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## RESEARCH ARTICLE

### Diminished Returns of Educational Attainment on Heart Disease among Black Americans

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#### Abstract:

#### Background:

Socioeconomic Status (SES) indicators, such as educational attainment, are social determinants of heart disease. Marginalization related Diminished Returns (MDRs) refer to smaller health benefits of high SES for racial and ethnic minorities compared to the majority group. It is still unknown, however, if MDRs also apply to the effects of education on heart disease.

#### Purpose:

Using a nationally representative sample, we explored racial/ethnic variation in the link between educational attainment and heart disease among American adults.

#### Methods:

We analyzed data (n=25,659) from a nationally representative survey of American adults in 2013. The first wave of the Population Assessment of Tobacco and Health - Adult (PATH-Adult) study was used. The independent variable was education (college graduate, high school graduate, less than a high school diploma). The dependent variable was any heart disease. Age and gender were the covariates. Race, as well as ethnicity, were the moderators. Logistic regressions were used to analyze the data.

#### Results:

Individuals with higher educational attainment had lower odds of heart disease. Race and ethnicity showed statistically significant interactions with education, suggesting that the protective effect of higher education on reducing odds of heart disease was smaller for Hispanic and Black people than for non-Hispanic and White individuals.

#### Conclusion:

Education reduces the risk of heart disease better among non-Hispanic Whites than for Hispanics and Blacks. Therefore, we may expect a disproportionately higher than expected risk of heart disease in Hispanics and Blacks with high educational attainment. Future research should test if the presence of high levels of environmental and behavioral risk factors contribute to the high risk of heart disease in highly educated Black and Hispanic Americans. Policymakers should not reduce health inequalities to just gaps in SES because disparities are present across SES levels, with high SES Blacks and Hispanics remaining at risk of health problems.

**Keywords:** Socioeconomic position, Socioeconomic status, Educational attainment, Ethnicity, Race, Ethnic groups, African Americans, Blacks, Heart disease.

#### Article History

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## 1. INTRODUCTION

Although the health effects of socioeconomic status (SES) are well established [1 - 5], such effects are unequal across racial and ethnic groups [6 - 10]. While a higher education level

predicts better health [3, 4], recent research has documented weaker protective effects of SES indicators for racial and ethnic minority groups [11 - 14]. Marginalization-related Diminished Returns (MDRs) refer to significantly weaker health effects of SES indicators, particularly education, for the

members of racial and ethnic minorities, particularly Blacks and Hispanics, relative to non-Hispanic White Americans [6, 7]. MDRs are being viewed as a paradigm shift as it investigates the mechanisms behind poor health of racial and ethnic minority people across SES levels [6, 7].

Considerable MDRs [6, 7] are shown in Blacks and Hispanics compared with Whites and non-Hispanics, documented as weaker effects of SES on the health of racial and ethnic groups [6, 7]. Such MDRs are shown for several SES indicators such as education [15 - 18], income [19 - 22], marital status [23], and employment [24] on various health outcomes. Supporting evidence has shown MDRs on drinking [15], smoking [18], diet [25] and exercise [16]. Similarly, MDRs exist for obesity as well [20, 26]. In addition, we can see MDRs for mental health indicators such as depression [22], anxiety [23], and risk of attempting suicide [27]. As a result, middle-class Blacks and Hispanics remain at a higher risk of chronic diseases (CDs) [19, 28, 29], disability [30], hospitalization [31], and mortality [32] even when they have a high SES.

In one study, highly educated Black and Hispanic people were found to be exposed to high levels of second-hand smoke exposure [33]. In addition, highly educated Blacks and Hispanics are more likely to drink alcohol [15, 34], smoke cigarettes [18, 35], and vape e-cigarettes [36]. This is probably why highly educated Black and Hispanic individuals may be at a higher risk of a wide range of non-communicable diseases such as hypertension [37], chronic obstructive pulmonary disease (COPD) [29] and asthma [28], compared with highly educated non-Hispanic Whites. Increased risk of heart disease may be particularly important and explain why highly educated Hispanics and Blacks stay at high risk of disability [30], hospitalization [31], and mortality [32], particularly for Black individuals.

Some of the mechanisms behind these MDRs include societal and structural processes and factors such as residential segregation, extra costs of moving upward in the society [38, 39], and a higher level of exposure [8, 40, 41] and sensitivity to discrimination [42] in ethnic minorities, particularly Blacks. As a result of such societal processes, high SES will be followed with less tangible health effects for Black people than non-Hispanic White people. However, less is known about MDRs of education level for heart disease in general.

As a result of MDRs [6, 7], the health impact of SES indicators including but not limited to education level, is diminished for racial and ethnic minority groups. Thus, diverse racial and ethnic groups not only vary in their SES [43 - 45] but also how their SES relates to health outcomes [22, 46].

Although high education reduces exposure to risk factors overall [47, 48], highly educated Blacks and Hispanics report high levels of environmental risk factors such as stress [39], discrimination [38], and active and passive exposure to smoke [18, 33, 36]. While the very same SES indicators, such as educational attainment, show a strong impact on lowering non-

Hispanic Whites' environmental risk exposures, highly educated Blacks and Hispanics are still at risk of factors that increase their risk to non-communicable illnesses such as hypertension [37], attention deficit hyperactivity disorder (ADHD) [19], asthma [28], and COPD [29].

## 2. AIMS

To better understand whether MDRs also applies to racial and ethnic disparities in heart disease, we compared Blacks, Hispanics, and non-Hispanic Whites for the negative effect of education level against heart disease. Although research has well-documented the effects of race/ethnicity [28, 49] and SES (education level) [28, 50, 51] on heart disease, few studies have ever tested MDRs of SES resources on heart disease [28, 29]. This study goes beyond the additive effect of race/ethnicity and SES and investigates the multiplicative effects of SES and race/ethnicity on heart disease [28, 29]. This work is in line with the research question if it is race/ethnicity and SES or race/ethnicity or SES that cause health disparities. To generate results that are generalizable to the U.S. population of adults, we borrowed data from the Population Assessment of Tobacco and Health - Adult (PATH-Adult) study, a survey with a nationally representative sample of adults (18+ years old). In line with the MDRs [6, 7] and previous relevant studies [28, 29], we hypothesized smaller effects of SES (educational attainment) on heart disease for Blacks and Hispanics than non-Hispanic Whites.

## 3. METHODS

### 3.1. Study Design and Setting

This cross-sectional survey borrowed existing data from the PATH 2013 [52 - 55] study, a national survey of American adults sponsored by the National Institutes of Health (NIH) and the Food and Drug Administration (FDA). PATH is a landmark survey of tobacco use and associated diseases. The data collection was carried out in 2013. The PATH design, sampling, sample design, and measures are described elsewhere [52 - 55].

The sample is limited to the civilian, non-institutionalized, adult (18+ years old) residents of the United States. The PATH data is a longitudinal study; however, we only used baseline data (wave 1). The sample design follows a multistage probability sample that recruited a representative sample of households and non-institutional people. The PATH study has used a multi-stage sampling strategy that involves survey weights. Due to the national sample and application of survey weights, the results of PATH are generalizable to the US population. In this study, 25,659 adults were analyzed.

### 3.2. Ethics

The PATH study protocol was approved by the Westat Institutional Review Board (IRB). All participating individuals signed informed written consent. All the PATH data were collected, stored, and analyzed anonymously.

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## 4. MEASURES

### 4.1. Independent Variable

#### 4.1.1. Education level

Education level was operationalized as a categorical variable with 3 levels: less than high school graduate, completed high school, and college graduates.

### 4.2. Moderators

#### 4.2.1. Race

All participants self-identified their race. Race was treated as a dichotomous variable in the current study [Blacks = 1, non-Hispanic Whites = 0].

#### 4.2.2. Ethnicity

All participants self-identified their ethnicity. Ethnicity was treated as a categorical variable in the current study [Hispanics = 1, Non-Hispanics = 0].

### 4.3. Covariates

Covariates in the current study included age (years) and gender (binary variable). Age was a categorical measure with the following levels: 1) 18 - 24 years old, 2) 25 - 34 years old, 3) 35 - 44 years old, 4) 45 - 54 years old, 5) 55 - 64 years old, 6) 65 - 74 years old, and, 7) 75+ years old. Gender was dichotomous (female = 0 vs male = 1).

### 4.4. Outcome

Heart Disease. Heart diseases in this study included heart attack, congestive heart disease, and any other heart disease. Three items were used to measure lifetime history of heart disease. For example, participants were asked, "Have you ever been told by a doctor or other health professional that you had heart attack?", "Have you ever been told by a doctor or other health professional that you had congestive heart disease?", "Have you ever been told by a doctor or other health professional that you had any other heart disease?"

### 4.5. Data Analysis

We used the survey mode of SPSS 23.0 (IBM Inc, NY, USA) to analyze the data. Taylor series linearization was used to re-calculate the standard errors (SEs) that address the complex design of the PATH sample. Our estimates and inferences are generalizable to the US sample. We ran logistic regression models without and with interaction terms, all in the pooled sample. Model 1 had the main effects of race, ethnicity, education level, and covariates. Model 2 also included the following interaction terms: race  $\times$  education level and ethnicity  $\times$  education level. In all models, educational attainment and poverty level were the independent variables (IVs), heart disease was the dependent variable (DV), and age and gender were covariates. Race and ethnicity were the moderators. Publicly available data are available at the University of Michigan ICPSR Website available at: <https://www.icpsr.umich.edu/icpsrweb/NAHDAP/studies/3623> 1. As Black and Hispanic were both coded as 1, for the main

effect of high educational attainment we expected a significant OR  $<1$  (protective factor), and a significant OR  $>1$  for the statistical interaction term between race/ethnicity and high educational attainment.

## 5. RESULTS

### 5.1. Descriptive Characteristics

This study included 25,659 American adults who were either White (82.9%), Black (17.1%), Non-Hispanic (83.9%), or Hispanic (16.1%). Table 1 provides a summary of the descriptive statistics of the study sample. Almost half of the participants were women.

**Table 1. Descriptive statistics in the overall sample.**

	n	%
Race	-	-
White	21265	82.9
Black	4394	17.1
Ethnicity	-	-
Non-Hispanic	21520	83.9
Hispanic	4139	16.1
Gender	-	-
Women	12705	49.5
Men	12954	50.5
Age (years)	-	-
18 - 24	6877	26.8
25 - 34	5197	20.3
35 - 44	4066	15.8
45 - 54	3979	15.5
55 - 64	3190	12.4
65 - 74	1636	6.4
75+	714	2.8
Education	-	-
Less than high school graduate	4973	19.4
High school graduate	15137	59.0
College Graduate	5549	21.6

### 5.2. Multivariable Models

Table 2 shows a summary of the output of 2 logistic regression models. In both models, educational attainment was the independent variable and any heart disease was the dependent variable. Both models were estimated in the total sample, which included Whites, Blacks, Hispanics, and non-Hispanics. *Model 1* only entered the main effects of educational attainment as well as race, ethnicity, and covariates. *Model 2*, however, also added 2 interaction terms between race and ethnicity with educational attainment.

As shown in Model 1, high education predicted lower odds of heart disease. Model 2, however, showed significant interaction terms between the variables race and ethnicity with the independent variable educational attainment on the outcome variable heart disease, suggesting that high education may have a smaller protective effect against heart disease for Blacks and Hispanics than non-Hispanic Whites. This finding was reflected with a  $<1$  and significant (protective factor) OR for the main effect of high educational attainment, and a  $>1$  and

**Table 2. Logistic regression in the pooled sample.**

	Model 1 (Main Effects)					Model 2 (Interactions)				
	OR	B	SE	95% CI	p	OR	B	SE	95% CI	p
-										
Race (Black)	0.83	-0.19	0.07	0.73 - 0.94	.005	0.66	-0.42	0.13	0.51 - 0.84	.001
Ethnicity (Hispanic)	0.52	-0.64	0.09	0.44 - 0.62	.000	0.39	-0.95	0.14	0.29 - 0.51	.000
Age (years)	-	-	-	-	-	-	-	-	-	-
18 – 24	-	-	-	-	-	-	-	-	-	-
25 – 34	1.24	0.22	0.11	1.00 - 1.54	.052	1.24	0.22	0.11	1.00 - 1.55	.049
35 – 44	2.09	0.74	0.10	1.70 - 2.57	.000	2.11	0.74	0.10	1.72 - 2.59	.000
45 – 54	3.57	1.27	0.09	2.97 - 4.30	.000	3.60	1.28	0.09	2.99 - 4.33	.000
55 – 64	6.48	1.87	0.09	5.43 - 7.73	.000	6.57	1.88	0.09	5.50 - 7.84	.000
65 – 74	10.25	2.33	0.10	8.50 - 12.35	.000	10.41	2.34	0.10	8.63 - 12.54	.000
75+	14.30	2.66	0.11	11.59 - 17.64	.000	14.57	2.68	0.11	11.80 - 17.99	.000
Educational Attainment	-	-	-	-	-	-	-	-	-	-
Less than High School Graduate	-	-	-	-	-	-	-	-	-	-
High School Graduate	0.71	-0.34	0.06	0.63 - 0.81	.000	0.71	-0.34	0.07	0.62 - 0.81	.000
College Graduate	0.80	-0.22	0.06	0.71 - 0.90	.000	0.71	-0.34	0.07	0.62 - 0.82	.000
Race (Black) x High School Graduate	-	-	-	-	-	1.12	0.11	0.21	0.73 - 1.69	.609
Race (Black) x College Graduate	-	-	-	-	-	1.35	0.30	0.15	1.00 - 1.83	.050
Ethnicity (Hispanic) x High School Graduate	-	-	-	-	-	1.09	0.08	0.30	0.61 - 1.94	.780
Ethnicity (Hispanic) x College Graduate	-	-	-	-	-	1.62	0.48	0.19	1.12 - 2.34	.010
Constant	0.03	-3.37	0.09	-	.000	0.04	-3.29	0.09	-	.000

Notes: Source Population Assessment of Tobacco and Health (PATH; 2013-2014)  
CI: Confidence Interval; SE: Standard Error; OR: Odds R.

significant (risk factor) OR for the statistical interaction term between race/ethnicity and high educational attainment. The differences in the OR of college graduation relative to lowest education were 35% and 62% for Blacks compared with Whites and Hispanic compared with non-Hispanics, respectively (Table 2).

## 6. DISCUSSION

Two findings were observed. First, education level was inversely associated with the prevalence of heart disease in the overall sample. Second, Blacks and Hispanics were at a relative disadvantage compared with non-Hispanic Whites regarding the protective effect of educational attainment on heart disease. To be more specific, a significant interaction was found between race/ethnicity and college-level education (but not with high school education), suggesting that the protective effect of college-level education was smaller for Blacks and Hispanics than non-Hispanic Whites. That is, the negative association between education and heart disease was weaker for Blacks and Hispanics than non-Hispanic Whites. As a result, highly educated Hispanics and Blacks remain at high risk of heart disease, compared with similarly educated non-Hispanic and White people.

The first finding on the inverse association between education and heart disease is in line with what is known about the protective influence of SES on health [1, 2], non-communicable diseases [28, 50, 56], and heart diseases [57, 58]. The protective health effect of SES is well known.

The second observation that the very same SES indicator (e.g. education) shows considerably weaker effects on heart disease for Blacks and Hispanics is relatively new. Previously,

for Blacks and Hispanics, high education has shown weaker effects on obesity [26, 20], asthma [28], COPD [33], hypertension [37], smoking, diet [25], exercise [16], hypertension [37], asthma [28] and COPD [29]. However, this was never shown for Hispanics. It was also not shown for heart disease overall.

We found that the protective effect of college-level education was smaller for Blacks and Hispanics than non-Hispanic Whites. The results may be due to the fact that highly educated Blacks and Hispanics use cigarettes [59], e-cigarettes [36], alcohol [15], have poor diets [25], live sedentary life styles [16], and have high BMI [26] at higher rates than expected based on their SES. Such a "more than expected" behavioral risk profile of high SES Blacks and Hispanics is not limited to tobacco as similar patterns are seen for impulse control [21], suicide [27], depression [22, 60 - 63], anxiety [23], stress [38, 39], and obesity [26]. These patterns are shown inside clinical settings [27] and in communities [23, 64], as well as within [24] and between [21] generations. They are also shown for children [28], youth [23], adults [24], and older adults [17]. The universal nature of these diminished returns is suggestive of structural factors that reduce the health effects of SES. Some may attribute these patterns to structural racism and social stratification [6, 7].

Another explanation for the lower health effects of educational attainment for Blacks and Hispanics compared with non-Hispanic Whites is the differences in the "quality" of education for Whites and Blacks and Hispanics may account for the lower effects of education on heart disease (and other measures of well-being) in Blacks and Hispanics. In other words, high-school and college education may not mean the same thing for Whites, Blacks and Hispanics. Hispanics and

Blacks are more likely to attend urban public schools with lower resources [65]. Manley and others have shown that schooling differences may explain some of the differential effects of education for Whites and people of color [66, 67].

Another explanation for this finding is that compared with non-Hispanic Whites, Blacks and Hispanics with high education are more likely to be new to the educational class. This is because children with highly educated parents are more likely to attain higher education as well. Future research should test recency to the middle class, parental education, and being a first-generation college graduate, as these factors may hint at mechanisms by which non-White families gain less health from their educational attainment.

There is also a need to evaluate how early in the life course SES disadvantage results in atherosclerotic changes among Blacks. Research has shown that one reason high SES during adulthood is still associated with poor health outcomes among Blacks is childhood poverty [68 - 72]. That means early adversity results in some effects that cannot be undone with later availability of resources and human capital [73 - 77]. According to the Barker hypothesis [78], pathological changes that mediate adversities may start in utero. Some behavioral mechanisms such as drinking [34], vaping [36], smoking [18, 59], poor diet [25], poor health care use [79, 80], and low exercise [16] that are all common in highly educated Blacks may mediate the additional cardiovascular risk of middle-class Blacks. Another mechanism is environmental exposures in highly educated Blacks [81 - 83]. Genetics may also accelerate the process of atherosclerosis for Black people, and some research suggests that genes may increase the vulnerability of Black populations to hypertension [84 - 87] and kidney disease [87 - 91], which both have implications for development and outcomes of heart disease [92, 93]. Diabetes may also be more common in highly educated Blacks through some genetic predisposition [94].

## 7. LIMITATIONS

The major limitation of this study is its cross-sectional design. As a result of such design, we do not infer causal effects from our observations. Most SES indicators and health outcomes have bidirectional links and reverse causal effect of health on SES cannot be ruled out. Poor health is one of the reasons behind downward social mobility. This study measured heart diseases such as COPD and asthma based on self-report rather than physical examination, laboratory testing, or administered data. Self-reports have been shown to generate valid and reliable measures of chronic diseases. However, future research may replicate these findings for other ethnic groups such as Asian Americans, Native Americans as well as immigrants. Future research may also use comprehensive measures. The study is at risk of omitted confounders such as wealth and area SES. We only described the MDRs of education on heart disease. Future research may test whether education quality, discrimination, segregation, labor market discrimination, or neighborhood poverty can explain why Blacks and Hispanics have less health gain from their available resources than non-Hispanic Whites. Finally, it is possible that the effect of education on heart disease may also be different

for males and females among Blacks and Hispanics (and Whites). Future work may also include interactions between education, race/ethnicity, and gender. Still, this study had a large sample size and extends what we know regarding the non-linear effects of race, ethnicity, and SES on health outcomes, particularly heart disease.

## CONCLUSION

In the United States, the inverse association between education and heart disease is weaker for Blacks and Hispanics than non-Hispanic Whites. More specifically, a significant interaction was found between race/ethnicity and college-level education (but not with high school education), suggesting that the protective effect of college-level education was smaller for Blacks and Hispanics than non-Hispanic Whites. As a result, a higher than expected prevalence of heart disease in highly educated Black and Hispanic people, a rate which is disproportionate to their SES, has been observed. Researchers should know that health disparities are not merely due to the additive but also the multiplicative effects of race/ethnicity and SES. Real solutions to racial and health disparities in heart disease would be based not only on increasing SES of Blacks and Hispanic but also empowering them to translate their available SES resources to health outcomes. Public policies need to go beyond equalizing SES and specifically address societal barriers, environmental risk factors, and structural factors that endanger the health and well-being of Blacks and Hispanics at all SES levels. Economic and public policies are needed to minimize diminished health returns of SES (*i.e.*, MDRs). Unfortunately, MDRs are historically overlooked as contributors to racial and ethnic health disparities in the US.

## AUTHORS' CONTRIBUTIONS

SA designed the conceptual model, secured funding, performed the analysis, wrote the first draft, and revised the manuscript. MB, MS and SC contributed to the interpretation of the findings, drafts, and revision. All authors approved the final version of the text.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The PATH study protocol was approved by the Westat Institutional Review Board (IRB), the Westat Federal wide Assurance (FWA) number is FWA00005551.

## HUMAN AND ANIMAL RIGHTS

Not applicable.

## CONSENT FOR PUBLICATION

Written informed consent has been obtained from all the participants.

## AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of the article is available in the ICPSR at <https://www.icpsr.umich.edu/icpsrweb/NAHDAP/studies/36231> with reference number ICPSR36231.

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**CONFLICTS OF INTEREST**

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

**REFERENCES**

- [1] Mirowsky J, Ross CE. Education, health, and the default American lifestyle. *J Health Soc Behav* 2015; 56(3): 297-306. [http://dx.doi.org/10.1177/0022146515594814] [PMID: 26272989]
- [2] Ross CE, Mirowsky J. Refining the association between education and health: the effects of quantity, credential, and selectivity. *Demography* 1999; 36(4): 445-60. [http://dx.doi.org/10.2307/2648083] [PMID: 10604074]
- [3] Marmot MG, Bell R. Action on health disparities in the United States: commission on social determinants of health. *JAMA* 2009; 301(11): 1169-71. [http://dx.doi.org/10.1001/jama.2009.363] [PMID: 19293419]
- [4] Marmot M. Economic and social determinants of disease. *Bull World Health Organ* 2001; 79(10): 988-9. [PMID: 11693982]
- [5] Marmot M. Social determinants of health inequalities. *Lancet* 2005; 365(9464): 1099-104. [http://dx.doi.org/10.1016/S0140-6736(05)74234-3] [PMID: 15781105]
- [6] Assari S. Health disparities due to diminished return among black Americans: public policy solutions. *Soc Issues Policy Rev* 2018; 12(1): 112-45. [http://dx.doi.org/10.1111/sipr.12042]
- [7] Assari S. Unequal gain of equal resources across racial groups. *Int J Health Policy Manag* 2017; 7(1): 1-9. [http://dx.doi.org/10.15171/ijhpm.2017.90] [PMID: 29325397]
- [8] Hudson DL, Bullard KM, Neighbors HW, Geronimus AT, Yang J, Jackson JS. Are benefits conferred with greater socioeconomic position undermined by racial discrimination among African American men? *J Mens Health* 2012; 9(2): 127-36. [http://dx.doi.org/10.1016/j.jomh.2012.03.006] [PMID: 22707995]
- [9] Hudson DL, Neighbors HW, Geronimus AT, Jackson JS. The relationship between socioeconomic position and depression among a US nationally representative sample of African Americans. *Soc Psychiatry Psychiatr Epidemiol* 2012; 47(3): 373-81. [http://dx.doi.org/10.1007/s00127-011-0348-x] [PMID: 21293845]
- [10] Farmer MM, Ferraro KF. Are racial disparities in health conditional on socioeconomic status? *Soc Sci Med* 2005; 60(1): 191-204. [http://dx.doi.org/10.1016/j.socscimed.2004.04.026] [PMID: 15482878]
- [11] Montez JK, Hummer RA, Hayward MD. Educational attainment and adult mortality in the United States: a systematic analysis of functional form. *Demography* 2012; 49(1): 315-6. [http://dx.doi.org/10.1007/s13524-011-0082-8] [PMID: 22246797]
- [12] Montez JK, Hummer RA, Hayward MD, Woo H, Rogers RG. Trends in the educational gradient of U.S. Adult mortality from 1986 to 2006 by race, gender, and age group. *Research aging* 2011; 33(2): 145-71. [http://dx.doi.org/10.1177/0164027510392388] [PMID: 21897495]
- [13] Zajacova A, Johnson-Lawrence V. Anomaly in the education-health gradient: Biomarker profiles among adults with subbaccalaureate attainment levels *SSM Popul Health* 2016; 2: 360-4. [http://dx.doi.org/10.1016/j.ssmph.2016.05.001] [PMID: 28580414]
- [14] Zajacova A, Lawrence EM. ; () : -2018;
- [15] Assari S, Farokhnia M, Mistry R. Education attainment and alcohol binge drinking: diminished returns of hispanics in Los Angeles. *Behav Sci (Basel)* 2019; 9(1): E9. [http://dx.doi.org/10.3390/bs9010009] [PMID: 30646592]
- [16] Assari S. Educational attainment and exercise frequency in American women; blacks' Diminished Returns. *Womens Health Bull* 2019; 6(3): e87413. [http://dx.doi.org/10.5812/whb.87413] [PMID: 31552286]
- [17] Assari S, Bazargan M. Educational attainment and self-rated oral health among american older adults: Hispanics' diminished returns *Dentistry J* 2019; 7(4): 97. [http://dx.doi.org/10.3390/dj7040097]
- [18] Assari S, Mistry R. educational attainment and smoking status in a national sample of american adults; evidence for the blacks' diminished return. *Int J Environ Res Public Health* 2018; 15(4) [http://dx.doi.org/10.3390/ijerph15040763] [PMID: 29659482]
- [19] Assari S, Caldwell CH. Family income at birth and risk of attention deficit hyperactivity disorder at age 15: Racial differences *Children (Basel)* 2019; 6(1) [http://dx.doi.org/10.3390/children6010010] [PMID: 30646634]
- [20] Assari S. Family income reduces risk of obesity for white but not black children. *Children (Basel)* 2018; 5(6): 73. [http://dx.doi.org/10.3390/children5060073] [PMID: 29890778]
- [21] Assari S, Caldwell CH, Mincy R. Family socioeconomic status at birth and youth impulsivity at age 15; blacks' diminished return *Children (Basel)* 2018; 5(5): 58. [http://dx.doi.org/10.3390/children5050058] [PMID: 29724004]
- [22] Assari S. High income protects whites but not African Americans against risk of depression. *Healthcare (Basel)* 2018; 6(2): 37. [http://dx.doi.org/10.3390/healthcare6020037] [PMID: 29690595]
- [23] Assari S, Caldwell CH, Zimmerman MA. Family structure and subsequent anxiety symptoms; minorities' diminished return *Brain Sci* 2018; 8(6): 97. [http://dx.doi.org/10.3390/brainsci8060097] [PMID: 29857488]
- [24] Assari S. Life expectancy gain due to employment status depends on race, gender, education, and their intersections. *J Racial Ethn Health Disparities* 2018; 5(2): 375-86. [http://dx.doi.org/10.1007/s40615-017-0381-x] [PMID: 28634876]
- [25] Assari S, Lankarani M. Educational attainment promotes fruit and vegetable intake for whites but not blacks *J* 2018; 1(1): 5. [http://dx.doi.org/10.3390/j1010005]
- [26] Assari S, Thomas A, Caldwell CH, Mincy RB. Blacks' diminished health return of family structure and socioeconomic status; 15 years of follow-up of a national urban sample of youth *J Urban Health* 2018; 95(1): 21-35. [http://dx.doi.org/10.1007/s11524-017-0217-3] [PMID: 29230628]
- [27] Assari S, Schatten HT, Arias SA, Miller IW, Camargo CA, Boudreaux ED. Higher educational attainment is associated with lower risk of a future suicide attempt among non-hispanic whites but not non-hispanic blacks. *J Racial Ethn Health Disparities* 2019; 6(5): 1001-10. [http://dx.doi.org/10.1007/s40615-019-00601-z] [PMID: 31278625]
- [28] Assari S, Moghani Lankarani M. Poverty status and childhood asthma in white and black families: National survey of children's health *Healthcare (Basel)* 2018; 6(2): 62. [http://dx.doi.org/10.3390/healthcare6020062] [PMID: 29895767]
- [29] Assari S, Chalian H, Bazargan M. High education level protects European Americans but not African Americans against chronic obstructive pulmonary disease: National health interview survey. *Int J Biomed Eng Clin Sci* 2019; 5(2): 16-23. [http://dx.doi.org/10.11648/j.ijbecs.20190502.12] [PMID: 31633081]
- [30] Assari S, Bazargan M. Educational attainment better reduces disability for non-hispanic than hispanic Americans. *Europ J Invest Health, Psychol Educat* 2019; 10(1): 10-7. [http://dx.doi.org/10.3390/ejihpe10010002]
- [31] Assari S, Bazargan M. Minorities' diminished returns of educational attainment on hospitalization risk: National health interview survey (NHIS). *Hospital Practices and Research* 2019.
- [32] Assari S, Lankarani MM. Race and urbanity alter the protective effect of education but not income on mortality. *Front Public Health* 2016; 4: 100. [http://dx.doi.org/10.3389/fpubh.2016.00100] [PMID: 27242992]
- [33] Assari S BM. Unequal effects of educational attainment on workplace exposure to second-hand smoke by race and ethnicity; minorities' diminished returns in the national health interview survey (NHIS). *J Med Res Innov* 3(2): e000179. [http://dx.doi.org/10.32892/jmri.179]
- [34] Assari S, Lankarani MM. Education and alcohol consumption among older Americans; black-white differences *Front Public Health* 2016; 4: 67. [http://dx.doi.org/10.3389/fpubh.2016.00067] [PMID: 27148514]
- [35] Assari S, Mistry R. Diminished return of employment on ever smoking among hispanic whites in Los Angeles. *Health Equity* 2019; 3(1):

- 138-44.  
[http://dx.doi.org/10.1089/heap.2018.0070] [PMID: 31289772]
- [36] Assari S, Mistry R, Bazargan M. Race, educational attainment, and e-cigarette use J Medical Research and Innovation 2020; 4(1): e000185-
- [37] Assari S. Socioeconomic determinants of systolic blood pressure; minorities' diminished returns. J Health Econ Dev 2019; 1(1): 1-11. [PMID: 31428747]
- [38] Assari S, Lankarani MM, Caldwell CH. Does discrimination explain high risk of depression among high-income African American men? Behav Sci (Basel) 2018; 8(4) [http://dx.doi.org/10.3390/bs8040040] [PMID: 29671796]
- [39] Assari S. Race, intergenerational social mobility and stressful life events Behav Sci (Basel) 2018; 8(10) [http://dx.doi.org/10.3390/bs8100086] [PMID: 30241335]
- [40] Hudson DL, Puterman E, Bibbins-Domingo K, Matthews KA, Adler NE. Race, life course socioeconomic position, racial discrimination, depressive symptoms and self-rated health. Soc Sci Med 2013; 97: 7-14. [http://dx.doi.org/10.1016/j.socscimed.2013.07.031] [PMID: 24161083]
- [41] Hudson DL, Neighbors HW, Geronimus AT, Jackson JS. Racial Discrimination, John Henryism, and Depression Among African Americans J Black Psychol 2016; 42(3): 221-43. [http://dx.doi.org/10.1177/0095798414567757] [PMID: 27529626]
- [42] Assari S, Preiser B, Lankarani MM, Caldwell CH. Subjective socioeconomic status moderates the association between discrimination and depression in African American youth. Brain Sci 2018; 8(4) [http://dx.doi.org/10.3390/brainsci8040071] [PMID: 29677115]
- [43] Navarro V. Race or class or race and class: Growing mortality differentials in the United States. Int J Health Serv 1991; 21(2): 229-35. [http://dx.doi.org/10.2190/5WXM-QK9K-PTMQ-T1FG] [PMID: 2071304]
- [44] Navarro V. Race or class *versus* race and class: Mortality differentials in the United States. Lancet 1990; 336(8725): 1238-40. [http://dx.doi.org/10.1016/0140-6736(90)92846-A] [PMID: 1978083]
- [45] Navarro V. Race or class, or race and class. Int J Health Serv 1989; 19(2): 311-4. [http://dx.doi.org/10.2190/CNUH-67T0-RLBT-FMCA] [PMID: 2714925]
- [46] Assari S, Preiser B, Kelly M. Education and income predict future emotional well-being of whites but not blacks: A ten-year cohort. Brain Sci 2018; 8(7) [http://dx.doi.org/10.3390/brainsci8070122] [PMID: 29966278]
- [47] Lunau T, Siegrist J, Dragano N, Wahrendorf M. The association between education and work stress: does the policy context matter? PLoS One 2015; 10(3): e0121573. [http://dx.doi.org/10.1371/journal.pone.0121573] [PMID: 25812142]
- [48] Hackman DA, Gallop R, Evans GW, Farah MJ. Socioeconomic status and executive function: developmental trajectories and mediation. Dev Sci 2015; 18(5): 686-702. [http://dx.doi.org/10.1111/desc.12246] [PMID: 25659838]
- [49] Kamil F, Pinzon I, Foreman MG. Sex and race factors in early-onset COPD. Curr Opin Pulm Med 2013; 19(2): 140-4. [http://dx.doi.org/10.1097/MCP.0b013e32835d903b] [PMID: 23361195]
- [50] Kanervisto M, Vasankari T, Laitinen T, Heliövaara M, Jousilahti P, Saarelainen S. Low socioeconomic status is associated with chronic obstructive airway diseases. Respir Med 2011; 105(8): 1140-6. [http://dx.doi.org/10.1016/j.rmed.2011.03.008] [PMID: 21459567]
- [51] Kim J, Kim YS, Kim K, *et al.* Socioeconomic impact of asthma, chronic obstructive pulmonary disease and asthma-COPD overlap syndrome J Thorac Dis 2017; 9(6): 1547-56. [http://dx.doi.org/10.21037/jtd.2017.05.07] [PMID: 28740668]
- [52] Chang CM, Rostron BL, Chang JT, *et al.* Biomarkers of exposure among u.s. adult cigar smokers: Population assessment of tobacco and health (path) study wave 1 (2013-2014) Cancer Epidemiol Biomarkers Prev 2019; 28(5): 943-53. [http://dx.doi.org/10.1158/1055-9965.EPI-18-0539] [PMID: 30733305]
- [53] Hyland A, Ambrose BK, Conway KP, *et al.* Design and methods of the Population Assessment of Tobacco and Health (PATH) Study Tob Control 2017; 26(4): 371-8. [http://dx.doi.org/10.1136/tobaccocontrol-2016-052934] [PMID: 27507901]
- [54] Tourangeau R, Yan T, Sun H, Hyland A, Stanton CA. Population Assessment of Tobacco and Health (PATH) reliability and validity study: selected reliability and validity estimates. Tob Control 2018. [http://dx.doi.org/10.1136/tobaccocontrol-2018-054561] [PMID: 30297373]
- [55] Harlow A, Stokes A, Brooks D. Socio-economic and racial/ethnic differences in e-cigarette uptake among cigarette smokers: Longitudinal analysis of the Population Assessment of Tobacco and Health (PATH) study. Nicotine Tob Res 2018. [http://dx.doi.org/10.1093/ntr/nty141] [PMID: 29986109]
- [56] Forno E, Celedon JC. Asthma and ethnic minorities: socioeconomic status and beyond. Curr Opin Allergy Clin Immunol 2009; 9(2): 154-60. [http://dx.doi.org/10.1097/ACI.0b013e3283292207] [PMID: 19326508]
- [57] Singh GK, Siahpush M, Azuine RE, Williams SD. Increasing area deprivation and socioeconomic inequalities in heart disease, stroke, and cardiovascular disease mortality among working age populations, United States, 1969-2011 Int J MCH AIDS 2015; 3(2): 119-33. [PMID: 27621992]
- [58] Zeki Al Hazzouri A, Haan MN, Neuhaus JM, *et al.* Cardiovascular risk score, cognitive decline, and dementia in older Mexican Americans: the role of sex and education J Am Heart Assoc 2013; 2(2): e004978. [PMID: 23608609]
- [59] Assari S, Mistry R. Diminished Return of Employment on Ever Smoking Among Hispanic Whites in Los Angeles. Health Equity 2019; 3(1): 138-44. [http://dx.doi.org/10.1089/heap.2018.0070] [PMID: 31289772]
- [60] Assari S. Combined Racial and Gender Differences in the Long-Term Predictive Role of Education on Depressive Symptoms and Chronic Medical Conditions. J Racial Ethn Health Disparities 2017; 4(3): 385-96. [http://dx.doi.org/10.1007/s40615-016-0239-7] [PMID: 27270925]
- [61] Assari S, Gibbons FX, Simons R. Depression among Black Youth; Interaction of Class and Place Brain Sci 2018; 8(6) [http://dx.doi.org/10.3390/brainsci8060108] [PMID: 29895752]
- [62] Assari S. Educational Attainment Better Protects African American Women than African American Men Against Depressive Symptoms and Psychological Distress. Brain Sci 2018; 8(10) [http://dx.doi.org/10.3390/brainsci8100182] [PMID: 30274391]
- [63] Assari S, Caldwell CH. High Risk of Depression in High-Income African American Boys. J Racial Ethn Health Disparities 2018; 5(4): 808-19. [http://dx.doi.org/10.1007/s40615-017-0426-1] [PMID: 28842841]
- [64] Assari S, Lapeyrouse LM, Neighbors HW. Income and Self-Rated Mental Health: Diminished Returns for High Income Black Americans Behav Sci (Basel) 2018; 8(5) [http://dx.doi.org/10.3390/bs8050050] [PMID: 29772799]
- [65] Sisco S, Gross AL, Shih RA, Sachs BC, Glymour MM, Bangen KJ, *et al.* The role of early-life educational quality and literacy in explaining racial disparities in cognition in late life J Gerontol B Psychol Sci Soc Sci 2015; 70(4): 557-67. [http://dx.doi.org/10.1093/geronb/gbt133] [PMID: 24584038]
- [66] Manly JJ, Jacobs DM, Touradji P, Small SA, Stern Y. Reading level attenuates differences in neuropsychological test performance between African American and White elders. J Int Neuropsychol Soc 2002; 8(3): 341-8. [http://dx.doi.org/10.1017/S1355617702813157] [PMID: 11939693]
- [67] Manly JJ, Byrd DA, Touradji P, Stern Y. Acculturation, reading level, and neuropsychological test performance among African American elders. Appl Neuropsychol 2004; 11(1): 37-46. [http://dx.doi.org/10.1207/s15324826an1101\_5] [PMID: 15471745]
- [68] Lawlor DA, Ebrahim S, Davey Smith G. Association between self-reported childhood socioeconomic position and adult lung function: findings from the British Women's Heart and Health Study. Thorax 2004; 59(3): 199-203. [http://dx.doi.org/10.1136/thorax.2003.008482] [PMID: 14985552]
- [69] Liu Y, Lachman ME. Socioeconomic Status and Parenting Style From Childhood: Long-Term Effects on Cognitive Function in Middle and Later Adulthood J Gerontol B Psychol Sci Soc Sci 2019; 74(6): e13-24. [http://dx.doi.org/10.1093/geronb/gbz034] [PMID: 30888020]
- [70] Osler M, Andersen AM, Due P, Lund R, Damsgaard MT, Holstein BE. Socioeconomic position in early life, birth weight, childhood cognitive function, and adult mortality A longitudinal study of Danish men born in 1953 J Epidemiol Community Health 2003; 57(9): 681-. [http://dx.doi.org/10.1136/jech.57.9.681] [PMID: 12933773]

- [71] Ramsay SE, Whincup PH, Lennon LT, Morris RW, Wannamethee SG. Longitudinal associations of socioeconomic position in childhood and adulthood with decline in lung function over 20 years: results from a population-based cohort of British men. *Thorax* 2011; 66(12): 1058-64. [http://dx.doi.org/10.1136/thoraxjnl-2011-200621] [PMID: 21784770]
- [72] Zeki Al Hazzouri A, Haan MN, Kalbfleisch JD, Galea S, Lisabeth LD, Aiello AE. Life-course socioeconomic position and incidence of dementia and cognitive impairment without dementia in older Mexican Americans: Results from the sacramento area latino study on aging. *Am J Epidemiol* 2011; 173(10): 1148-58. [http://dx.doi.org/10.1093/aje/kwq483] [PMID: 21430188]
- [73] Beauregard JL, Drews-Botsch C, Sales JM, Flanders WD, Kramer MR. Does socioeconomic status modify the association between preterm birth and children's early cognitive ability and kindergarten academic achievement in the United States? *Am J Epidemiol* 2018; 187(8): 1704-3. [http://dx.doi.org/10.1093/aje/kwy068] [PMID: 29757345]
- [74] Cox K. Reducing toxic stress experienced by children living in poverty. *Nurs Outlook* 2018; 66(2): 108-9. [http://dx.doi.org/10.1016/j.outlook.2018.02.010] [PMID: 29602448]
- [75] Cox KS, Sullivan CG, Olshansky E, et al. Critical conversation: Toxic stress in children living in poverty. *Nurs Outlook* 2018; 66(2): 204-9. [http://dx.doi.org/10.1016/j.outlook.2018.02.009] [PMID: 29555091]
- [76] Evans GW, Fuller-Rowell TE. Childhood poverty, chronic stress, and young adult working memory: The protective role of self-regulatory capacity. *Dev Sci* 2013; 16(5): 688-96. [http://dx.doi.org/10.1111/desc.12082] [PMID: 24033574]
- [77] Evans GW, Kim P. Childhood poverty and health: Cumulative risk exposure and stress dysregulation. *Psychol Sci* 2007; 18(11): 953-7. [http://dx.doi.org/10.1111/j.1467-9280.2007.02008.x] [PMID: 17958708]
- [78] Barker DJ, Winter PD, Osmond C, Margetts B, Simmonds SJ. Weight in infancy and death from ischaemic heart disease. *Lancet* 1989; 2(8663): 577-80. [http://dx.doi.org/10.1016/S0140-6736(89)90710-1] [PMID: 2570282]
- [79] Assari S, Hani N. Household Income and Children's Unmet Dental Care Need; Blacks' Diminished Return. *Dent J (Basel)* 2018; 6(2) [http://dx.doi.org/10.3390/dj6020017] [PMID: 29867015]
- [80] Assari S, Bazargan M. Educational attainment better increases the chance of breast physical exam for non-hispanic than hispanic American women: National health interview survey. *Hosp Pract Res* 2019; 4(4): 122-7. [http://dx.doi.org/10.15171/hpr.2019.25] [PMID: 32190811]
- [81] Assari S, Bazargan M. Unequal Associations between Educational Attainment and Occupational Stress across Racial and Ethnic Groups. *Int Journal Environment Res Pub Health* 2019; 16(19): 3539. [http://dx.doi.org/10.3390/ijerph16193539]
- [82] Assari S, Bazargan M. unequal effects of educational attainment on workplace exposure to second-hand smoke by race and ethnicity; minorities' diminished returns in the national health interview survey (NHIS). *J Med Res Innov* 2019; 3(2) [http://dx.doi.org/10.32892/jmri.179] [PMID: 31404444]
- [83] Assari S BM. Second-hand exposure home second-hand smoke exposure at home in the united states; minorities' diminished returns *Int J Travel Med Glob Health* 2019; 7(3)
- [84] Brewster LM, Clark JF, van Montfrans GA. Is greater tissue activity of creatine kinase the genetic factor increasing hypertension risk in black people of sub-Saharan African descent? *J Hypertens* 2000; 18(11): 1537-44. [http://dx.doi.org/10.1097/00004872-200018110-00002] [PMID: 11081764]
- [85] Cooper R, Rotimi C. Hypertension in populations of West African origin: is there a genetic predisposition? *J Hypertens* 1994; 12(3): 215-27. [PMID: 8021474]
- [86] Daniel HI, Rotimi CN. Genetic epidemiology of hypertension: an update on the African diaspora. *Ethn Dis* 2003; 13(2)(Suppl. 2): S53-66. [PMID: 13677415]
- [87] George C, Yako YY, Okpechi IG, Matsha TE, Kaze Folefack FJ, Kengne AP. An African perspective on the genetic risk of chronic kidney disease: A systematic review. *BMC Med Genet* 2018; 19(1): 187. [http://dx.doi.org/10.1186/s12881-018-0702-x] [PMID: 30340464]
- [88] Price DA, Crook ED. Kidney disease in African Americans: Genetic considerations *J Natl Med Assoc* 2002; 94(8 Suppl): 16S-27S. [PMID: 12152908]
- [89] Reidy KJ, Hjorten R, Parekh RS. Genetic risk of APOL1 and kidney disease in children and young adults of African ancestry. *Curr Opin Pediatr* 2018; 30(2): 252-9. [http://dx.doi.org/10.1097/MOP.0000000000000603] [PMID: 29406442]
- [90] Swift PA, Macgregor GA. Genetic variation in the epithelial sodium channel: A risk factor for hypertension in people of African origin. *Adv Ren Replace Ther* 2004; 11(1): 76-86. [http://dx.doi.org/10.1053/j.arrt.2003.10.011] [PMID: 14730541]
- [91] Udler MS, Nadkarni GN, Belbin G, Lotay V, Wyatt C, Gottesman O, et al. Effect of Genetic African ancestry on eGFR and kidney disease *J Am Soc Nephrol* 2015; 26(7): 1682-92. [http://dx.doi.org/10.1681/ASN.2014050474] [PMID: 25349204]
- [92] Cooper R. The role of genetic and environmental factors in cardiovascular disease in African Americans. *Am J Med Sci* 1999; 317(3): 208-13. [http://dx.doi.org/10.1016/S0002-9629(15)40504-X] [PMID: 10100695]
- [93] Wassel CL, Pankow JS, Peralta CA, Choudhry S, Seldin MF, Arnett DK. Genetic ancestry is associated with subclinical cardiovascular disease in African-Americans and Hispanics from the multi-ethnic study of atherosclerosis. *Circ Cardiovasc Genet* 2009; 2(6): 629-36. [http://dx.doi.org/10.1161/CIRCGENETICS.109.876243] [PMID: 20031644]
- [94] Meigs JB, Grant RW, Piccolo R, et al. Association of african genetic ancestry with fasting glucose and hba1c levels in non-diabetic individuals: the boston area community health (BACH) prediabetes study *Diabetologia* 2014; 57(9): 1850-8. [http://dx.doi.org/10.1007/s00125-014-3301-1] [PMID: 24942103]