



High Education Level Protects European Americans But Not African Americans Against Chronic Obstructive Pulmonary Disease: National Health Interview Survey

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Abstract: *Background:* Education level reduces the risk of chronic diseases (CDs), including Chronic Obstructive Pulmonary Disease (COPD). Minorities' Diminished Returns, however, refer to smaller health benefits of socioeconomic position (SEP) improvement for racial and ethnic minorities compared to majority groups. It is not known if MDRs exist for the effects of education level on COPD for African Americans (AAs), relative to European Americans (EAs). *Aims:* Using a nationally representative sample, the current study explored racial and ethnic variation in the association between education level and COPD among American adults. *Methods:* Data came from the National Health Interview Survey (NHIS 2015), a national survey. A total of 25,488 adults (18+ years old) were included in the study. From this number, 4,533 (17.8%) were AAs and 20,955 (82.2%) were EAs. Education level was the independent variable. COPD was the outcome. Age, gender, and income were the covariates. Race/ethnicity was the moderator. *Results:* Overall, education level was inversely associated with the odds of COPD. A statistically significant interaction was found between race/ethnicity and education level on odds of COPD, indicating smaller effect of education for AAs compared to EAs. *Conclusions:* In line with the Minorities' Diminished Returns (MDRs), highly educated AAs remained at high risk for COPD, a pattern which is not observed for EAs. Policies that exclusively address racial/ethnic inequalities in SEP may not be enough for eliminating racial/ethnic inequalities in COPD in the US. Public policies must go beyond equalizing SEP and address structural and environmental barriers that disproportionately increase risk of COPD in AAs across SEP levels. Future research should test if residential segregation and exposure to air pollutants contributes to high prevalence of COPD in highly educated AAs. Research is needed on multi-level interventions that may minimize MDR-related health disparities.

Keywords: Socioeconomic Position, Socioeconomic Status, Educational Attainment, Ethnicity, Race, Ethnic Groups, African Americans, Blacks, COPD, Chronic Obstructive Pulmonary Disease

1. Introduction

Although socioeconomic position (SEP) is amongst the strongest determinants of health [1–8], such effect is unequal across racial/ethnic groups [9, 10]. While high education level predicts better health [11, 12], and low education level strongly predicts worse health [13], these effects are not identical across various social groups. As such, Minorities' Diminished Returns (MDRs) refer to smaller health effects of

SEP indicators particularly education level in the members of racial and ethnic minorities particularly African Americans (AAs), relative to European Americans (EAs), as an overlooked mechanism behind racial and ethnic inequalities in health [9, 10].

Considerable MDRs [9], defined as relative disadvantage of racial and ethnic groups in receiving health gain from SEP resources, are shown for many health outcomes [10]. Supporting this framework [9, 10], SEP indicators such as

education level are shown to have stronger effects on drinking [14], depression [15], suicide [16], chronic disease (CDs) [15], and mortality [17–20] for EA than AA individuals.

Some of the mechanisms behind the MDRs include societal and structural processes and factors such as residential segregation, extra costs of moving upward in society [21, 22], and higher level of exposure and sensitivity to discrimination [23] in non-EAs (particularly AAs). As a result of such societal processes, high SEP tends to produce less tangible health effects for AA than EA people. However, less is known about MDRs of education level for COPD.

As a result of MDRs [9, 10], the health effects of SEP indicators such as education level [25–27] are diminished for racial and ethnic minority groups [9, 10, 28, 95–97]. Thus, diverse racial and ethnic groups not only vary in their SEP but also how their SEP turns to health outcomes [23, 29, 30]. Although high education level means less exposure to risks overall [25–27], social groups with the same level of education level have unequal life experience [21, 22, 31]. That is, the very same SEP indicator, such as education level, shows a smaller impact of the purchasing power for the racial/ethnic minority groups, compared to the majority group [32–35]. For example, high education level gives less access to goods and services, quality of residential places, job quality, and health to AAs than EAs [37, 25–27, 36]. As the US society tends to treat individuals based on their race/ethnicity, heritage, and skin color, high SEP generates fewer opportunities for AAs than EAs [38, 39]. AAs face more problems and barriers to leverage and built on their available material resources, human capital, and psychological assets [38, 39]. As a result of MDRs [9, 10], we observe worse than expected health effects in high SEP and highly educated AAs, when compared to EA people [29, 43].

Aims

To better understand whether MDRs also apply to racial/ethnic disparities in COPD, we compared AA and EA people for the negative effect of education level on COPD. Although research has well-documented the effects of race/ethnicity [101] and SEP (education level) [102] on COPD, very few studies have ever tested MDRs of SEP on COPD. Such study would require studying the non-additive effects of race/ethnicity, and SEP on COPD. So, it is still not fully known whether it is whether race/ethnicity and SEP or race/ethnicity or SEP that cause COPD disparities [83]. To produce generalizable results, we used data from the National Health Interview Survey (NHIS 2015), a study with a nationally representative sample of adults (18+ years old). As suggested by the MDRs [9], we expected smaller effect of SEP (education level) on COPD for AAs than EAs.

2. Materials and Methods

Design and Setting

This cross-sectional study borrowed data from the NHIS 2015, a national health survey of American adults sponsored by the Centers for Disease Control and Prevention (CDC). The NHIS is a landmark health survey that produces national

prevalence estimates for a wide range of health indicators [103]. The data collection is done by the National Center for Health Statistics (NCHS), CDC.

The sample is limited to the civilians, non-institutionalized, adults, who were residing in the United States. The NHIS data collection is conducted in a continuous manner throughout each year. The sample design follows a multistage probability sample that recruited a representative sample of households and non-institutional people.

The NHIS sampling and sample design is described elsewhere. NHIS uses a multi-stage sampling strategy that involves survey weights. The first stage of the current multi-stage sample design was sampling 428 primary sampling units (PSUs) drawn from 1,900 PSUs, with all the 50 US states and the District of Columbia have representative PSUs in the study. A PSU may be either a county, some small counties, or a metropolitan statistical area.

Sample and Sampling

The NHIS sampling cores consist of the following components: (1) the Household Composition section, (2) the Family Core, (3) the Sample Child Core, and (4) the Sample Adult Core. The U.S. Census Bureau acts as the data collection agent for the NHIS, under a contractual agreement between the two organizations. The NHIS interviews were face-to face, however, they could rarely occur in the participants' households. This interview is sometimes followed with a telephone interview. 28932 adults enter this analysis.

Ethics

The NHIS study ethics was approved by the CDC's Institutional Review Board (IRB). All participants provided informed written consent. All the data were collected, stored, and analyzed without any identifier [48].

Measures

Independent Variable

Education level (EA). Education level was operationalized as an interval (continuous) variable with a range between 0 and 21. Participants were asked about the number of years of schooling. Higher scores reflect higher education level (number of schooling).

Moderator

Race/Ethnicity. All participants self-identified their race/ethnicity. Race/ethnicity was treated as a categorical variable in the current study [AAs = 1, EAs = 0]. All AAs and EAs in this study were non-Hispanic Blacks.

Covariates

Sociodemographic characteristics in the current study included gender, age, region, and income. Age was a continuous measure. Gender was dichotomous (male 1, female 0). Region was a nominal variable with the following four levels: (1) Northeast, (2) Midwest, (3) South, and (4) West. West was the reference category. Income was measured as annual last year income, which was operationalized as a 11-level continuous measure.

Outcome

Chronic Obstructive Pulmonary Disease (COPD). The following item was used to measure the lifetime history of

COPD. Participants were asked, “Have you EVER been told by a doctor or other health professional that you had chronic obstructive pulmonary disease, also called COPD”?

Data Analysis

We used survey mode of the SPSS 23.0 (IBM Inc, NY, USA) to analyze the NHIS-2015 data. Taylor series linearization was used to re-calculate the standard errors (SEs) that address complex design of the NHIS sample. As a result, our estimates are generalizable to the US sample [44–46]. To describe our sample, we reported n and %. We ran four logistic regression models for our multivariable modeling, both t 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/ethnicity × education level. *Model 3* was performed in EAs. *Model 4* was performed in AAs. In all models, education level was the independent variable (IV), COPD was the dependent variable (DV), and age, gender, region, marital status, employment, and income were covariates. Race/ethnicity was the moderator.

3. Results

3.1. Descriptive Data

This analysis included 25488 adults (18+ years old). From this number, 4,533 (17.8%) were AAs and 20,955 (82.2%) were EAs. Table 1 presents the summary of descriptive characteristics of the overall sample and by race/ethnicity. 4.6% had COPD. 17.5% were current smokers. As this table shows, from all participants, 55.2% were women, 27.8% were AA, and 82.2% were EA.

Table 1. Descriptive statistics (n = 25488).

Characteristics	Mean	SD	Mean	SD	Mean	SD
Age	51.73	18.39	52.29	18.47	49.14	17.78
Education	15.48	2.82	15.66	2.73	14.65	3.08
Income *	6.70	3.10	6.83	3.12	5.87	2.86
	n	%	n	%	n	%
Gender*						
Female	14072	55.2	11311	54.0	2761	60.9
Male	11416	44.8	9644	46.0	1772	39.1
Region*						
Northeast	4395	17.2	3769	18.0	626	13.8
Midwest	6262	24.6	5492	26.2	770	17.0
South	9118	35.8	6385	30.5	2733	60.3
West	5713	22.4	5309	25.3	404	8.9
Employed						
No	11803	46.3	9586	45.7	2217	48.9
Yes	13685	53.7	11369	54.3	2316	51.1
Married*						
No	14419	56.6	11014	52.6	3405	75.1
Yes	11069	43.4	9941	47.4	1128	24.9
Current Smoking						
No	21024	82.5	17303	82.6	3721	82.1
Yes	4464	17.5	3652	17.4	812	17.9
COPD						
No	24320	95.4	19927	95.1	4393	96.9
Yes	1168	4.6	1028	4.9	140	3.1

* *p* < 0.05, Chronic Obstructive Pulmonary Disease (COPD), African American (AA), standard Deviation (SD)

3.2. Logistic Regressions

Table 2 summarizes the results of two nested logistic regressions. *Model 1* was without interactions (Model 1). *Model 2*, however had two interactions. *Model 1* showed that overall, higher education level is associated with lower odds of COPD. *Model 2* showed significant interactions between the effects of race/ethnicity and education level on odds of COPD, suggesting that the negative effect of education level on odds of COPD is smaller for AAs compared to EAs (Table 2).

Table 2. Pooled sample logistic regressions.

	B	SE	OR	95% CI	p	
Model 1 (Main Effects)						
Race / Ethnicity (AA)	-0.63	0.10	0.53	0.44	0.64	.000
Gender (male)	0.07	0.06	1.07	0.95	1.22	.272
Region						
West	1.00					
Northeast	-0.10	0.11	0.91	0.74	1.11	.353
Midwest	0.07	0.09	1.07	0.90	1.29	.439
South	0.15	0.09	1.16	0.98	1.38	.089
Smoker	1.49	0.07	4.44	3.85	5.11	.000
Age	0.04	0.00	1.04	1.03	1.04	.000
Married	-0.01	0.07	0.99	0.87	1.13	.928
Employed	-1.30	0.09	0.27	0.23	0.33	.000
Education	-0.10	0.01	0.91	0.89	0.93	.000
Constant	-3.85	0.24	0.02			.000
Model 2 (Main Effects + Interactions)						
Race / Ethnicity (AA)	-2.20	0.40	0.00	0.11	0.05	0.24
Gender (male)	0.07	0.06	0.25	1.08	0.95	1.22
Region						
West	1.00					
Northeast	-0.10	0.11	0.33	0.90	0.73	1.11
Midwest	0.06	0.09	0.52	1.06	0.88	1.28
South	0.14	0.09	0.10	1.15	0.97	1.37
Smoker	1.48	0.07	0.00	4.40	3.82	5.07
Age	0.04	0.00	0.00	1.04	1.03	1.04
Married	0.00	0.07	0.95	1.00	0.87	1.14
Employed	-1.30	0.09	0.00	0.27	0.23	0.33
Education	-0.11	0.01	0.00	0.89	0.87	0.91
Education * AA	0.12	0.03	0.00	1.12	1.06	1.19
Constant	-3.61	0.25	0.00	0.03		

Outcome: Chronic Obstructive Pulmonary Disease (COPD), African American (AA), Confidence Interval (CI).

Table 3 summarizes the results of two identical ethnic-specific logistic regression models. *Model 3* was in EAs and *Model 4* was in AAs. *Model 3* showed that higher education level is associated with lower odds of COPD for EAs. *Model 4*, however, did not show any effect of educational level and odds of COPD. This suggests a negative effect of education level for EAs but not AAs (Table 3).

Table 3. Ethnic-specific logistic regressions.

	B	SE	OR	95% CI		p
Model 3 (EAs)						
Gender (Male)	0.09	0.07	1.09	0.95	1.25	.203
Region						
West	1.00					
Northeast	-0.12	0.11	0.88	0.71	1.09	.256
Midwest	0.04	0.10	1.04	0.86	1.26	.697
South	0.14	0.09	1.15	0.96	1.38	.118
Smoker	1.56	0.08	4.75	4.07	5.54	.000
Age	0.04	0.00	1.04	1.03	1.04	.000
Married	-0.05	0.07	0.95	0.83	1.10	.502
Employed	-1.29	0.10	0.27	0.23	0.33	.000
Education	-0.11	0.01	0.89	0.88	0.91	.000
Constant	-3.67	0.26	0.03			.000
Model 4 (AAs)						
Gender (Male)	-0.02	0.18	0.98	0.68	1.40	.901
Region						
West	1.00					
Northeast	0.21	0.43	1.23	0.53	2.83	.626
Midwest	0.43	0.40	1.54	0.71	3.35	.279
South	0.30	0.36	1.35	0.66	2.74	.409
Smoker	1.01	0.20	2.76	1.88	4.05	.000
Age	0.04	0.01	1.04	1.03	1.05	.000
Married	0.41	0.20	1.50	1.01	2.23	.043
Employed	-1.41	0.28	0.24	0.14	0.42	.000
Education	-0.01	0.03	0.99	0.94	1.05	.815
Constant	-5.72	0.69	0.00			.000

Outcome: Chronic Obstructive Pulmonary Disease (COPD), African American (AA), Confidence Interval (CI).

4. Discussion

Two findings were observed. First, education level was inversely associated with the prevalence of COPD in the overall sample. Second, AAs were at a relative disadvantage in comparison to EAs regarding the protective effect of education level on COPD. That is, the negative association between SEP (i.e., education level) and COPD was weaker for AAs than EAs. As a result, highly educated AAs remain at high risk of COPD, compared to highly educated EAs.

The first finding on the inverse association between education level and COPD reflects protective effect of SEP against COPD. Protective effect of SEP, particularly education level, is well established in the epidemiology [78] and economics [77] literatures. Prevalence of CDs is higher in low SEP sections of the society [77]. Some evidence suggests that CD gap mediates the mortality gap in race/ethnicity and SEP [104].

The second finding that the very same SEP indicator (education level) showed a considerably stronger impact on prevalence of COPD for EAs than AAs is not new. In one study, education better reduced blood pressure of non-Hispanics than Hispanics [105]. In another study, education better reduced disability for Whites than Blacks. Similar to the patterns seen for blood pressure, the effects of SEP on overall health, obesity, impulsivity, and smoking, and drinking are larger for EAs than AAs [56, 58, 93]. These patterns are robust as shown for children [107-110], adults [15, 16] and older adults [29, 37].

One of the mechanisms of the MDRs is that high education level has a smaller effect on reducing the risk of poverty for AAs, compared to EAs [57, 94]. Another mechanism is that

high SEP AAs face more not less discrimination [111-117].

Researchers should also consider that health disparities research may require study of multiplicative effects of race/ethnicity and SEP. This is because race/ethnicity and SEP, but not race/ethnicity or SEP, cause disparities.

Limitations

Every study has some limitations. To list a few methodological limitations, we can refer to the cross-sectional design that limits any causal conclusions. It is, however, unlikely that COPD causes low SEP. Still, CDs may result in downward social mobility [70-73]. This study measured COPD with a self-reported rather than measured or administered data. Although self-reported COPD is valid [54, 55], future research may test if these results can be replicated using other SEP indicators, other racial and ethnic groups, and using comprehensive measures. The study is at risk of omitted confounders.

5. Conclusions

In the United States, the inverse association between education level and COPD is weaker for AAs than EAs. As a result, we observe more COPD in highly educated AAs compared to highly educated EAs. Public and social policy solutions should go beyond equalizing SEP and specifically address structural causes of MDRs of SEP. Such MDRs are historically and systemically overlooked contributor to racial and ethnic health disparities in the US.

Authors' Contributions

S. A. designed and performed the approved the revisions and confirmed the final version. H. C. and M. B. contributed to the drafts and revision.

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Conflicts of Interest

Authors declare no conflicts of interest.

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