Spatial social polarisation: using the Index of Concentration at the Extremes jointly for income and race/ethnicity to analyse risk of hypertension

Justin M Feldman[1], **Pamela D Waterman**[1], **Brent A Coull**[2], and **Nancy Krieger**[1]

[1]Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, Massachusetts, USA

[2]Department of Environmental Health, Department of Biostatistics, Harvard T.H. Chan School of Public Health, Boston, Massachusetts, USA

Abstract

Background—Growing spatial social and economic polarisation may be an important societal determinant of health, but only a few studies have used the recently developed Index of Concentration at the Extremes (ICE) to analyse the impact of joint concentrations of privilege and privation on health outcomes. We explore use of the ICE to investigate risk of hypertension in an urban, multiracial/ethnic, and predominantly working-class study population of US adults.

Methods—We generated novel ICE measures at the census tract level that jointly assess extreme concentrations of both income and racial/ethnic composition. We then linked the ICE measures to data from two observational, cross-sectional studies conducted in the Boston metropolitan area (2003–2004; 2008–2010; N=2145).

Results—The ICE measure for extreme concentrations of white compared with black residents was independently associated with lower odds of hypertension (OR=0.76; 95% CI 0.62 to 0.93), controlling for race/ethnicity, age, gender, smoking, body mass index, household income, education and self-reported exposure to racial discrimination. Even stronger associations were observed for the ICE measures that compared concentrations of high-income white residents versus low-income residents of colour (OR=0.61; 95% CI 0.40 to 0.96) and high-income white versus low-income black residents (OR=0.48; 95% CI 0.29 to 0.81).

Conclusions—Results suggest public health studies should explore the joint impact of racial/ethnic and economic spatial polarisation on population health.

INTRODUCTION

The consequences of rising spatial socioeconomic polarisation and entrenched racial/ethnic segregation in the late 20th and early 21st centuries has become a matter of growing concern.[1] To analyse this phenomenon, Douglas Massey, a sociologist renowned for his work on residential racial and economic segregation,[1] created a new measure in 2001 that he termed the Index of Concentration at the Extremes (ICE). Unlike conventional measures of segregation, such as the widely used dissimilarity index (which, typically, is computed at the city level by measuring how many people within the city would need to move from one census tract to another to create a uniform distribution[2]), the ICE simultaneously measures concentrations of privilege and privation, and can do so at any given geographic level.[3]

To date, however, relatively little research has explored the joint impact of spatial economic and racial/ethnic polarisation on population health.[4] Only eight public health studies have employed the ICE;[35–11] with one exception,[11] all examined polarisation based on resident income, or education alone,[35–10] to predict psychological, anthropometric and chronic disease-related outcomes, including major risk factors for cardiovascular disease (CVD).[57] An additional publication analyses the same data set used in the present study, but in relation to environmental exposures,[11] not health, and employed novel ICE measures that incorporate data on racial/ethnic plus economic polarisation, separately and combined.[11] The present study builds on this prior work by using these established and novel ICE measures to analyse an outcome not addressed in the prior public health studies investigations using the ICE: hypertension.

Motivating our choice of hypertension, research indicates that this health condition is socially patterned in the USA: prevalence increases as socioeconomic position (SEP) decreases, and is higher among black populations compared with non-Hispanic whites.[12] Affecting 30% of US adults,[12] high blood pressure (HBP) is an important risk factor for CVD, the leading cause of death for US black and non-Hispanic white populations alike.[13] Suggesting hypertension would be a plausible outcome for which to examine the effects of spatial social polarisation, prior research has documented strong associations between risk of hypertension and exposure to residential racial/ethnic segregation,[14–19] as measured primarily at the city or regional level.

To conduct our study, we use data from two prior population-based observational cross-sectional studies conducted in Boston (2003–2004;[20] 2008–2010[21]), which we newly link to the novel ICE measures that we have generated.[11] As with our prior papers, our approach is informed by the eco-social theory of disease distribution, which focuses on how people literally embody their societal and ecological context, at multiple levels and across the life course and historical generations, thereby producing population patterns of health, including health inequities.[22]

METHODS

Population

In prior publications,[11][20][21] we describe the populations of United For Health (UFH; conducted 2003–2004), and My Body My Story (MBMS; conducted 2008–2010), two cross-sectional observational studies conducted in Boston, Massachusetts, and the surrounding metropolitan area. Both studies were approved by the Harvard School of Public Health Institutional Review Board (Protocol CR-17739-02 and Protocol CR-11950-02, respectively), as was the joint use of their data linked to the ICE data (Protocol MOD-23169-01).

The UFH study recruited a multiethnic cohort of workers (both US-born and foreign-born) from union rosters at 14 work-sites variously engaged in meat processing, electrical light manufacturing, retail grocery stores, and school bus driving. Among the 2323 union members contacted, 1776 met eligibility criteria (age 25–64 years, and employed for at least 2 months), of whom 1282 (72%) completed the survey. The unions and management had no access to the study data and no role in the preparation, review or approval of the study's scientific papers. The MBMS study, in turn, recruited and enrolled 1005 participants (504 black, 501 white) from a random sample of the membership rosters of 4 community health centres in Boston; eligibility criteria were: self-identify as white or black, be US-born, speak English, be age 35–64 years, and be cognitively able to provide information on eligibility and for ethical written informed consent. Fully 94.4% of eligible screened persons agreed to participate (black: 97.0%; white: 91.9%), and the overall response rate (defined as: (completed interviews)/eligible[23]), equalled 82.4% (black: 86.0%; white: 81.4%). Consequently, whereas US-born black and white study participants were common to both MBMS and UFH, all other racial/ethnic groups and all persons not born in the USA, came only from the UFH study, rendering nativity and study collinear.

Exposure: ICE

As noted above, in 2001, Massey[24] first proposed the ICE as a continuous measure of concentrated neighbourhood affluence and poverty, calculated as:

$$ICE_i = (A_i - P_i)/T_i$$

where A_i is the number of affluent persons in neighbourhood i, P_i the number of poor persons in neighbourhood i and T_i the total population for whom income level is known in neighbourhood i. The ICE can range from −1 (most deprived) to 1 (most privileged). A value of 0 can thus represent two possibilities: (1) none of the residents are in the best-off or worst-off categories or (2) an equal number of persons are in the best-off and worst-off categories, and in both cases indicates that the area is not dominated by extreme concentrations of either of the two groups.[11] The ICE allows for meaningful computation at multiple geographic levels and scales as well as comparisons within and between cities.[3][24] Building on prior public health and social science studies that have used ICE measures based on income and education,[3][5–10][24–26] we explore use of ICE measures for race/ethnicity, alone and combined with income.[11] The data and formulas used to create these measures are

provided in table 1. We defined thresholds for low (<US$20 000 annual household income) and high income (>US$100 000) to correspond, respectively, with the 20th and 80th centiles of the national household income distribution based on 2010 US Census data.

We linked the ICE measures to participants' records using the census tract of residence, ascertained after geocoding their home street addresses.

Outcome: high blood pressure

In both studies, we measured participants' systolic and diastolic blood pressures (SBP and DBP, 3 readings, at 1 min intervals, taken after a 3 min seated resting time) using automated blood pressure monitors (Omron HEM-711AC for MBMS, and Dinamap 8100 for UFH). Using the average of the three measurements, we followed the clinical guidelines that were in effect at the time of measurement[27] and defined hypertension as SBP 140 OR DBP 90 mm Hg, OR taking blood pressure medication, with this medication history ascertained using validated questions employed in the National Health and Nutrition Examination Survey (NHANES).[28]

Individual-level covariates

We used validated instruments to obtain self-report data on covariates potentially associated with HBP:[20][21] age, race/ethnicity, gender, educational attainment (for themselves and their parents/guardians), annual household income, smoking,[29] social desirability,[30] and exposure to racial discrimination, using the 9-item 'Experiences of Discrimination' measure.[31] We calculated body mass index (BMI kg/m^2) based on our measurement of the participants' height (to the nearest half-inch) and weight (to the nearest pound), both assessed without shoes.

Statistical analyses

We conducted all statistical analyses using Stata V.13 (Stata Corp., College Station, Texas, USA). As per the prior UHF analyses,[20] we excluded the 80 participants whose reported age in the survey was either missing or outside the eligible range (final N=1202). Additionally, we excluded the 62 participants (2.4%) with missing hypertensive status (table 2), yielding an analytic data set of 2141. Although most variables had little missing data (<3%), missingness for some of the SEP variables ranged from 5.2% (participants' educational attainment) to 20.9% (their parents' educational attainment). Accordingly, we multiply imputed missing data for all covariates included in the analytic models, using Stata's mi impute command to create five imputed data sets, and then combined estimates for the imputed data sets using standard methods. To examine bivariate patterns of association, we first conducted one-way analysis of variance comparisons of means for the five ICE measures across levels of each of the individual-level covariates. Then, we created four sets of logistic regression models to analyse odds of hypertension for: (1) each variable included in the analytic model (model 1; univariable); (2) each ICE measure, controlling solely for data source (UFH vs MBMS) (models 2a–e); (3) key covariates and data source only (model 3a: sociodemographic; model 3b: SEP; model 3c: racial discrimination) and (4) each separate ICE measure plus data source and the model 3 covariates (models 4a–f, multivariable; each model included only 1 ICE measure to avoid collinearity).

RESULTS

ICE measures: distribution

Among all 2145 study participants, the mean value of the ICE ranged from –0.12 (SD 0.26) for income (ie, in the direction of more extreme concentration of low income) to 0.20 (SD 0.55) for race/ethnicity (ie, in the direction of a more extreme concentration of white residents) (table 2). All five ICE measures were significantly associated ($p<0.05$) with the participants' race/ethnicity, household poverty level, census tract poverty, and self-reported racial discrimination (table 2), and all the remaining covariates exhibited significant associations with either three or four of the ICE measures, except for BMI (significant only for ICE for income and for education) and age (significant only for ICE for education and for race/ethnicity plus income; table 2), As discussed in prior papers,[20][21] black and Latino study participants reported higher exposure to racial discrimination and experienced greater economic deprivation compared to their white counterparts, and among all study participants combined, fully 37% were below the US federal poverty level, and 34.2% were hypertensive (table 2).

Analytic results (statistical models)

In the univariable analyses (table 3: model 1), all ICE measures except for education exhibited significant inverse associations with hypertension (ie, greater extreme concentration of privilege associated with lower odds), with the OR ranging between 0.37 and 0.66 (95% CI excluding 0), and all ICE measures were significantly associated with hypertension after adjusting for data source (models 2a–e). In the multivariable sociodemographic model (3a), male gender, greater age, smoking, greater BMI and self-identification as black were all significantly associated with higher odds of hypertension. In the multivariable economic model 3b, significant inverse associations with hypertension were evident for the participants' educational level and that of their parents, but not for household income. In the multivariable racial discrimination model, both self-reported exposure to racial discrimination and social desirability tended to be associated with odds of being hypertensive (model 3c).

The five models (4a–f) that examined the relationship between the ICE and hypertension after adjusting for individual sociodemographic, economic and racial discrimination variables found that the ICE measures for race/ethnicity, alone and combined with income, remained significantly associated with odds of hypertension (95% CI excluded 1), and the ICE for income tended to show this association, whereas the ICE for education did not. Thus, extreme concentrations of white versus black persons (ICE_{race_wb}) were associated with lower odds of hypertension, with the OR for a 1-unit change in the scale equal to 0.76 (95% CI 0.62 to 0.93). For extreme concentrations of high-income white persons versus low-income persons of colour ($ICE_{wpc+inc}$), the effect size was greater (OR=0.61; 95% CI 0.40 to 0.92). The ICE measure for extremes of high-income white versus low-income black residents (ICE_{wb+inc}) showed the strongest association (OR=0.48; 95% CI 0.29 to 0.81).

DISCUSSION

In this study of an urban, multiracial/ethnic and predominantly working-class population of US adults, we found that census tract-level measures of extreme residential concentrations of economic and racial privilege and privation were associated with individuals' risk of hypertension, independent of their individual-level sociodemographic and economic characteristics and self-reported exposure to racial discrimination. Thus, for the ICE capturing extreme concentrations of white versus black residents, and even more so for the two ICE measures that combined data on race/ethnicity and income (capturing extremes of affluent white vs low-income black residents and affluent whites vs low-income residents of colour), the odds of being hypertensive were 24% to 52% lower with each 1-unit increase in the ICE value.

Study limitations and strengths

Before interpreting our findings, it is important to first consider the study's limitations and strengths. Although use of a cross-sectional design limits causal inference, the studies did employ lifetime data on SEP and exposure to racial discrimination, albeit not on participant histories for neighbourhood of residence. Study strengths include: high response rates, reliance on validated measures for covariates, and use of novel ICE measures for race/ethnicity, alone and in combination with income. Additionally, our use of multiple imputation for covariates of hypertension depends on Missing At Random (MAR) assumptions, that is, that conditional on observed covariates, non-response to a specific question is not associated with the outcome variable (HBP). Although we cannot test these assumptions in our data set, the inclusion of multiple established HBP covariates in our imputation model reduced the possibility of violating MAR assumptions.

Interpretation of results

Our findings are in accord with prior research indicating that neighbourhood privation is associated with higher risk of HBP[15 16 19 32 33] and privilege with lower risk,[18 34–36] independent of individual-level covariates. Our results extend this literature, however, in several ways, methodologically and conceptually.

First, by using the ICE, we avoid problems of collinearity potentially arising when models simultaneously include area-based measures of privilege and of privation, as has been the cases for several prior US studies of neighbourhood socioeconomic conditions and risk of hypertension.[14 15 18 19 32 37] Second, use of the ICE permits explicit examination of the role of spatial concentrations of social groups whose pairing reflects the social relations that give rise to socioeconomic and racial/ethnic inequality.[20 22 38] These relationships are obscured in studies that employ indices of neighbourhood privation or privilege that combine multiple factors into a single scale.[35 36] Third, using novel ICE measures for race/ethnicity, singly and combined with income,[11] we were able to demonstrate that although the ICE for race/ethnicity exhibited stronger associations with the outcome compared to the ICE for income, the strongest association occurred for the ICE measures combining race/ethnicity and income.

The paucity of health research using ICE measures precludes our ascertaining why, among the participants of our Boston study, the ICE for income and education were not by themselves associated with risk of hypertension, in contrast with associations observed with the ICE for other health outcomes among the handful of studies based on diverse local to national US databases, and one study conducted in Australia.[35–10] Possible explanations may range from differences in the health outcomes examined to differences in the confounding structures of the different study context[39] to chance. Additionally, because affluent individuals were absent from our study population, ORs for ICE measures may have been biased towards the null of no effect. This is because our range of comparisons for both hypertension and neighbourhood polarisation was restricted:[2021] participants had a relatively high prevalence of hypertension (34.2%, vs 29.4% for the entire Massachusetts adult population according to the 2013 Behavioral Risk Factor Surveillance System) and tended to live in deprived neighbourhoods (for all 5 of the measures, mean ICE values were lower than the statewide average for Massachusetts residents). More research employing the ICE will be needed to clarify the context in which diverse types of extreme concentrations of social groups are, versus are not, associated with what types of health outcomes.

Future studies should explore causal pathways that may account for associations between hypertension and neighbourhood social polarisation. Polarisation may influence residents' employment opportunities; housing, healthcare, education and municipal services quality; access to healthy foods and walkable streets; and exposure to violence.[1524] Each of these factors can produce inequalities in the psychosocial and material condition under which individuals live, potentially determining their risk for hypertension.

In summary, our study results attest to the relevance of population health research that jointly analyses the racial/ethnic and income dimensions of spatial social polarisation, a topic for which scant health research exists.[411] What is needed is a 'both/and', rather than an 'either/or', approach to the concurrent realities of extreme spatial concentrations involving race/ethnicity and economic resources, and hence extends beyond the dominant approach of measuring racial segregation but controlling only for individual or household SEP.[214–19] A robust body of research further indicates that marked temporal and geographic variation exist in extreme spatial distributions of privilege and privation.[13840] The larger implication is that if patterns of extreme social spatial concentrations are modifiable, then so are the excess burdens of adverse health that they create.

Acknowledgments

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What is already known on this subject

The Index of Concentration at the Extremes (ICE) was recently developed to measure economic polarisation, by simultaneously assessing the concentration of people with low versus high economic resources in a given area. To date, used in only eight public health studies, the ICE appears to be associated with a range of somatic and mental health outcomes and adverse exposures.

What this study adds

Using ICE measures computed at the census tract level, we found that risk of high blood pressure was not associated with ICE for either income or education, but was associated with a novel ICE that combined data on both race/ethnicity and income, controlling for relevant covariates. Health researchers should further explore the joint role of neighbourhood racial/ethnic and socioeconomic polarisation on health.

Table 1

Calculation of the Index of Concentration at the Extreme (ICE) variables (using American Community Survey (ACS) 5-year estimates, 2008–2012)

Domain	Variable name	Formula	ACS table ID
Income	ICE_{inc}	((over US$100 k)–(under US$25 k))/total population_household income	B19001
Education	ICE_{edu}	((4 years college or more)–(less than high school))/total population_education note: educational level determined solely for adults 25 years old	B15002
Race/ethnicity	ICE_{race_wb}	((white non-Hispanic)–(black non-Hispanic))/total population_race	B03002
Income and race/ethnicity combined	ICE_{wb+inc}	((white non-Hispanic over US$100 k)–(black alone under US$25 k))/total population_household income	B19001
Income and race/ethnicity combined	$ICE_{wpc+inc}$	((white non-Hispanic over US$100 k) –(total under US$25 k–white non-hispanic under US$25 k))/total population_household income	B19001

Table 2

Sociodemographic, economic, discrimination and health characteristics of the combined United For Health (UFH; Greater Boston Area, 2003–2004) and My Body, My Story (MBMS; Boston, 2008–2010) study participants and the corresponding Index of Concentration at the Extremes (ICE) values (N=2203)

Variable	Distribution*		ICE measures: mean (SD)*				
	N	Per cent	ICE_{inc}	ICE_{edu}	ICE_{race_wb}	ICE_{wb+inc}	$ICE_{wpc+inc}$
ICE							
ICE_{inc}	2151	NA	−0.12 (0.26)				
(missing: N, %)	(52)	(2.4)					
ICE_{edu}	2151	NA		0.09 (0.27)			
(missing: N, %)	(52)	(2.4)					
ICE_{race_wb}	2151	NA			0.20 (0.55)		
(missing: N, %)	(52)	(2.4)					
ICE_{wb+inc}	2151	NA				0.03 (0.21)	
(missing: N, %)	(52)	(2.4)					
$ICE_{wpc+inc}$	2151	NA					−0.06 (0.27)
(missing: N, %)	(52)	(2.4)					
Sociodemographic							
Age (years)							
25–34	233	10.6	−0.14 (0.24)	**0.07 (0.24)**	0.13 (0.57)	**−0.01 (0.21)**	−0.09 (0.25)
35–54	1514	68.7	−0.12 (0.26)	**0.08 (0.26)**	0.21 (0.54)	**0.03 (0.21)**	−0.06 (0.27)
55–64	456	20.7	−0.10 (0.28)	**0.12 (0.29)**	0.20 (0.56)	**0.04 (0.23)**	−0.05 (0.28)
(missing: N, %)	(0)	(0.0)					
Nativity							
US born	1575	73.3	**−0.10 (0.27)**	**0.12 (0.27)**	**0.16 (0.56)**	0.02 (0.23)	−0.07 (0.28)
Not US born	575	26.7	**−0.15 (0.25)**	**0.00 (0.24)**	**0.29 (0.49)**	0.04 (0.18)	−0.06 (0.24)
(missing: N, %)	(53)	(2.4)					
Gender							
Women	1096	50.4	−0.11 (0.27)	**0.12 (0.27)**	**0.14 (0.56)**	**0.02 (0.23)**	−0.07 (0.28)
Men	1078	49.6	−0.12 (0.26)	**0.06 (0.26)**	**0.25 (0.53)**	**0.04 (0.20)**	−0.06 (0.26)
(missing: N, %)	(29)	(1.3)					

Variable	Distribution*		ICE measures: mean (SD)*				
	N	Per cent	ICE$_{inc}$	ICE$_{edu}$	ICE$_{race\_wb}$	ICE$_{wb-inc}$	ICE$_{wpe+inc}$
Study							
MBMS	1001	45.4	−0.08 (0.28)	0.17 (0.28)	0.14 (0.57)	0.03 (0.24)	−0.06 (0.30)
UFH	1202	54.6	−0.14 (0.24)	0.02 (0.24)	0.24 (0.52)	0.03 (0.19)	−0.07 (0.24)
(missing: N, %)	(0)	(0.0)					
Race/ethnicity							
Black	982	45.4	−0.18 (0.24)	0.03 (0.24)	0.05 (0.55)	−0.03 (0.20)	−0.14 (0.25)
Latino	274	12.7	−0.13 (0.25)	0.04 (0.25)	0.15 (0.56)	0.00 (0.20)	−0.09 (0.26)
White	788	36.4	−0.03 (0.27)	0.18 (0.27)	0.38 (0.48)	0.11 (0.21)	0.04 (0.26)
Other population of colour	121	5.6	−0.14 (0.25)	0.03 (0.23)	0.29 (0.49)	0.04 (0.18)	−0.06 (0.24)
(missing: N, %)	(38)	(1.7)					
Economic							
Individual level: current							
Occupational class							
Working class: non-supervisory employee	1033	52.3	−0.13 (0.26)	0.05 (0.26)	0.22 (0.54)	0.03 (0.21)	−0.07 (0.26)
Not working class: supervisory employee	434	22.0	−0.10 (0.27)	0.10 (0.26)	0.17 (0.55)	0.03 (0.22)	−0.06 (0.27)
Self-employed/freelance	147	7.4	−0.04 (0.24)	0.16 (0.27)	0.25 (0.56)	0.07 (0.22)	0.00 (0.26)
Own or run business	104	5.3	−0.09 (0.25)	0.12 (0.28)	0.26 (0.50)	0.06 (0.20)	−0.04 (0.26)
Not in paid labour force	259	13.1	−0.12 (0.30)	0.16 (0.29)	0.14 (0.58)	0.02 (0.24)	−0.08 (0.31)
(missing: N, %)	(226)	(10.3)					
Educational attainment							
<High school (HS)/12 years/GED	403	19.3	−0.14 (0.26)	0.06 (0.26)	0.18 (0.55)	0.01 (0.21)	−0.09 (0.27)
HS/GED and <4 years college	1333	63.7	−0.13 (0.26)	0.07 (0.25)	0.18 (0.56)	0.02 (0.21)	−0.08 (0.27)
4 years college	355	17.0	−0.03 (0.27)	0.20 (0.30)	0.25 (0.51)	0.09 (0.22)	0.00 (0.28)
(missing: N, %)	(112)	(5.1)					
Household-level: current							
Annual household income (US$)							
<12 000	519	26.1	−0.16 (0.26)	0.05 (0.25)	0.16 (0.54)	0.00 (0.20)	−0.10 (0.26)
12 000 to <36 000	727	36.6	−0.13 (0.25)	0.07 (0.26)	0.20 (0.55)	0.02 (0.21)	−0.07 (0.27)
36 000 to <48 000	155	7.8	−0.11 (0.25)	0.06 (0.24)	0.27 (0.54)	0.04 (0.21)	−0.04 (0.26)
48 000 to <72 000	306	15.4	−0.08 (0.26)	0.12 (0.26)	0.19 (0.55)	0.05 (0.22)	−0.04 (0.27)

Variable	Distribution*		ICE measures: mean (SD)*				
	N	Per cent	ICE_{inc}	ICE_{edu}	ICE_{race_wb}	ICE_{wb+inc}	$ICE_{wpe+inc}$
72 000 to <120 000	135	6.8	-0.04 (0.27)	0.20 (0.29)	0.22 (0.53)	0.07 (0.24)	-0.01 (0.28)
120 000	147	7.4	-0.05 (0.28)	0.15 (0.30)	0.23 (0.54)	0.07 (0.23)	-0.02 (0.30)
(missing: N, %)	(214)	(9.7)					
Poverty level (household)							
<100% poverty	733	37.0	-0.17 (0.26)	0.04 (0.25)	0.15 (0.55)	0.00 (0.21)	-0.11 (0.27)
100–199% poverty	451	22.8	-0.10 (0.26)	0.10 (0.27)	0.25 (0.56)	0.04 (0.22)	-0.04 (0.28)
200% poverty	797	40.2	-0.08 (0.27)	0.13 (0.27)	0.22 (0.53)	0.05 (0.22)	-0.03 (0.27)
(missing: N, %)	(222)	(10.1)					
Census tract: current							
20% below poverty	1009	46.9	-0.32 (0.19)	-0.06 (0.23)	-0.05 (0.51)	-0.11 (0.17)	-0.26 (0.20)
10–19% below poverty	572	26.6	-0.04 (0.13)	0.15 (0.24)	0.19 (0.52)	0.05 (0.16)	0.00 (0.16)
5–9% below poverty	372	17.3	0.09 (0.14)	0.22 (0.18)	0.55 (0.34)	0.19 (0.13)	0.16 (0.14)
<5% below poverty	198	9.2	0.28 (0.14)	0.36 (0.19)	0.79 (0.18)	0.34 (0.13)	0.33 (0.13)
(missing: N, %)	(52)	(2.4)					
Childhood: household education†							
<HS/12 years/GED	521	29.1	-0.14 (0.26)	0.05 (0.26)	0.20 (0.54)	0.02 (0.21)	-0.08 (0.27)
HS/GED and <4 years college	918	51.3	-0.11 (0.26)	0.09 (0.25)	0.21 (0.55)	0.03 (0.21)	-0.06 (0.27)
4 years college	350	19.6	-0.05 (0.28)	0.18 (0.30)	0.21 (0.55)	0.06 (0.23)	-0.02 (0.29)
(missing: N, %)	(414)	(18.8)					
Exposure to racial discrimination							
Experiences of discrimination (EOD)							
EOD (categorical)							
0 (none)	840	38.9	-0.09 (0.26)	0.10 (0.28)	0.23 (0.53)	0.05 (0.22)	-0.03 (0.27)
1–2 (moderate)	554	25.7	-0.10 (0.27)	0.12 (0.26)	0.21 (0.53)	0.04 (0.20)	-0.05 (0.28)
3+ (high)	764	35.4	-0.15 (0.25)	0.06 (0.25)	0.17 (0.55)	0.02 (0.22)	-0.11 (0.27)
(missing: N, %)	(45)	(2.0)					
Health outcomes							
Body mass index (BMI)							
<25 (not overweight or obese)	477	22.6	-0.09 (0.27)	0.12 (0.27)	0.19 (0.55)	0.04 (0.23)	-0.04 (0.28)
25 to <30 (overweight)	725	34.4	-0.12 (0.25)	0.06 (0.26)	0.22 (0.52)	0.03 (0.20)	-0.06 (0.26)

| Variable | Distribution[*] | | ICE measures: mean (SD)[*] | | | | |
	N	Per cent	ICE_{inc}	ICE_{edu}	ICE_{race_wb}	ICE_{wb+inc}	$ICE_{wpc+inc}$
30 (obese)	907	43.0	**-0.12 (0.27)**	**0.08 (0.26)**	0.21 (0.55)	0.02 (0.22)	-0.07 (0.28)
(missing: N, %)	(94)	(4.3)					
Smoking							
Non-smoker	1521	69.5	-0.11 (0.26)	0.09 (0.27)	**0.21 (0.53)**	**0.04 (0.21)**	**-0.06 (0.27)**
Current smoker	667	30.5	-0.13 (0.26)	0.09 (0.26)	**0.16 (0.57)**	**0.01 (0.22)**	**-0.08 (0.26)**
(missing: N, %)	(15)	(0.7)					
Hypertension							
No	1408	65.8	**-0.11 (0.26)**	0.08 (0.27)	**0.24 (0.54)**	**0.04 (0.21)**	**-0.05 (0.27)**
Yes	733	34.2	**-0.13 (0.27)**	0.09 (0.26)	**0.11 (0.55)**	**0.00 (0.22)**	**-0.10 (0.27)**
(missing: N, %)	(62)	(2.8)					

[*]
The per cent distributions are based on the observed (non-missing) values, and the per cent missing is based on the total eligible participants (n=2203); the reported means (SD) for the ICE measures are based on the imputed data (n=2145) and bold font connotes p<0.05 for differences in ICE distribution across categories of variable.

[†]Highest level of education attained in the household by the mother, father, or guardian.

NA, not applicable.

Table 3

Multivariable OR for being hypertensive: Index of Concentration at the Extremes (ICE) and covariates, My Body My Story (MBMS)+United For Health (UFH) (n=2145 [*])

Variable	Model 1 (univariable)		Model 2a (ICE$_{inc}$)		Model 2b (ICE$_{edu}$)		Model 2c (ICE$_{race\_wb}$)		Model 2d (ICE$_{wb+inc}$)		Model 2e (ICE$_{wpc\_inc}$)		Model 3a (Socio-demographic)	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
ICE														
ICE$_{inc}$	0.66	(0.47 to 0.94)	0.50	(0.35 to 0.71)										
ICE$_{edu}$	1.14	(0.81 to 1.60)			0.57	(0.39 to 0.82)								
ICE$_{race\_wb}$	0.66	(0.56 to 0.78)					0.71	(0.60 to 0.84)						
ICE$_{wb+inc}$	0.39	(0.25 to 0.59)							0.37	(0.24 to 0.57)				
ICE$_{wpc+inc}$	0.50	(0.35 to 0.69)									0.47	(0.33 to 0.66)		
Sociodemographic														
Age (years)	1.07	(1.05 to 1.08)											1.06	(1.04 to 1.07)
Gender														
Women	1.05	(0.88 to 1.26)											0.62	(0.50 to 0.77)
Men (referent)	1												1	
Race/ethnicity														
Black	1.56	(1.28 to 1.90)											1.79	(1.44 to 2.22)
Latino	0.23	(0.15 to 0.37)											0.69	(0.42 to 1.14)
Other	0.46	(0.28 to 0.75)											1.06	(0.62 to 1.81)
White (referent)	1												1	
Smoking														
Current smoker	1.39	(1.15 to 1.68)											1.35	(1.08 to 1.67)
Non-smoker (referent)	1												1	
Body mass index (BMI)	1.08	(1.06 to 1.09)											1.08	(1.06 to 1.10)
Economic														
Annual household income	1.10	(1.04 to 1.17)												
Education (participant)														
<High school (HS)/12 year/GED	1.12	(0.90 to 1.41)												
HS (referent)	1													
Education (childhood: household)														

Variable	Model 1 (univariable) OR	(95% CI)	Model 2a (ICE_{inc}) OR	(95% CI)	Model 2b (ICE_{edu}) OR	(95% CI)	Model 2c (ICE_{race_wb}) OR	(95% CI)	Model 2d (ICE_{wb+inc}) OR	(95% CI)	Model 2e (ICE_{wpc_inc}) OR	(95% CI)	Model 3a (Socio-demographic) OR	(95% CI)
<HS/12 year/GED	1.05	(0.86 to 1.29)												
HS (referent)	1													
Racial discrimination														
Experiences of discrimination (EOD) (0–9 scale)	1.07	(1.03 to 1.10)												
Social desirability	1.00	(1.00 to 1.01)												
Data source														
Study														
MBMS	3.35	(2.78 to 4.04)	3.52	(2.91 to 4.25)	3.66	(3.01 to 4.46)	3.27	(2.71 to 3.94)	3.39	(2.81 to 4.09)	3.39	(2.81 to 4.09)	2.77	(2.20 to 3.50)
UFH (referent)	1		1		1		1		1		1		1	

Variable	Model 3b (Economic) OR	(95% CI)	Model 3c (Racial Discrimination) OR	(95% CI)	Model 4a (ICE_{inc} +Models 3a–3c) OR	(95% CI)	Model 4b (ICE_{edu} +Models 3a–3c) OR	(95% CI)	Model 4c (ICE_{race_wb} +Models 3a–3c) OR	(95% CI)	Model 4d (ICE_{wb+inc} +Models 3a–3c) OR	(95% CI)	Model 4f ($ICE_{wpc+inc}$ +Models 3a–3c) OR	(95% CI)
ICE														
ICE_{inc}					0.71	(0.48 to 1.07)								
ICE_{edu}							0.94	(0.63 to 1.41)						
ICE_{race_wb}									0.76	(0.62 to 0.93)				
ICE_{wb+inc}											0.48	(0.29 to 0.81)		
$ICE_{wpc+inc}$													0.61	(0.40 to 0.92)
Sociodemographic														
Age (years)					1.05	(1.04 to 1.07)	1.05	(1.04 to 1.07)	1.05	(1.04 to 1.07)	1.05	(1.04 to 1.07)	1.05	(1.04 to 1.07)
Gender														
Women					0.6	(0.48 to 0.74)	0.59	(0.47 to 0.74)	0.58	(0.46 to 0.73)	0.6	(0.48 to 0.74)	0.59	(0.47 to 0.74)
Men (referent)					1		1		1		1		1	
Race/ethnicity														
Black					1.73	(1.33 to 2.24)	1.76	(1.36 to 2.28)	1.58	(1.21 to 2.06)	1.79	(1.39 to 2.33)	1.61	(1.24 to 2.10)
Latino					0.59	(0.35 to 0.99)	0.59	(0.35 to 1.01)	0.54	(0.31 to 0.92)	0.60	(0.36 to 1.01)	0.55	(0.32 to 0.95)
Other					1.06	(0.62 to 1.81)	1.13	(0.63 to 2.01)	1.06	(0.60 to 1.90)	1.09	(0.63 to 1.87)	1.07	(0.60 to 1.90)
White (referent)					1		1		1		1		1	
Smoking														

Variable	Model 3b (Economic) OR	(95% CI)	Model 3c (Racial Discrimination) OR	(95% CI)	Model 4a (ICE$_{inc}$ +Models 3a–3c) OR	(95% CI)	Model 4b (ICE$_{edu}$ +Models 3a–3c) OR	(95% CI)	Model 4c (ICE$_{race\_wb}$ +Models 3a–3c) OR	(95% CI)	Model 4d (ICE$_{+inc}$+Models 3a–3c) OR	(95% CI)	Model 4f (ICE$_{wpe+inc}$ +Models 3a–3c) OR	(95% CI)
Current smoker					1.33	(1.07 to 1.65)	1.34	(1.07 to 1.67)	1.32	(1.06 to 1.64)	1.34	(1.08 to 1.67)	1.32	(1.06 to 1.64)
Non-smoker (referent)					1		1		1		1		1	
BMI					1.08	(1.06 to 1.10)	1.08	(1.06 to 1.10)	1.08	(1.06 to 1.10)	1.08	(1.06 to 1.10)	1.08	(1.06 to 1.10)
Economic														
Annual household income	1.01	(0.95 to 1.08)			1.02	(0.95 to 1.10)	1.02	(0.95 to 1.08)	1.02	(0.95 to 1.09)	1.02	(0.95 to 1.09)	1.02	(0.96 to 1.09)
Education (participant)														
<HS/12 year/GED	1.36	(1.05 to 1.76)			1.31	(0.99 to 1.73)	1.30	(0.99 to 1.71)	1.31	(1.00 to 1.72)	1.31	(1.00 to 1.73)	1.30	(0.99 to 1.71)
HS (referent)	1				1		1		1		1		1	
Education (childhood: household)														
<HS/12 year/GED	1.38	(1.11 to 1.72)			1.26	(0.99 to 1.61)	1.27	(0.98 to 1.64)	1.28	(0.99 to 1.66)	1.26	(0.99 to 1.61)	1.27	(0.98 to 1.64)
HS (referent)	1				1		1		1		1		1	
Racial discrimination														
EOD (0–9 scale)			1.04	(1.00 to 1.08)	0.97	(0.93 to 1.01)	0.97	(0.93 to 1.02)	0.97	(0.93 to 1.02)	0.97	(0.93 to 1.02)	0.97	(0.93 to 1.02)
Social desirability			1.00	(1.00 to 1.01)	1.00	(1.00 to 1.00)	1.00	(1.00 to 1.00)	1.00	(1.00 to 1.00)	1.00	(1.00 to 1.00)	1.00	(1.00 to 1.00)
Covariates														
Study														
MBMS	3.72	(3.03 to 4.58)	3.31	(2.74 to 3.99)	3.08	(2.39 to 3.96)	3.11	(2.40 to 4.02)	2.95	(2.29 to 3.80)	3.02	(2.35 to 3.88)	3.08	(2.38 to 3.99)
UFH (referent)	1		1		1		1		1		1		1	

*Values based on 5 imputed data sets, with imputation model including all variables included in analytic models 1 through 4f.