to in this paper as "extreme REP-Gap." Please note there are 676 (33%) PUMAs have a REP-Gap score between 1.99 and 2.99—refer to as "high REP-Gap" PUMAs—and the rest of them [i.e., 1,157 (56%)] have a REP-Gap value between 0 and 1.98.

Statistical Approach

The geographical distribution of the place-level measure is presented with cartographic maps. Descriptive statistics are presented for the analytic sample used in the model. The 3,752,372 person-level units are geographically referenced (i.e., nested into) to 2,055 geographical units (i.e., PUMAs) to model the likelihood of having a mobility disability. The multilevel logistic model was executed using HLM 6.08 software (Raudenbush et al., 2004).

RESULTS

Descriptive Statistics

Maps 1, 2, and 3 (provided as supplementary material with this article) visually represent the geographical distribution of Race-Ethnicity Poverty Gap over the continental US, Los Angeles, and New York. A qualitative appraisal of the cartographic maps indicates that REP-Gap may not be uniformly distributed over the geography.

Maps of other metropolitan areas are available upon request from the author. From Table 1, we see that on average, PUMAs have a Race-Ethnicity Poverty Gap (REP-Gap) of 1.79%—indicating that for the most part, race-majority individuals have less poverty than race-minority individuals in the same area of residence. On average, individuals in the sample have a about a high-school diploma. About 18% of the observations have mobility disability. The majority of the sample (85%) is made up of Non-Latino-Whites, 53% are female, 93% US-born, and have an average age of 62.

Multilevel Analysis

The use of a multilevel model must first be justified quantitatively by estimating how much variance in the outcome could potentially be explained by place-level measures. Results from the following intercept-only model were used to estimate the between PUMA intra-class correlation (ICC)—where "has mobility disability" is "Y=1":

$$\mathrm{Prob}(Y=1|B) = P$$

$$\log[P/(1-P)] = \gamma_{00} + u_0$$

As instructed elsewhere [21-23], the can be calculated as follows:

$$ICC = \tau 00 / [(\tau 00 + (\pi^2/3)].$$

The τ_{00}=0.1208, so that: ICC= 0.1208/ [(0.1208 + (3.14159^2/3)]=0.0354. This means 4% of the variance in mobility disability can be explained by PUMA-level factors. Because the τ_{00} is statistically significant ($\alpha < 0.001$) and the ICCs greater than zero, a multilevel model is necessary (Raudenbush, 2002; 2004; Hox, 1995). The equation that includes person-level educational attainment and PUMA-level REP-gap is as follows:

$$\mathrm{Prob}(Y=1|B) = P$$

$$\log[P/(1-P)] =$$

$$\gamma_{00} + (\gamma_{01}*\mathrm{REPgap}) +$$

$$(\gamma_{10}*\mathrm{Education}) + (\gamma_{11}*\mathrm{REPgap}*\mathrm{Education}) +$$

$$(\gamma_{20}*\mathrm{Age}) + (\gamma_{21}*\mathrm{REPgap}*\mathrm{Age}) +$$

$$(\gamma_{30}*\mathrm{Female}) + (\gamma_{31}*\mathrm{REPgap}*\mathrm{Female}) +$$

$(\gamma_{40}$ *Non-Latino-Black) + $(\gamma_{41}$ * REPgap*Non-Latino-Black) +

$(\gamma_{50}$ *Mexican-Latino) + $(\gamma_{51}$ * REPgap*Mexican-Latino) +

$(\gamma_{60}$ *USborn) + $(\gamma_{61}$ * REPgap*USborn) + u_0,

where the “direct effect” of education on the likelihood of having mobility disability is captured by “γ_{10}” and the “indirect effect” of PUMA’s Race-Ethnicity Poverty Gap through education on mobility disability is captured by “γ_{11}.”

The results are presented in Table 2. The results indicate that with each increment of educational attainment category the risk for ambulatory disability decreases (γ_{10}=-0.11)—after adjusting for age, sex, race, and nativity. The model indicates the “education advantage” diminishes as the Race-Ethnicity Poverty Gap (REP-Gap) increases (γ_{21}=0.01). The regression results confirm that risk for ambulatory disability vary as a function of educational attainment and the Race-Ethnicity Poverty Gap in place of residence: i.e., as a function of person- and place-characteristics. This finding is important because if social inequality in place of residence can affect risk for mobility disability, and social structures can influence the level of socioeconomic inequality between race-ethnic groups, then formal (e.g., policies) and informal (e.g., discrimination) social systems have the potential to affect the health of individuals *above and beyond* their personal characteristics

DISCUSSION

After noting the geographical distribution of the Race-Ethnicity Poverty Gap at the PUMA-level (i.e., place exposure measures), the study provides empirical evidence that risk for ambulatory disability varies as a function of person attributes (educational attainment) and place characteristics (Race-Ethnicity Poverty Gap in place of residence). The study helps fill a gap in the literature showing evidence that: Place-level measures on the socioeconomic gap between majority and minority racial-ethnic groups can help explain person-level mobility disability. This suggests that both factors affecting and being affected by agency and structure can influence risk for mobility disability. By merging epidemiological and sociological perspectives, the multilevel analysis clearly demonstrates an instance when risk for mobility disability is not distributed at random. Because risk for ambulatory disability may vary as a function of person- and place-characteristics, future research should seek ways to include measures of the environment.

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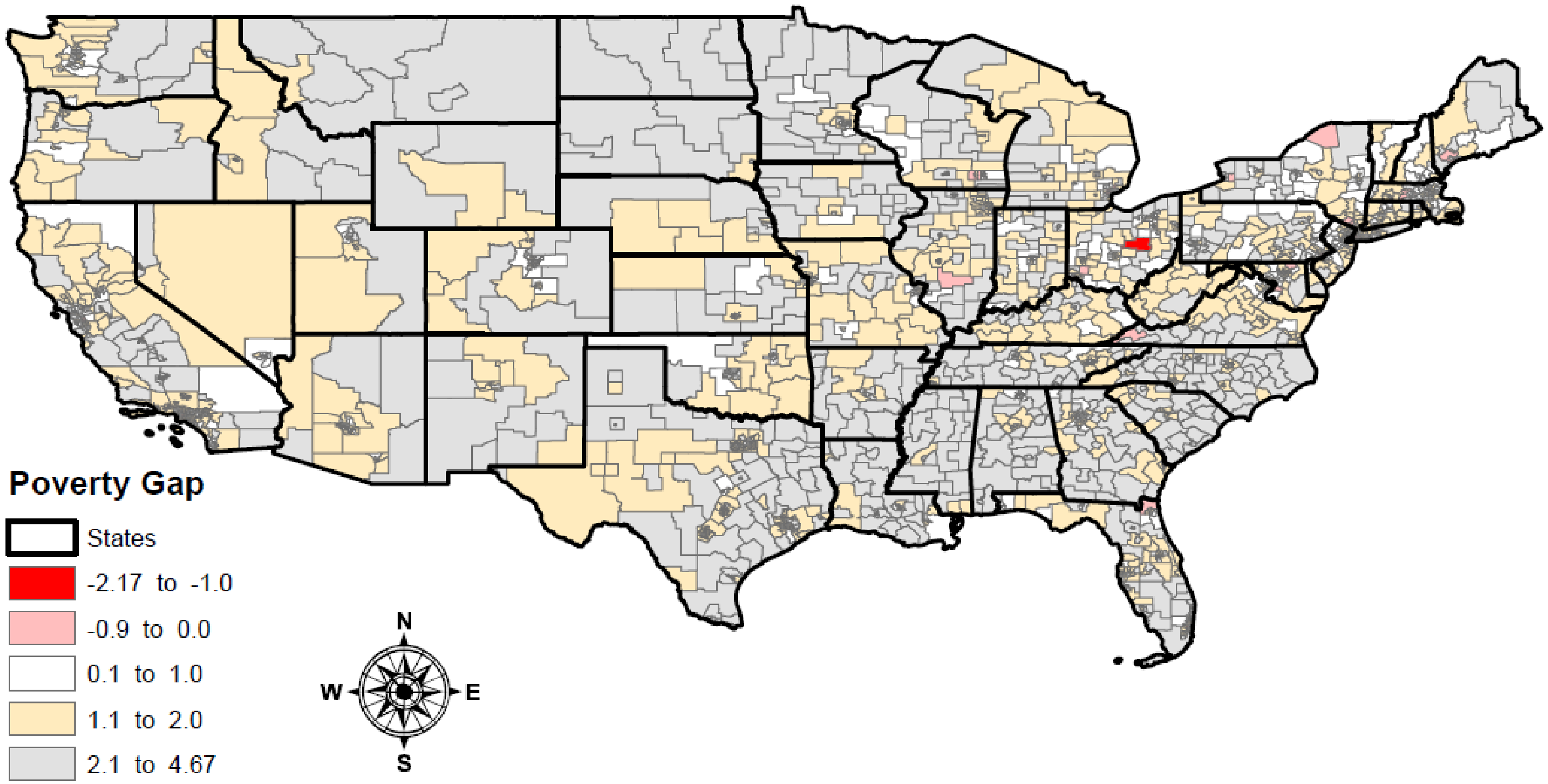
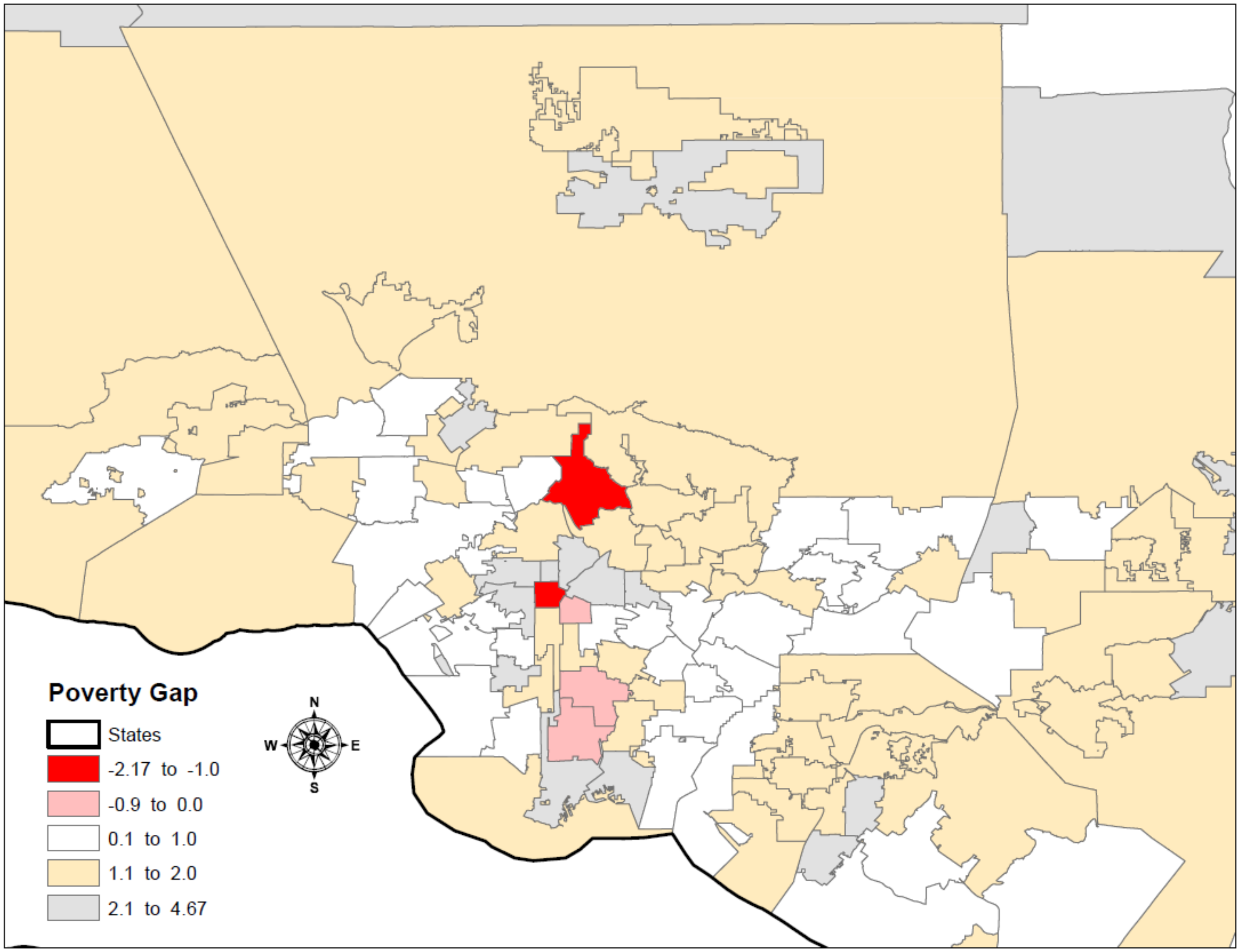
Map 1 Poverty gap by Public Use Microdata Areas in the US mainland



Map 2 Zoomed-in area in Los Angeles, California to view geographical characteristics of PUMAs in heavily populated areas



Map 3 Zoomed-in area in New York, New York to view geographical characteristics of PUMAs in heavily populated areas

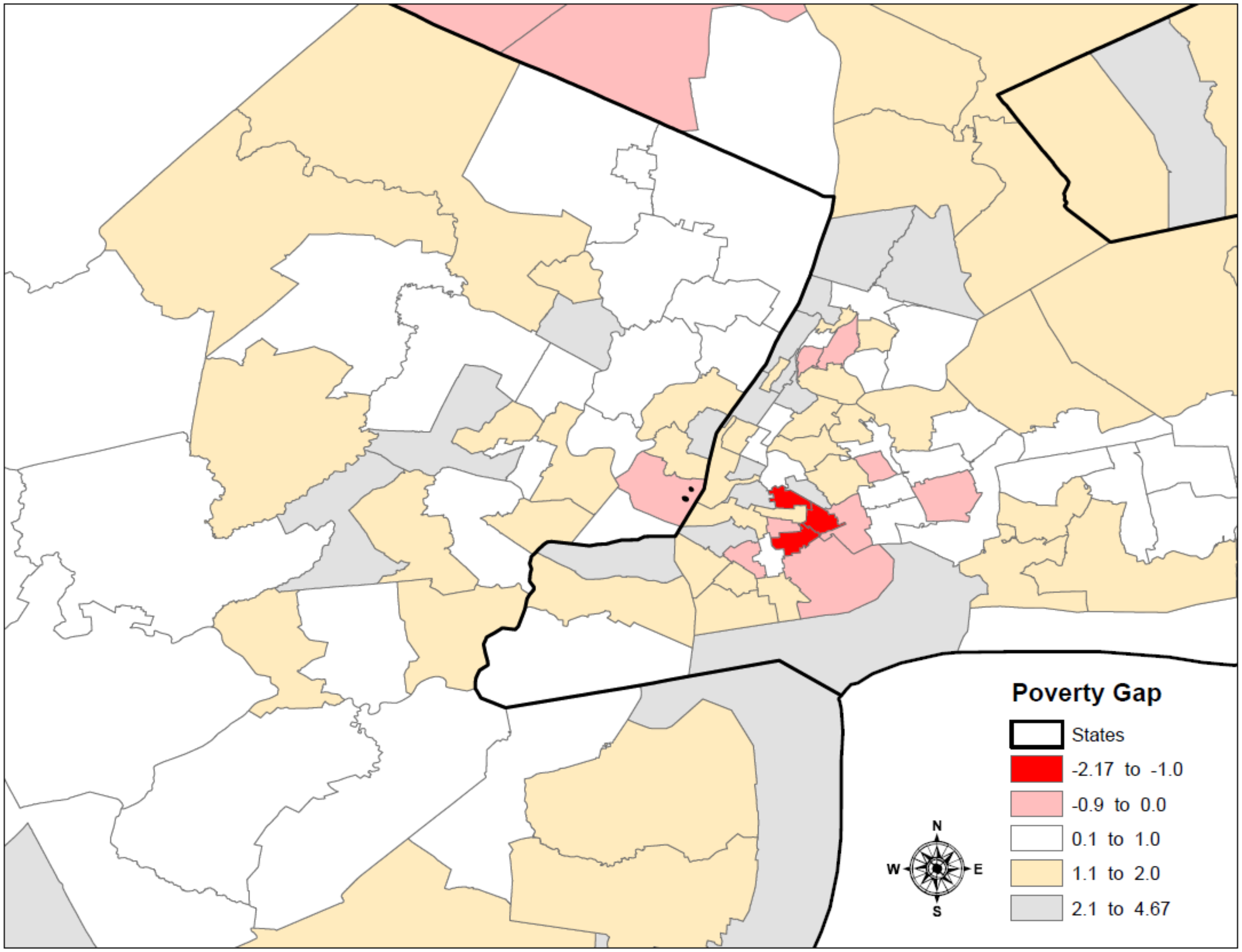


Table 1

Descriptive statistics for analytic sample

	Mean	**SD**[1]
PUMA-Level (n=2,055)		
REP-Gap[2]	1.79	0.92
Person-Level (n=3,752,372)		
Mobility Disability[3]	0.18	0.38
Ambulatory	0.16	0.36
Independent	0.10	0.30
Educational Attainment[4]	17.61	3.77
Non-Latino-White	0.85	0.36
Non-Latino-Black	0.10	0.30
Mexican-Latino	0.05	0.22
Age[5]	6.20	1.20
Female	0.53	0.50
Native Born	0.93	0.26

[1] Standard deviation

[2] Racial and ethnic poverty gap ranging from -2.17 to 4.67

[3] Ambulatory and/or independent difficulty reported

[4] Runs from 1 (no schooling) through 24 (doctorate degree)

[5] (Age ÷ 10) and ranges from 4.5 (i.e., 45) to 9.5 (i.e., 95)

Table 2

Multilevel logistic model predicting likelihood of mobility disability

	β	OR[1]	α
Intercept	-4.58	0.01	***
Intercept*REP-Gap[2]	0.19	1.21	***
Educational Attainment			
Education[3]	-0.11	0.89	***
Education*REP-Gap	0.01	1.01	***
Demographics			
Age[4]	0.67	1.96	***
Age*REP-Gap	-0.04	0.96	***
Female	0.24	1.27	***
Female*REP-Gap	-0.01	0.99	
Non-Latino-Black[5]	0.45	1.57	***
NLB*REP-Gap	0.03	1.03	***
Mexican-Latino[5]	-0.27	0.76	***
Mexican*REP-Gap	0.06	1.06	***
Native Born	0.34	1.40	***
Native*REP-Gap	0.10	1.10	***

*** $\alpha < 0.001$; [1] Odds ratio

[2] Racial-Ethnic Poverty Gap:

[(NLW %-in-Poverty) – (Minority %-in-poverty)]

[3] Runs from 1 (no schooling) through 24 (doctorate degree)

[4] Age by groups of 10= (Age ÷ 10)

[5] Reference group is Non-Latino-White