Intersectional Analyses Exploring Population-Level Body Mass Index in the Period of the Great Recession

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ABSTRACT

Economic shocks such as the Great Recession invoke psychosocial stress. Unemployment rates increase and economic insecurity heightens, especially among the poor. Individuals may adopt unhealthy coping behaviors, potentially causing weight gain or loss. The present study examines population-level heterogeneity in body mass index at the intersection of socioeconomic status, gender, race, and ethnicity during the period of the Great Recession. Using data from the National Health and Nutrition Examination Survey 2003-2014, findings reveal increases in body mass index during the period of the Great Recession among the following five demographic subgroups: poor white males and females, poor Hispanic males and females, and non-poor black females. Poor white women experience the largest gains in body mass index during the study period, followed by non-poor black women. Adverse health behaviors partially mediate, but do not fully attenuate the elevated BMI observed among these demographic subgroups. These findings suggest that the biosocial health effects of recessions are complex and vary on account of socioeconomic status, gender, race, and ethnicity.

KEYWORDS: Great Recession; body mass index; racial/ethnic inequality; gender; intersectionality; socioeconomic status; alcohol use; smoking; macroeconomic conditions; health

1. INTRODUCTION

Between December 2007 and June 2009, the U.S. and many global marets underwent a period of economic decline known as the Great Recession. Unemployment rates in the U.S. rose from 5 percent to a peak of 10 percent during the height of the recession in October 2009 (U.S. Bureau of Labor Statistics 2012). Concordantly, the steady growth in median household income in the decade prior to the Great Recession stagnated in 2008 ($50,303) and reached a low in 2010 ($49,276) (U.S. Census Bureau 2017).

Not all sociodemographic groups experience the economic hardships of recessions equally. During the Great Recession, men were more likely than women to be unemployed (10.5% vs. 8.6%) (U.S. Bureau of Labor Statistics 2017b). Though men face higher risk of negative recessionary events, they also experience recovery sooner (Hoynes, Miller, and Schaller 2012). In 2010, non-Hispanic black adults experienced the highest unemployment rates

(16%) relative to Hispanics (13%) and non-Hispanic whites (8.7%) (U.S. Bureau of Labor Statistics 2012, 2017a). Non-Hispanic black males were most affected with an unemployment rate spiking to 18.4 percent (U.S. Bureau of Labor Statistics 2017a). Compared to whites, non-Hispanic blacks and Latinos experience more recession hardships such as job loss, reduced work hours, and home foreclosure (Zemore et al. 2013). Further, lower-income households bear the steepest consequences of recessions, experiencing greater relative income losses and a longer duration to economic recovery (Acs 2008).

Previous research highlights the cyclical relationship between macroeconomic forces and health behaviors with mixed findings. Some studies note the positive influence of recessions on health via reductions in smoking and alcohol use on account of less discretionary funds, and increases in physical activity due to more leisure time (Ruhm 2000; Ruhm and Black 2002). In contrast, to cope with heightened psychosocial stress related to unemployment uncertainty, individuals may adopt adverse health behaviors such as alcohol use, decreasing physical activity, smoking, and consuming less healthy diets (Dávalos, Fang, and French 2011; Dave and Kelly 2012; Dee 2001; Mohammad Ali and Lindström 2006; Rosenthal et al. 2012). Engagement in these behaviors differs by sociodemographic characteristics. Non-Hispanics blacks are more at risk for developing alcohol problems due to recessions and gaining weight when unemployment rates rise (Charles and DeCicca 2008; Zemore et al. 2013). Further, prior research suggests recession hardships increase waist circumference (Kirsch and Ryff 2016) and living among home foreclosures raises risk of weight gain (Arcaya et al. 2013). The Great Recession, therefore, potentially may exacerbate existing public health crises, such as the obesity epidemic, particularly among those most vulnerable in society.

1.1. Obesity

Approximately 37.7 percent of the U.S. adult population has a body mass index (BMI) above 30 kg/m^2, the clinical definition of obesity (NIDDK 2017). Obesity increases risk for several top causes of death, including heart disease, certain forms of cancer, chronic lower respiratory diseases, and diabetes (Calle and Thun 2004; Eckel 1997; National Heart, Lung, and Blood Institute 2013; Poulain et al. 2006; Wolin, Carson, and Colditz 2010). Obese individuals experience comorbidities, increasing their health care expenditures relative to those of normal weight. Estimates from the 2006 Medical Expenditure Panel Survey indicate that annual health care costs for obese adults totaled $303.1 billion compared to $259.6 billion in expenses for those of normal weight (Stagnitti 2009). With trends indicating an increase in the prevalence of obese adults in the U.S., it is crucial to understand and identify the interplay between the biological and social underpinnings of this epidemic (NIDDK 2017).

Obesity prevalence varies by social demographic characteristics such as gender, race, and ethnicity. In the U.S., women experience obesity at higher rates than men (Ogden et al. 2014). Non-Hispanic blacks have the highest prevalence of obesity (47.8%) followed by Hispanics (42.5%) and non-Hispanic whites (32.6%) (Ogden et al. 2014). Examining the intersection of race, ethnicity, and gender illustrates further population heterogeneity in obesity prevalence. Non-Hispanic black women (56.6%), Hispanic women (44.4%), Hispanic men (40.1%), and non-Hispanic black men (37.1%) all experience higher rates of obesity relative to non-Hispanic white women (32.8%) and men (32.4%) (Ogden et al. 2014).

The association between socioeconomic status and obesity varies by gender. For females, income and education are inversely related to obesity prevalence, with the highest

income earners and most educated having lower levels of obesity (Ogden et al. 2014). The relationship between socioeconomic status and obesity among men varies by race and ethnicity. Whereas non-Hispanic white males experience consistent levels of obesity across income brackets, obesity rates are highest among higher income non-Hispanic black and Mexican American males (Ogden et al. 2014). The complex associations among sociodemographic factors and obesity highlight the need for analyses sensitive to intersectional pathways.

1.2. Theoretical Framing and Intersectionality

Differential access to health promoting resources such as knowledge, power, prestige, and social connections underlie the association between socioeconomic status and health outcomes (Link and Phelan 1995; Phelan, Link, and Tehranifar 2010). The pervasive nature of this association suggests that those with more access to flexible resources maintain better health than those lower in the social hierarchy. Fundamental cause theory articulates that individuals' abilities to evade unhealthy environments and utilize health promoting resources relies on their socioeconomic status, making it a fundamental cause of disease (Phelan et al. 2010).

During recessions, several factors affect socioeconomic status, underlying fundamental cause theory, such as: home foreclosures, job insecurity and loss, difficulty paying bills, devaluation of assets and wealth, reduced work hours, and fewer societal resources for welfare programs (Modrek et al. 2013). These social conditions expose individuals to greater psychosocial stress, increasing risk for negative health events and outcomes (Burgard and Kalousova 2015; Houle 2014; Kirsch and Ryff 2016; Margerison-Zilko et al. 2016; Modrek et al. 2013).

Race and ethnicity expound similar rationales as fundamental causes of disease given persistent associations with health despite varying cultural, geographical, and historical contexts (Schnittker 2007; Williams 1999). During the Great Recession, racial minority neighborhoods (predominantly Hispanic and/or black) experienced the highest rates of housing foreclosures (Hall, Crowder, and Spring 2015). Predatory lenders targeted minority communities making segregation a confounding factor of the housing crisis (Rugh and Massey 2010). Thus, structural socioeconomic and racial stratification processes have the capacity to predispose individuals to adverse social conditions, ultimately influencing morbidity, an important, focal consideration.

Social statuses, like race and ethnicity, gender, and socioeconomic status, pattern daily experiences by interacting with one another and compounding cumulative effects (Choo and Ferree 2010; Collins 2000; Springer, Hankivsky, and Bates 2012). Furthermore, individuals of similar socioeconomic status experience within-group heterogeneity in life events due to race, ethnicity, and gender (Miech et al. 2011). Interacting social forces produce differential exposure to inequality, influencing psychosocial attitudes, and ultimately, health (Collins 2000; Kane 2000; Springer et al. 2012). The intersectionality perspective strengthens fundamental cause theory by accounting for the simultaneous and multiplicative effects of sociodemographic factors on health outcomes (Miech et al. 2011; Richman 2017; Springer et al. 2012).

Human bodies incrementally adapt to adverse, chronic social conditions (Geronimus et al. 2006; Krieger 2005; Willson, Shuey, and Elder Jr. 2007). Known as 'weathering,' poor social conditions become embodied, inducing psychosocial stress and, over time, elevating risk for

chronic disease (Ben-Shlomo and Kuh 2002; Galobardes, Lynch, and Davey Smith 2004; Geronimus et al. 2006; Pearlin et al. 2005). Researchers note the significant effects of recessions on psychosocial stress via increased work-related stress, unemployment, economic insecurity, and home foreclosure (Burgard, Ailshire, and Kalousova 2013; Burgard, Brand, and House 2009; Burgard and Kalousova 2015; Houdmont, Kerr, and Addley 2012). Furthermore, the physiological effects of social disadvantage accumulate with age, becoming further amplified in the presence of multiple, concurrent adverse social conditions (Choo and Ferree 2010; Collins 2000; Springer et al. 2012).

1.3. Overview

The present study examines the interactive effects of race, ethnicity, gender, and socioeconomic status on BMI during the Great Recession among a representative sample of working-aged adults in the U.S. To reflect the disparate sociodemographic pathways individuals experience, we employ a categorical approach which focuses on "the complexity of relationships among multiple social groups within and across analytical categories" (McCall 2005, pg. 1786). We contribute to the aforesaid literature by analyzing how multiple social disadvantages interact to affect BMI levels before, during, and after the period of the Great Recession. We can therefore ascertain the health consequences of societal economic collapse, with sensitivity to the disparate pathways individuals experience on account of intersecting sociodemographic factors. Further, we examine indicators of the Great Recession and individual health behaviors as potential mediators of the focal association.

This study addresses the following research questions:
1. Prior to the Great Recession, to what extent do body mass index levels vary in the U.S. population at the intersection of race/ethnicity × socioeconomic status for each gender?
2. Do body mass index levels fluctuate within each race/ethnicity × socioeconomic status demographic subgroup across the study period (i.e. pre-recession, during the recession, and post-recession)?
3. What effect does individual employment status and the associated demographic subgroups' national unemployment rate have on the association between race/ethnicity × socioeconomic status and body mass index for each gender in the period surrounding the Great Recession?
4. To what extent do adverse health behaviors like smoking and alcohol use, potentially adopted as coping mechanisms during the Great Recession, mediate the focal association?

2. METHODS

2.1 Data

NHANES collects data from in-person interviews, physician-performed physical examinations, and laboratory testing utilizing a complex, multistage probability sampling design across all fifty states and the District of Columbia (Johnson, Paulose-Ram, and Ogden 2013; Zipf, Chiappa, and Porter 2013). This study employs data from six continuous, cross-sectional National Health and Nutrition Examination Survey (NHANES) years: 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, and 2013-2014. Pre-recession data combines two continuous NHANES datasets, spanning years 2003-2006. The next four years, between 2007-

2010, constitute the period of the Great Recession. Post-recession data sequentially follows the period of the Great Recession from 2011 to 2014. Merging multiple survey years strengthens statistical power when conducting statistical analyses stratified by gender, socioeconomic status, and race and ethnicity.

Appending NHANES data, we derive data on national unemployment rates from the Bureau of Labor Statistics (BLS 2022). National unemployment rates are noted for each race/ethnicity × gender subgroup, monthly from 2003 to 2014. To sync BLS data with NHANES, we average six-month national unemployment rates for each race/ethnicity × gender to align with respondents' date of interview. NHANES provides respondents' date of interview within a six-month span and specific year in one of two categories: November 1 through April 30 or May 1 through October 31. The resulting merged BLS data corresponds to the associated national unemployment rate for each demographic subgroup at the time of respondents' interview.

Our sample includes those of working-age between 25 and 66 years, not pregnant, and self-identifying as non-Hispanic white, non-Hispanic black, or Hispanic (native- and foreign-born) (*note*: NHANES did not begin collecting data specifically on non-Hispanic Asian Americans until the 2011-2012 survey cycle and, therefore, are excluded from the study). We utilize survey weights to account for NHANES complex survey design; the resulting analyses represent the U.S.'s civilian, non-institutionalized population for the stated demographic subgroups. The final analytic sample includes 16,484 individuals, of which 8,221 are females and 8,263 are males.

2.2. Body Mass Index

The outcome variable is a continuous measure of BMI, calculated as weight (kg) divided by height (m^2). Clinically speaking, BMI categorical cutoffs indicate the presence of underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (24.9-29.9 kg/m^2), and obese (≥30 kg/m^2) individuals. Although not a direct measure of body fatness, BMI correlates with body fatness indicators such as percent body fat, skinfold thickness, and waist circumference, making it a valid comparable measure (Flegal and Graubard 2009; Steinberger et al. 2005; Sun et al. 2010). Higher BMI is associated with many age-related chronic diseases including: heart disease, stroke, type 2 diabetes, osteoarthritis, and some cancers- breast, colon, endometrium, esophageal, kidney, gallbladder, and liver (Bhaskaran et al. 2014; Bogers et al. 2007; Calle and Thun 2004; National Heart, Lung, and Blood Institute 2013). Further, higher BMI elevates risk for mortality (Flegal and Graubard 2009; National Heart, Lung, and Blood Institute 2013). NHANES participants have their height and weight recorded as part of the body measure examination in the Mobile Examination Center (MEC).

2.3. Intersecting Sociodemographic Characteristics

The focal predictor variable focuses on three social and demographic characteristics: gender, socioeconomic status, and race and ethnicity. Employing McCall's (2005) categorical approach, we operationalize these intersecting sociodemographic factors into twelve subgroups: poor and non-poor white males and females, poor and non-poor black males and females, and poor and non-poor Hispanic males and females. Respondents' gender is coded as male or female. NHANES' poverty income ratio indicates socioeconomic status by specifying the poverty threshold by family size, with one or below indicating those living below the federal poverty line. We characterize socioeconomic disadvantage, being poor, as a poverty income ratio less than two (twice the federal poverty line) to reflect the substantial economic hardship

faced by many low-income Americans living above the federal poverty line. Respondents self-report their race and ethnicity during the questionnaire portion of the NHANES interview. We categorize respondents as non-Hispanic white (here on referred to as white), non-Hispanic black (here on referred to as black), and Hispanic.

2.4. Mediators

We explore two potential mediators to ascertain the extent to which the Great Recession and health behaviors underlie the focal association. Employment status and national unemployment rates comprise indicator proxies for the Great Recession. Employed individuals report working at a job or business within the past week of their interview. National unemployment rates are noted for each race/ethnicity × gender subgroup, utilizing a six-month average to align with the time of respondents' interviews. Analyzed health behaviors include smoking and alcoholic drinking habits. Respondents may be categorized as: those that never smoked or quit smoking (reference category); those that smoke occasionally (five or less cigarettes per day on average [Schane, Ling, and Glantz 2010]); and regular smokers (six or more cigarettes per day on average). Alcohol consumption definitions vary by gender with female heavy drinkers consuming two or more alcoholic beverages daily and males consuming three or more. Female moderate drinkers consume one drink per day, whereas male moderate drinkers imbibe on two alcoholic drinks daily. Those that do not drink alcohol serve as the reference category.

2.5. Covariates

We control for three additional factors with noted associations with BMI, including: age, educational attainment, and nativity × acculturation. NHANES researchers recorded age, in years, at the time of interview. Respondents note their highest level of education completed. We categorize educational attainment as less than high school, high school, and more than high school. Given that immigrants, on average, have lower BMI than our native born population (Barrington et al. 2010; Cunningham, Ruben, and Venkat Narayan 2008), we control for nativity × acculturation utilizing an interaction term between binary-coded foreign born and the number of years lived in the U.S. This combination of variables operates as an internal moderator for the effects of immigration and assimilation (Mirowsky 2013).

2.6. Sample

Table 1 reports the absolute number of respondents in each race/ethnicity × gender × socioeconomic subgroup before, during, and after the Great Recession. For both genders, non-poor whites comprise the largest subsample of NHANES participants. The recession-specific demographic subgroup with the fewest participants is post-recession, non-poor Hispanic males and females, illustrating the relative rarity of this combination of social statuses.

Table 1. Weighted Sample Recession Distribution by Race and Ethnicity, Gender, and Socioeconomic Status (Absolute *N*s and Percentages), NHANES 2003-2014

	Non-Poor			Poor			
	White	**Black**	**Hispanic**	**White**	**Black**	**Hispanic**	
Females							**Total**
All Ages	30.50%	12.24%	10.94%	17.95%	12.33%	16.04%	100.00%
n	2507	1,006	899	1,476	1,014	1,319	8221
Pre-Recession	36.79%	13.33%	9.39%	14.37%	11.88%	14.24%	100.00%
n	886	321	226	346	286	343	2408
Recession	29.62%	10.49%	11.79%	18.75%	10.27%	19.07%	100.00%
n	932	330	371	590	323	600	3146
Post-Recession	25.83%	13.31%	11.32%	20.25%	15.19%	14.10%	100.00%
n	689	355	302	540	405	376	2667
Total	2507	1006	899	1476	1014	1319	8221
Males							Total
All Ages	32.17%	13.31%	11.52%	17.40%	10.32%	15.27%	100.00%
n	2,658	1,100	952	1,438	853	1,262	8263
Pre-Recession	37.83%	15.03%	10.53%	13.77%	8.56%	14.28%	100.00%
n	959	381	267	349	217	362	2535
Recession	31.82%	11.79%	12.79%	16.97%	9.37%	17.26%	100.00%
n	988	366	397	527	291	536	3105
Post-Recession	27.11%	13.46%	10.98%	21.43%	13.15%	13.88%	100.00%
n	711	353	288	562	345	364	2623
Total	2658	1100	952	1438	853	1262	8263

2.7. Analytical Strategy

We use age-adjusted ordinary least squares (OLS) multiple regression models to explore the joint effects of race and ethnicity, gender, and socioeconomic status on BMI in the period before, during, and after the Great Recession. We further explore linear combinations of OLS regression coefficients using Stata's "lincom" command to identify significant differences in BMI within race/ethnicity × socioeconomic status demographic subgroups by gender.

We conduct separate analyses for men and women given the disparate pathways by which men and women embody social stress (Connell 2012). To examine the relationship between race/ethnicity × socioeconomic status on BMI during the period of the Great Recession, we perform age-adjusted, gender-specific analyses for working-aged adults (25-66 years old), controlling for educational attainment and nativity × acculturation (Baseline Model). The second statistical model builds on the baseline model to examine employment status and demographic-specific national unemployment rate as potential mediators of the focal association (Recession Model). The final model includes indicators of alcohol use and smoking behavior to evaluate the extent to which the effect of race/ethnicity × socioeconomic status on BMI during the period of the Great Recession may be explained by deleterious health behaviors

(Health Behaviors Model). Our statistical models met checks for linearity, normally distributed errors, and uncorrelated errors. All analyses were performed using Stata 17 (StataCorp. 2022).

3. RESULTS

3.1. Race/Ethnicity × Socioeconomic Status and Body Mass Index

Table 2 and Figure 1 present results from multivariate OLS regression models estimating the joint effects of race and ethnicity, socioeconomic status, and recession period on BMI (kg/m^2) by gender compared to pre-recession, non-poor whites. Among females aged 25-66 years, pre-recession, non-poor white women, our reference group, have the lowest BMI (Table 2 Model 1 and Figure 1). Poor and non-poor black, poor and non-poor Hispanic, and poor white women experience elevated BMI throughout the study period compared to the reference group. Poor black women in the period following the recession record the largest disparity in BMI (5.970 kg/m^2, p < 0.001).

Compared to working-aged females, males in this age demographic have less variation in BMI on average (Table 2 Model 4 and Figure 2). Regardless of proximity to the Great Recession, non-poor black, poor Hispanic, and non-poor Hispanic males' BMI consistently stands higher than their non-poor white counterparts. In contrast, poor white males have significantly lower BMI before the recession (-0.917 kg/m^2, p < 0.01). We observe the most elevated BMI for working-aged males among poor Hispanic men post-recession (2.141 kg/m^2, p < 0.001).

Fig. 1. Sociodemographic OLS Coefficients Predicting Body Mass Index among Females aged 25-66 years, NHANES 2003-2014
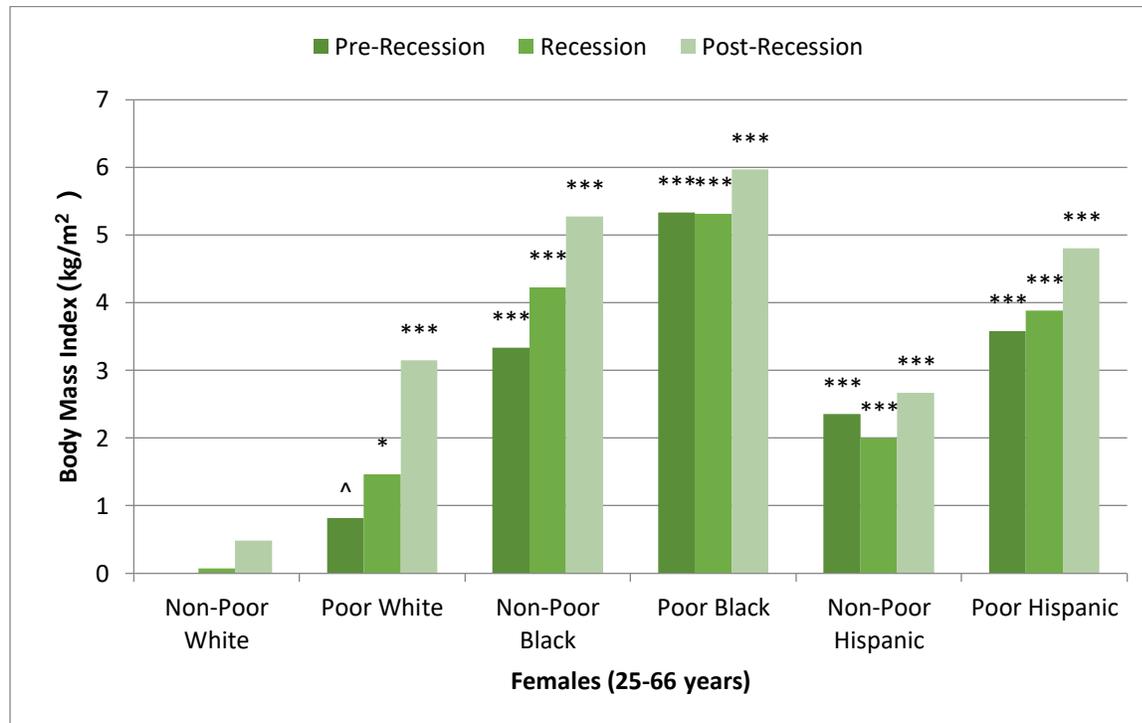
Note: Pre-recession, non-poor white females serve as reference categories. Asterisks denote significant differences between each subgroup and the reference category: ^p<0.10. *p < 0.05. **p < 0.01. ***p < 0.001

**Table 2.** Ordinary Least Squares Regression Models Predicting Body Mass Index (kg/m^2), NHANES 2003-2014

Variable Name	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Demographic Included	**Females 25-66 years**			**Males 25-66 years**		
	Baseline	**Recession**	**Health Behaviors**	**Baseline**	**Recession**	**Health Behaviors**
Poor Black Pre-Recession	5.335***	5.286***	4.703***	0.139	-0.107	-0.040
	(0.58)	(0.66)	(0.64)	(0.52)	(0.61)	(0.59)
Poor Black Recession	5.318***	5.224***	5.095***	-0.021	-0.428	-0.169
	(0.57)	(0.86)	(0.85)	(0.46)	(0.65)	(0.63)
Poor Black Post-Recession	5.970***	5.870***	5.635***	-0.116	-0.487	-0.383
	(0.51)	(0.76)	(0.74)	(0.51)	(0.67)	(0.66)
Non-Poor Black Pre-Recession	3.332***	3.236***	2.791***	0.872*	0.681	0.631
	(0.48)	(0.59)	(0.60)	(0.36)	(0.44)	(0.43)
Non-Poor Black Recession	4.228***	4.101***	3.649***	1.662***	1.352*	1.261*
	(0.71)	(0.76)	(0.76)	(0.37)	(0.61)	(0.61)
Non-Poor Black Post-Recession	5.276***	5.128***	4.770***	1.324**	1.021^	0.953^
	(0.59)	(0.79)	(0.77)	(0.41)	(0.57)	(0.57)
Poor White Pre-Recession	0.820^	0.861*	0.931*	-0.917**	-0.966**	-0.739*
	(0.42)	(0.42)	(0.44)	(0.33)	(0.34)	(0.37)
Poor White Recession	1.467*	1.482*	1.590**	0.067	-0.075	0.034
	(0.61)	(0.61)	(0.58)	(0.39)	(0.42)	(0.41)
Poor White Post-Recession	3.147***	3.158***	3.208***	0.405	0.279	0.415
	(0.54)	(0.55)	(0.54)	(0.43)	(0.46)	(0.44)
Non-Poor White Recession	0.076	0.040	-0.028	0.176	0.084	-0.029
	(0.39)	(0.44)	(0.43)	(0.29)	(0.28)	(0.29)
Non-Poor White Post-Recession	0.484	0.456	0.487	0.128	0.069	-0.069
	(0.45)	(0.47)	(0.47)	(0.30)	(0.29)	(0.29)
Poor Hispanic Pre-Recession	3.577***	3.581***	3.158***	0.866^	0.827^	0.546
	(0.57)	(0.60)	(0.57)	(0.48)	(0.49)	(0.49)
Poor Hispanic Recession	3.880***	3.833***	3.263***	1.722***	1.561**	1.305**
	(0.47)	(0.59)	(0.58)	(0.42)	(0.50)	(0.49)

Poor Hispanic Post-Recession	4.805***	4.754***	4.209***	2.141***	2.003***	1.647***
	(0.51)	(0.62)	(0.63)	(0.41)	(0.43)	(0.43)
Non-Poor Hispanic Pre-Recession	2.353***	2.327***	1.983***	1.249***	1.238***	1.122**
	(0.46)	(0.49)	(0.49)	(0.35)	(0.35)	(0.34)
Non-Poor Hispanic Recession	1.999***	1.921**	1.682**	1.834***	1.694***	1.425**
	(0.49)	(0.60)	(0.60)	(0.45)	(0.48)	(0.46)
Non-Poor Hispanic Post-Recession	2.667***	2.592**	2.352**	1.754***	1.648***	1.427***
	(0.67)	(0.79)	(0.78)	(0.39)	(0.40)	(0.40)
Age	0.053***	0.054***	0.040***	0.038***	0.036***	0.029***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Foreign Born	-2.329***	-2.335***	-2.656***	-1.649***	-1.637***	-1.815***
	(0.35)	(0.35)	(0.36)	(0.22)	(0.22)	(0.23)
Foreign Born x Years in U.S.	0.089***	0.089***	0.101***	0.020^	0.020^	0.020^
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
High School	0.478	0.459	0.412	0.713*	0.719*	0.471
	(0.31)	(0.30)	(0.30)	(0.30)	(0.30)	(0.31)
More than High School	-0.463^	-0.487^	-0.670*	0.074	0.088	-0.335
	(0.27)	(0.27)	(0.27)	(0.26)	(0.27)	(0.27)
Employed		0.172	0.206		-0.209	-0.353
		(0.21)	(0.21)		(0.22)	(0.23)
National Unemployment Rate		0.019	0.030		0.032	0.027
		(0.07)	(0.07)		(0.05)	(0.04)
Moderate Alcohol Drinker			-1.631***			-0.797**
			(0.30)			(0.24)
Heavy Alcohol Drinker			-1.716***			-0.374
			(0.29)			(0.26)
Occasional Smoker			-0.805^			-1.912***
			(0.41)			(0.24)
Regular Smoker			-1.917***			-2.240***
			(0.31)			(0.22)
Constant	25.952***	25.703***	28.117***	27.048***	27.147***	29.061***

	(0.56)	(0.69)	(0.79)	(0.46)	(0.57)	(0.65)
N	8221	8221	8221	8263	8263	8263

Note: Each cell contains regression coefficients and standard errors (in parentheses). Significant differences among groups are denoted as follows: ^p<0.10. *p < 0.05. **p < 0.01. ***p < 0.001.

Fig. 2. Sociodemographic OLS Coefficients Predicting Body Mass Index among Males aged 25-66 years, NHANES 2003-2014
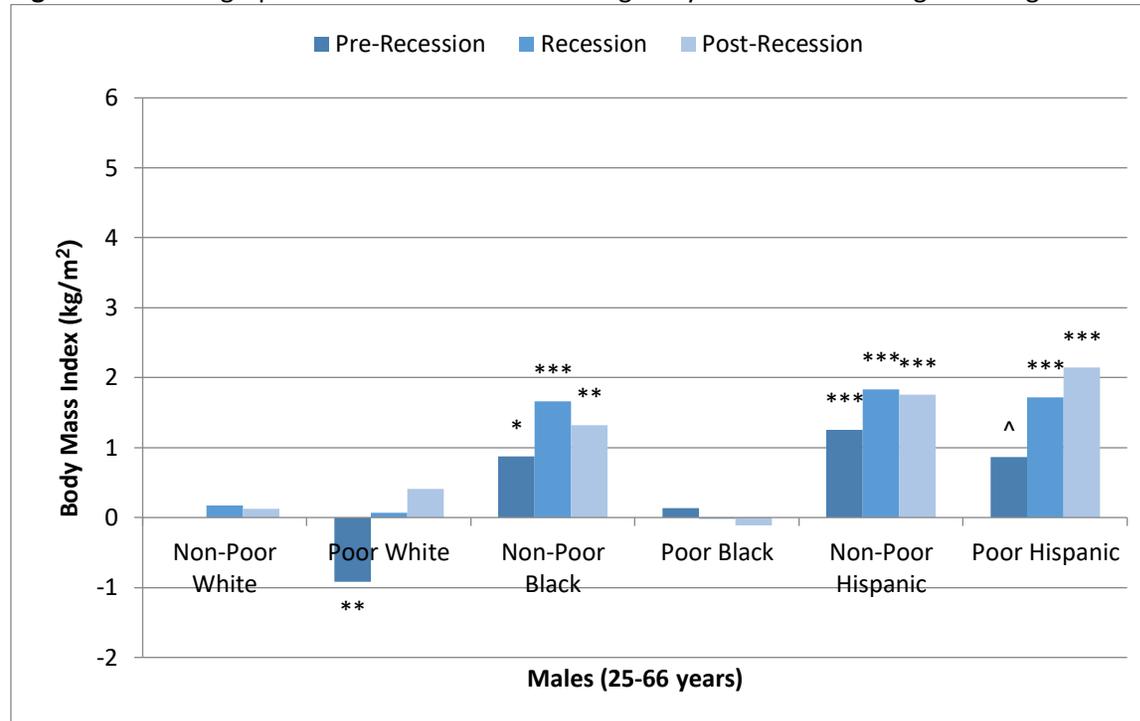
Note: Pre-recession, non-poor white males serve as reference categories. Asterisks denote significant differences between each subgroup and the reference category: ^p<0.10. *p < 0.05. **p < 0.01. ***p < 0.0

3.2. The Great Recession and Health Behaviors as Mediators

Table 2 Models 2 and 5 explore the effects of employment status and the national unemployment rate on the focal association for working-aged females and males, respectively. Both indicators for the Great Recession are not significantly associated with BMI. For non-poor black males, however, employment status and national unemployment rate appear to fully mediate the focal association, accounting for non-poor black males' elevated BMI. The indirect effect of these Great Recession proxy variables is not significant (0.191 kg/m^2, p = 0.479) however, and, therefore, we find no evidence of mediation on account of employment status and the national unemployment rate for any demographic subgroup.

Moderate alcohol consumption is inversely related to BMI for both males and females in the sample. Whereas being a heavy alcohol drinker has no association with BMI for males, consuming two or more alcoholic beverages daily is negatively associated with BMI for females. Likewise, males and females who smoke occasionally or regularly also experience lower BMI, with a stronger negative effect noted among regular smokers (Table 2 Models 3 and 6).

Among females, deleterious health behaviors partially account for elevated BMI levels across all recession periods among the following demographic subgroups: poor and non-poor blacks, as well as poor and non-poor Hispanics. Smoking behaviors and alcohol intake suppress the focal relationship for poor white women, regardless of recession period. This suggests that if it were not for poor white women's engagement in moderate and heavy drinking as well as occasional and regular smoking, their BMI would be even higher (Table 2 Model 3).

Alcohol consumption and smoking behaviors partially account for elevated BMI relative to pre-recession, non-poor white males among the following demographic subgroups: non-poor Hispanic males across all recession periods; poor Hispanic males and non-poor black males during the recession and post-recession; and poor white males, pre-recession (Table 2 Model 6). Thus, for males, elevated BMI levels persist among a subset of sociodemographic groups despite adverse health behaviors partially mediating the relationship between race/ethnicity × socioeconomic status and BMI.

3.3. Within Sociodemographic Subgroup Variation (Linear Combination Analyses)

Linear combination analyses explore variation in BMI across recession periods within each demographic subgroup, utilizing the fully mediated regression models (i.e. Model 3 for females and Model 6 for males). Table 3 reports and Figures 3 and 4 illustrate significant findings from these analyses, comparing recession and post-recession BMI within each demographic subgroup to their pre-recession baseline BMI.

**Table 3**. Significant Findings from Linear Combination Analyses, NHANES 2003-2014

Sociodemographic Group	Females	Males
25-66 years		
Poor White		
Pre-Recession to Post-Recession	2.277***	1.154*
	(0.559)	(0.536)
Recession to Post-Recession	1.619*	
	(0.637)	
Poor Hispanic		
Pre-Recession to Post-Recession	1.051^	1.101*
	(0.585)	(0.456)
Recession to Post-Recession	0.946*	
	(0.465)	
Non-Poor Black		
Pre-Recession to Post-Recession	1.979**	
	(0.649)	

Note: Each cell contains regression coefficients and standard errors (in parentheses). Significant differences among groups are denoted as follows:
^$p<0.10$. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

Among females, poor white women experience the largest gains in BMI when comparing BMI post-recession to pre-recession BMI (2.277 kg/m^2, $p < 0.001$). A significant portion of this rise in BMI for poor white females took place in the post-recession period relative to the recession period (1.619 kg/m^2, $p < 0.05$). Similarly, poor Hispanic women experienced gains in BMI in the post-recession period relative to the pre-recession years (1.051 kg/m^2, $p < 0.10$), with the majority of this gain occurring in the period between the recession and post-recession (0.946 kg/m^2, $p < 0.05$). The post-recession period also saw significant gains in BMI for non-poor black females relative to their pre-recession BMI (1.979 kg/m^2, $p < 0.01$).

Fig. 3. Linear Combination Analyses Predicting Body Mass Index among Females aged 25-66 years, NHANES 2003-2014
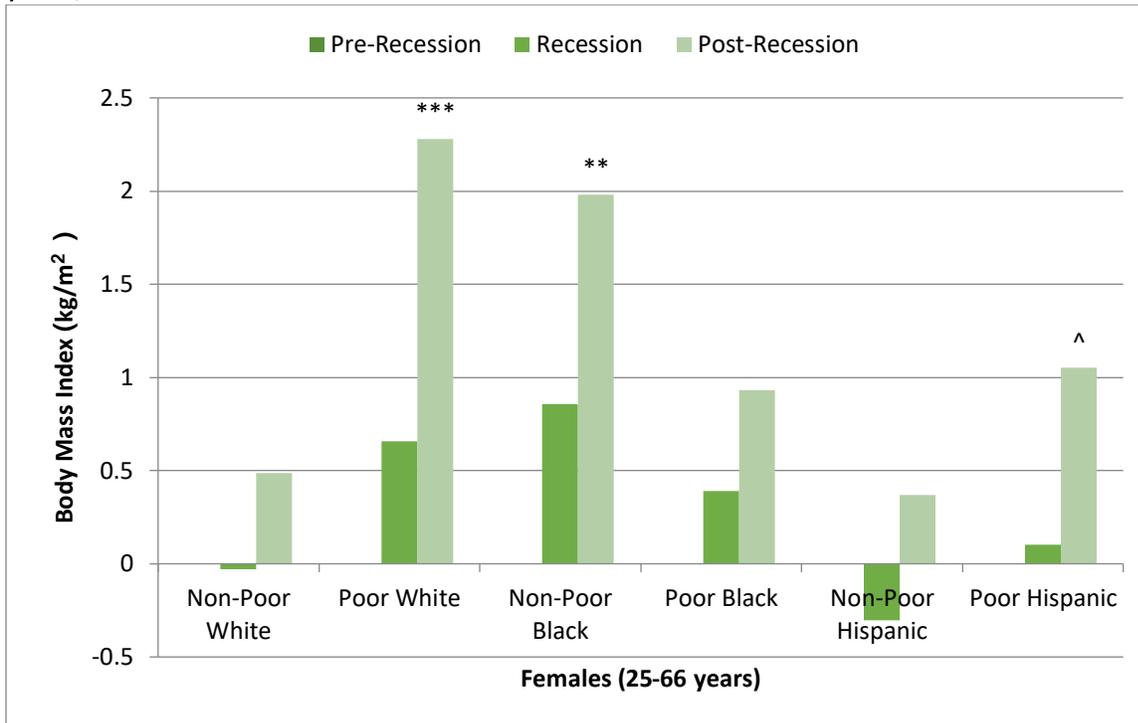
Note: The reference category varies for each demographic subgroup; within each demographic subgroup, the respective pre-recession race/ethnicity × socioeconomic status group serves as the reference category, e.g., pre-recession poor Hispanic females are the reference group for the poor Hispanic subgroup. Asterisks denote significant differences between each subgroup and the reference category: ^p<0.10. *p < 0.05. **p < 0.01. ***p < 0.001.

Poor white males and poor Hispanic males each exhibit significantly higher BMI in the post-recession period relative to their pre-recession BMI baseline. Poor white males' BMI increased by 1.154 kg/m^2 (p < 0.05), while poor Hispanic males' BMI rose by 1.101 kg/m^2 (p < 0.05).

Fig. 4. Linear Combination Analyses Predicting Body Mass Index among Males aged 25-66 years, NHANES 2003-2014
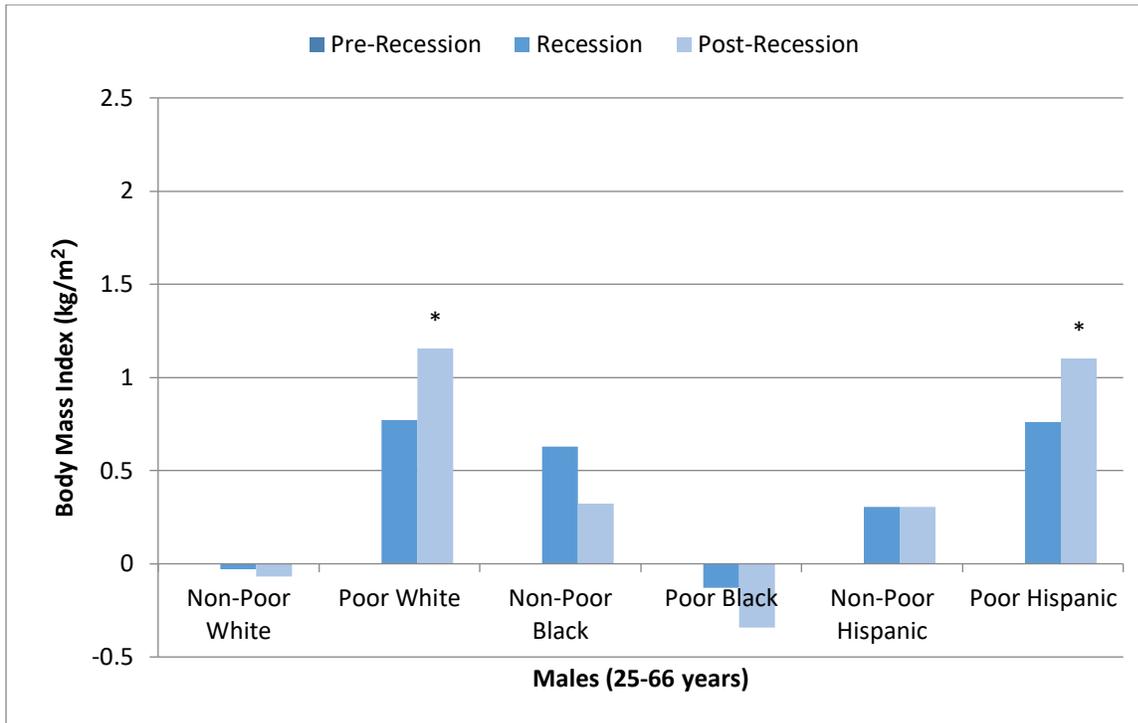
Note: The reference category varies for each demographic subgroup; within each demographic subgroup, the respective pre-recession race/ethnicity × socioeconomic status group serves as the reference category, e.g., pre-recession poor Hispanic males are the reference group for the poor Hispanic subgroup. Asterisks denote significant differences between each subgroup and the reference category: ^p<0.10. *p < 0.05. **p < 0.01. ***p < 0.001.

4. DISCUSSION

Multiple dimensions of social disadvantage intersect to affect population-level BMI preceding, during, and following the Great Recession. We note significant increases in BMI during and after the period of the Great Recession in the following *five* demographic subgroups: poor white males and females, poor Hispanic males and females, and non-poor black females. Notably, the continued rise of BMI in the post-recession period for these five demographic subgroups suggests that recession-induced behavioral changes affecting BMI endure beyond, and lag behind, the Great Recession's economic recovery.

The adverse health effects during the period of the Great Recession are most evident among those of working-age with the highest likelihood to be directly affected by societal economic collapse (subsequent analyses external to this study examining the focal findings by age group denote that most fluctuations in BMI occur among working-aged adults). The BMI gains experienced by working-aged adults are problematic given their higher pre-recession BMI (see Appendix A for the weighted sample distribution of pre-recession BMI by age, race, gender, and socioeconomic status). While BMIs of the analytic sample range from a low of 27.92 kg/m^2 for poor white males to a high of 33.28 kg/m^2 for poor black females, all observed

demographic subgroups are classified as overweight or obese during the pre-recession period (25.0-29.9 kg/m^2 and 30.0 kg/m^2 and above, respectively).

Our regression analyses illuminate consistent and significant disparities in BMI on account of race/ethnicity × socioeconomic status for each gender. Poor and non-poor black females, poor and non-poor Hispanic females, and poor white females all experience elevated BMI relative to non-poor white females. The same is true of poor Hispanic, non-poor Hispanic, and non-poor black males, compared to non-poor white males. These findings persist net of mediators for the Great Recession and select health behaviors. Thus, increases in BMI during the study period are concerning as increased risk for obesogenic-related morbidities and mortality are compounded by their pre-existing overweight or obese status and significant sociodemographic disparities.

4.1. Gender Inequities in BMI

The period of the Great Recession affected females' BMI more severely than males on account of magnitude and duration. Five demographic subgroups note increasing BMI during the study period, with females accounting for three of these subgroups. Further, when characterizing the extent of increase in BMI, female demographic subgroups account for the two largest gains (Table 3). While both poor white and poor Hispanic males and females experienced rising BMI during the whole study period (i.e. pre-recession to post-recession), poor white and poor Hispanic females' BMI also sustained rises during the Great Recession and through the post-recession period. These findings intimate that the deleterious effects of economic stress are more pronounced and enduring for females, consistent with the extant literature (Hoynes et al. 2012; Kochhar 2011). Future studies may consider employing intersectional analyses stratified by gender to enable more nuanced understanding of biosocial health and the subsequent underlying pathways garnering prolonged economic duress among females.

4.2. The Intersection of Race/Ethnicity × Socioeconomic Status × Gender on BMI

Previous research highlights that recessions hit those lower in socioeconomic status hardest- both during the recession and in economic recovery (Acs 2008). Poor white and poor Hispanic males and females, therefore, may be more likely to face job insecurity and financial hardship, leading to unhealthy coping behaviors and subsequent weight gain.

Given that non-Hispanic blacks' unemployment rates peaked higher than any other race and ethnicity during the Great Recession (U.S. Bureau of Labor Statistics 2017a) and household wealth declined by 53% from $12,124 to $5,677 (Taylor et al. 2011), we would expect the psychosocial effects to be reflected in BMI fluctuations among the poor. The period of the Great Recession had no noticeable effect on poor black males and females' BMI. Conversely, the BMI of non-poor black working-aged females rose during the recession, continuing in the post-recession period.

Several structural and cultural factors characterize non-Hispanic blacks' tenuous history with the U.S. economy. Social institutions such as slavery (abolished 1865) and segregation (made unlawful in the 1960s) ravaged blacks' abilities to garner wealth and become upwardly mobile through generations (Landry 1987). A culture of racism and discrimination continues to limit blacks' access to jobs and participation in the middle class (Landry 1987; Pattillo 2013; Rothstein 2017).

The black middle class fully emerged in the 1960s, with the percent of black workers holding middle class jobs increasing from 10 to 27 percent since the 1950s (for reference, approximately 40 percent of whites held middle class jobs in the 1950s) (Landry 1987). Blacks in the middle class, however, continue to differ in key aspects compared to similarly situated whites; blacks in the middle class are more likely to reside in neighborhoods with more low-income individuals, face higher rates of downward mobility, and experience chronic racism and discrimination (Feagin and Sikes 1994; Pattillo 2013). In times of economic downturn, blacks are first to be fired, exemplifying the pervasive nature of racism regardless of socioeconomic status (Couch and Fairlie 2010). Consequently, during the Great Recession, non-poor black females' stress may be heightened relative to non-poor whites, due to increased fears of job loss, unemployment, and foreclosure, ultimately leading to riskier health behaviors and subsequent BMI gains. In contrast, poor blacks may have inured themselves to sudden economic shocks given their lengthy history of marginal relations with the economy. Since the 1980s, global economic trends such as deindustrialization and globalization have disproportionately displaced low-wage black workers (Wilson 2009). Further, high rates of incarceration destabilize black families adding to the multitude of economic shocks experienced by the poor (Wilson 2009).

Resilience may be defined as facing hardship and persevering. In a mixed-methods study of resilience among low-income black women, researchers found higher resilience among women with less problematic social ties and a favorable view of self relative to others (Todd and Worell 2000). Further, women identified strong social support as an important factor underlying their resilience (Todd and Worell 2000). Low-income black adults are most likely to live in highly segregated neighborhoods (Fischer 2003), thereby potentially increasing social support and resilience via favorable comparisons to others. By living in more desegregated neighborhoods, non-poor black women feel more in-group rejection, reducing feelings of support and solidarity (Postmes and Branscombe 2002). Therefore, non-poor black females may be more susceptible to the psychosocial consequences of economic shocks due to lower resiliency. The greater psychosocial stress may lead to unhealthy coping behaviors, ultimately elevating BMI. In contrast, poor black adults may reap the protective benefits of stronger social support and resiliency, thereby buffering the harsh consequences of the Great Recession.

4.3. The Mediators: the Great Recession and Health Behaviors

Potential mediators of the focal association examined the extent to which indicators of the Great Recession and adverse health behaviors underscore the effect of race/ethnicity × socioeconomic status on BMI during the period of the Great Recession. Employment status and national unemployment rate proxy for the Great Recession in the statistical models and are not significantly associated with the dependent variable, BMI. Therefore, our findings indicate that employment status and national unemployment rate do not attenuate the focal association nor explain the noted elevated BMI among select demographic subgroups. Thus, the rise in BMI incurred by select demographic subgroups during the period of the Great Recession, remains a period effect and not directly attributable to the observed economic characteristics of the Great Recession. Future research may explore a more robust selection of indicators to proxy for the Great Recession, further examining the theoretically significant and plausible relationship between macroeconomic forces and BMI (e.g., timing of job loss, experience of home foreclosure, changes in work hours, psychosocial stress in response to the economic climate, difficulty paying bills, etc.).

Occasionally or regularly smoking and moderate alcohol consumption are inversely related to BMI for both males and females in our study. For females, heavy drinking is also negatively associated with BMI. Consistent with our results, research examining the effects of smoking on BMI generally find that smoking reduces body weight (Dare, Mackay, and Pell 2015; Piirtola et al. 2018). Our findings on heavy drinking among females, however, contrast the established literature that posits that heavy drinking promotes weight gain and is a risk factor for obesity (Traversy and Chaput 2015). Likewise, moderate alcohol intake is not typically associated with decreased adiposity (Kwok et al. 2019; Traversy and Chaput 2015). The context of unemployment, however, may provide perspective on these findings. Bolton and Rodriguez (2009) report higher alcohol consumption and lower BMI among groups experiencing unemployment. Research examining alcohol consumption and BMI in the context of societal economic upheaval is warranted to further elucidate the potential mechanisms by which moderate and heavy alcohol consumption decreases BMI (e.g., dietary compensation).

4.4. Limitations

Our study is not without limitations. The cross-sectional study design infers that our findings indicate population-level variation in BMI before, during, and after the Great Recession. A longitudinal, cohort study would create clearer understanding of BMI changes within individuals over time with respect to the Great Recession, e.g., timing of job loss, experience of home foreclosure, difficulty paying bills, individual differences in BMI growth curves, changes in work hours, elements of psychosocial stress in response to the economic climate, changes in health behaviors, etc. Data limitations preclude the aforementioned analyses pursuant to a representative sample of U.S. citizens. Our findings are therefore limited in scope to examining variation in BMI during the period of the Great Recession at the macro-level.

Our study does not include Asian Americans and cannot differentiate the focal findings within Hispanic subgroups. Since NHANES did not begin collecting data specifically on non-Hispanic Asian Americans until the 2011-2012 survey cycle, they are not included in this study. Being that Asian Americans are the most prosperous and well-educated racial group in the U.S., their inclusion in this study would further elucidate the relationship between race/ethnicity × socioeconomic status and BMI during the Great Recession. Researchers note great heterogeneity among Asian and Hispanic subgroups on account of lived experiences and sociodemographic characteristics (National Research Council 2006). Best practices would suggest conducting analyses sensitive to the disparate experiences of Mexicans compared to Cubans compared to Puerto Ricans, for instance. Data restraints prohibit these analyses using NHANES. Future research investigating Asian Americans and heterogeneity among Hispanics is merited.

We analyze two health behaviors as potential mediators underlying the focal association: alcohol consumption and smoking behavior. Research suggests that health behaviors may provide direct pathways through which societal economic changes affect BMI (Dávalos et al. 2011; Dave and Kelly 2012; Dee 2001; Mohammad Ali and Lindström 2006). While changes in alcohol consumption and smoking behavior are associated with economic shocks, physical activity and diet are also important considerations. Beginning in the 2007-2008 survey cycle, NHANES updated their survey questions pertaining to physical activity. Consequently, cross-survey comparisons of physical activity before and after this time period

are inhibited. The extent to which pathways such as physical activity and diet underlie the association between the Great Recession and BMI on account of sociodemographic groups is an important consideration for future studies.

5. CONCLUSIONS

Significant disparities exist in population-level BMI at the intersection of socioeconomic status, race, and ethnicity, particularly among women. The period of the Great Recession exacerbated these disparities among poor white males and females, poor Hispanic males and females, and non-poor black females. Adverse health behaviors, including alcohol consumption and smoking behavior, partially mediate the observed inequalities in BMI. Though our indicators of the Great Recession did not provide direct evidence of mediation, future studies should consider an expanded selection of proxy variables for the Great Recession to examine the observed rise in BMI among demographic subgroups.

Further understanding of these distinct pathways is imperative to creating policy aimed at reducing health disparities. The importance of the intersectionality perspective in biosocial health research cannot be overstated. Unique life experiences and social statuses provide context for exposure to societal events and subsequent embodiment of stressors, particularly in periods of societal economic shock. Policies aimed at reducing the underlying causes of socioeconomic disadvantage, in turn, may decrease risk for obesogenic-related morbidities and mortality, ultimately leading to reduced health care expenditures and greater societal well-being.

APPENDIX A.

NHANES 2003-2014 Weighted Sample Distribution of Pre-Recession Body Mass Index (kg/m^2) by Race/Ethnicity × Socioeconomic Status × Gender

Pre-Recession	Non-Poor			Poor			
BMI (kg/m^2)	White	Black	Hispanic	White	Black	Hispanic	
Females							**Total**
25-66 years	28.05	31.25	29.45	28.91	33.28	29.78	28.90
n	886	321	226	346	286	343	2408
Males							**Total**
25-66 years	28.89	29.60	29.15	27.92	28.84	28.06	28.75
n	959	381	267	349	217	362	2535

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