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Race, Socioeconomic Status, and Prenatal Tobacco Exposure in US Children in the Adolescent Brain Cognitive Development (ABCD) Study

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Abstract

Background: According to the Minorities' Diminished Returns (MDRs) theory, racism reduces the real-life effects of Socioeconomic Status (SES) resources such as marital status, family income, and parental education for racial minorities compared to Whites. However, there are few studies if any on racial variation in the protective effects of such SES resources on children's prenatal exposure to tobacco.

Aim: We aimed to test the effects of three SES resources namely marital status, family income, and parental education family income on children's prenatal exposure to tobacco, and to test racial variation in these effects.

Methods: In this cross-sectional study, we borrowed Adolescent Brain Cognitive Development (ABCD) data that included 1055 racially diverse group of US children. The independent variables were parental education, family income, and marital status. The primary outcome was self-reported tobacco use during pregnancy. Mixed-effects regression models were used for data analysis to adjust for data nested to the centers, families, and individuals.

Results: In the pooled sample and in the absence of interaction terms in the model, marital status showed an inverse association with tobacco use during pregnancy. However, race showed significant interaction with family structure on prenatal tobacco use, suggesting higher prevalence of prenatal tobacco exposure of African American children with married parents.

Conclusion: The protective effects of family structure against tobacco use during pregnancy might be weaker for racial minorities compared to Whites, a difference that is attributed to diminished returns of SES for racialized families under racism.

Keywords: Race; Socioeconomic position; Tobacco use during pregnancy; Prenatal exposure; Tobacco use

Introduction

Maternal tobacco use during pregnancy, also known as prenatal tobacco exposure, is a modifiable risk factor for the maternal and neonatal health and is associated with higher risk of maternal, fetal, and infant morbidity and mortality [1]. A large body of existing research has shown that maternal smoking during pregnancy increases the risk of low birth weight [2] and other negative birth and pregnancy outcomes, such as preterm birth [3], respiratory distress [4], stillbirth [5], and prenatal death [6]. Maternal tobacco use during pregnancy is also a risk factor for long-term morbidity in offspring, and sudden unexpected infant death [7]. As such, prenatal tobacco exposure is a target for behavioral interventions, and it is believed that prevention of tobacco use in pregnancy will have considerable health effects [8].

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Maternal smoking exposes the fetus to hundreds of toxins that may interfere with the healthy and normal fetal growth [7]. Exposure to prenatal tobacco may alter normal development of multiple organs such as heart, brain, lungs, to list a few. As such, such exposure will negatively impact the fetal development across multiple organs and systems [7]. For example, babies of smoking mothers had lower Apgar scores, a standardized index of newborn health at birth and is strongly associated with the risk of neonatal and infant death [9], compared to those of non-smokers [10].

While the rate of overall smoking in general [11] and maternal smoking during pregnancy [12] is lower in higher Socioeconomic Position (SES) individuals, defined based on parental education, family income, and marital status, the effects of these SES indicators on tobacco use are weaker for racial minorities than Whites [13]. As a result, tobacco use remains high in highly educated high income married individuals who are from racial minority backgrounds [13-19]. Similarly, the prevalence of passive smoking remains high in high SES minorities [16], however, this pattern is only shown for tobacco use not prenatal tobacco use.

Due to historical racism in the United States, race [20] and socioeconomic position [21] closely overlap, as on average African Americans have lower SES, compared to Whites [22]. As race and low SES correlate with health outcomes, it is essential to decompose the role of race and SES on health and behavioral outcomes such as maternal smoking during pregnancy [22]. In addition, as low SES, measured as low education, income, and unmarried family structure, maybe one of the mechanisms that connect race to behaviors [23], it is important to test the additive as well as multiplicative effects of race and SES on maternal smoking during pregnancy [24,25]. As the effects of SES indicators may vary by race, it is important to test differential effects of SES across racial groups [22].

A recent body of literature has suggested that the protective effects of SES on behavioral and health outcomes differ for White and racial minority families, a finding that holds for children [26,27], adults [28-31] and older adults [32,33]. These differences may be because adverse life experiences, stress, and trauma remain high in the lives of high SES minorities particularly African Americans [34,35]. For example, highly educated African American adults reported a higher level of occupation-related adverse life experiences than highly-educated White adults [36] and highly educated African Americans may remain at risk of poverty than highly educated Whites [37,39]. High-income African American families might remain in dangerous neighborhoods [40]. Ethnic and racial discrimination and stress also remains high in high SES African American families [28-31]. However, this research has never tested diminished returns of SES on prenatal tobacco exposure.

According to Minorities' Diminished Returns (MDRs), relative to Whites, African Americans show weaker effects of family SES indicators such as family income on tangible health outcomes [41,42]. Various SES indicators, such as income, tend to generate fewer health outcomes for the members of racial minority groups. Racial minority groups may not have the access, literacy, and connections to successfully navigate the available resource systems to secure tangible outcomes [42-47]. However, most of this literature is on African American families who show weaker effects of family income on various outcomes relative to Whites [41-49]. Thus, there is a need to include other racial groups in such an analysis.

Aim

This study aimed to investigate the effects of three SES indicators namely parental education, household income, and marital status on tobacco smoking during pregnancy. The study also investigated racial variation in these effects.

Methods

Design and Settings

This cross-sectional study was a secondary analysis of the existing data. Data came from the Adolescent Brain Cognitive Development (ABCD) study [50-54], a national longitudinal investigation of a diverse sample of children and their parents. More information about ABCD's purpose, methodology, and measurement is available elsewhere [50,55]. Some advantages of the ABCD data include a longitudinal, national, large, and diverse sample of race, SES, and geography [50-54]. The ABCD sampling was predominantly from schools nested in cities across states [56]. The analytical sample was 1055 pre-children who had participated in the baseline of the ABCD study and were between 9 and 10 years old.

Study Variables

The study variables included race, ethnicity, two demographic factors, namely age and gender, three SES indicators namely parental education, family income, and family structure, and prenatal tobacco use of mother.

Confounders

Age, gender, and ethnicity were the confounders. Parents reported the child's date of birth, and the child's age was calculated in the month at the time of baseline data collection. Age was treated as a continuous measure in months. Gender was a dichotomous variable, with males coded as one and females coded as 0.

Independent Variable

Parental education: Parents reported, "What is the highest grade or level of school you have completed or the highest degree you have received?" They also reported the highest educational attainment of their partner. Responses in this study included a five-level categorical variable as below: Less than high school, high school completed, some college, college graduated, and graduate studies. This variable captured both maternal and paternal education. The reference group was the lowest education, which was less than high school. Parents reported their marital status.

Family income: Family income was a three-level categorical measure. The exact question was, "What is your total combined family income for the past 12 months? This should include income (before taxes and deductions) from all sources, wages, rent from properties, social security, disability and veteran's benefits, unemployment benefits, workman". Responses included Less than $50,000, between $50,000 and $100,000, and $100,000 or more.

Family structure: Family structure was a dichotomous variable and coded 1 for married and o for any unmarried status. Latino ethnicity was reported by the parent.

Dependent Variables

Maternal tobacco use during pregnancy was measured by parent. This variable was self-reported by the parent during the

interview at baseline of the study when the child was 9 or 10 year olf. This variable was a dichotomous variable with 1 and 0.

Moderator

Race: Race was identified as African American or Black, Asian, Mixed/Other, and White (reference category).

Data Analysis

We used the Data Exploration and Analysis Portal (DEAP) platform for our data analysis. Average (Standard Deviation [SD]) and n = frequency (%) were described overall and by race. For multivariable analysis, we ran mixed-effects regression models that adjusted for nested data and multiple observations per family and center. All models were performed in the pooled sample that included all racial groups. While *Model 1* did not include any interaction terms, *Model 2* included interaction terms between race and parental education, *Model 3* included an interaction term between race and family income, and *Model 4* included an interaction term between family structure and race. Our models controlled for age, gender, ethnicity, center, and family. The outcome was maternal smoking during pregnancy (prenatal tobacco exposure), a dichotomous measure. Predictors were parental education, family income, and marital status all as categorical variables. The moderator was race. Standardized coefficients, 95% CI, and p-value were reported. Appendix 1 presents our formula doe analysis is DEAP. Appendix 2 shows the distribution of our variables and regression error terms.

Ethical Aspect

The ethics of the ABCD study protocol was approved by the University of California, San Diego (UCSD) Institutional Review Board (IRB). All children provided assent, and all parents signed informed consent. For more information on the IRB and ethics of the ABCD study, please consult here [55]. For this analysis, we used fully de-identified data. Our study was deemed exempt from a full IRB review by the Charles R. Drew University of Medicine and Science.

Results

Descriptives

Table 1 presents descriptive statistics of the pooled sample and by race. The current analysis was performed on 10555 9-10 years old children who were either White (n=6986 (66.2%)), African American (n=1543 (14.6%)), Asian (n=235 (2.2%)), and other/mixed race (n=1791 (17.0%)). Racial groups differed in parental education, family income, ethnicity, family structure, and maternal smoking during pregnancy.

Multivariate Analysis

Table 2 shows the effect sizes, and the model fits. Models with interactions showed a better fit.

Table 3 summarizes the results of four regression models in the overall (pooled) sample with prenatal tobacco exposure as the outcome. *Model 1* (Main Effect Model) showed associations between race, parental education, household income, marital status, and prenatal tobacco exposure. *Model 2* showed an interaction between race and parental education. *Model 3* showed an interaction between race and family income. Model 4 showed an interaction between race and family structure suggesting that the association between family structure and prenatal tobacco exposure vary by race (weaker for African American than White children). Figure 1 shows overall and racial variation in the association between parental education, family income, and family structure and prenatal exposure to tobacco.

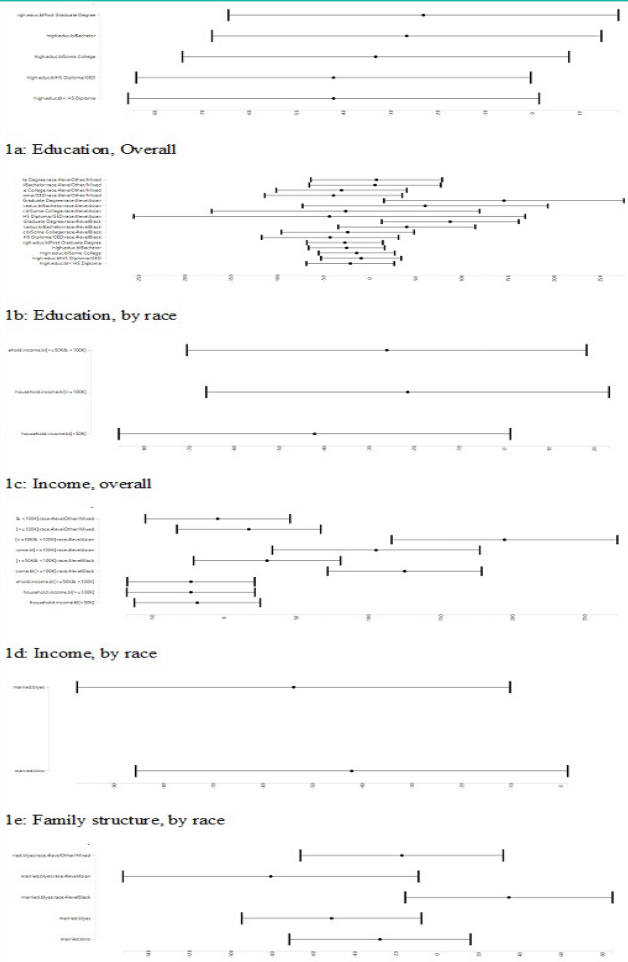

Figure 1: Overall and racial variation in the effect of parental education, family income, and family structure on prenatal exposure to tobacco.

Discussion

This study showed the protective effect of married status on prenatal tobacco exposure of children overall. In addition to the protection in the overall sample, we showed that this protective effect is weaker for African American than White children. While prenatal exposure to tobacco smoke is low for White children with married parents, this risk remains high in African American married families. We attribute this variation of protective effect of family structure for African American families to racism and racialization.

Such MDRs could help us understand why chronic conditions and health problems remain higher than expected in high SES African American youth and adults [41,42]. We argue that such remaining health risk may be one of the mechanisms for the trans-generational transmission of health inequalities in African American families. It is unknown what policies and conditions can break such negative cycles.

Our finding is a replication and expansion of our previous observation. Our finding indicated diminished returns of family structure on prenatal tobacco exposure for African American children relative to White children. In other words, married family structure better translates to a healthy behavior and lower risk for Whites than African Americans. Thus, while White children from married families remain protected against prenatal tobacco exposure, African American children from married families experience high risk of prenatal tobacco ex-

Table 1. Socio-demographic data overall and by race.

Vars	Level	Overall	White	African American	Asian	Other/Mixed	P
N		10555	6986(66.2)	1543(14.6)	235(2.2)	1791(17.0)	
		Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	
Age (Month)*		119.00(7.50)	119.06(7.52)	118.99(7.25)	119.46(7.84)	118.68(7.54)	0.206
		N(%)	N(%)	N(%)	N(%)	N(%)	
Married Family*							
	No	3215(30.5)	1431(20.5)	1081(70.1)	33(14.0)	670(37.4)	<0.001
	Yes	7340(69.5)	5555(79.5)	462(29.9)	202(86.0)	1121(62.6)	
Sex							
	Female	5061(47.9)	3294(47.2)	773(50.1)	118(50.2)	876(48.9)	0.123
	Male	5494(52.1)	3692(52.8)	770(49.9)	117(49.8)	915(51.1)	
Family Education*							
	<HS Diploma	395(3.7)	148(2.1)	126(8.2)	6(2.6)	115(6.4)	<0.001
	HS Diploma/GED	878(8.3)	333(4.8)	348(22.6)	3(1.3)	194(10.8)	
	Some College	2704(25.6)	1473(21.1)	612(39.7)	18(7.7)	601(33.6)	
	Bachelor	2799(26.5)	2082(29.8)	231(15.0)	66(28.1)	420(23.5)	
	Post Graduate Degree	3779(35.8)	2950(42.2)	226(14.6)	142(60.4)	461(25.7)	
Family Income*							
	<50K	3045(28.8)	1275(18.3)	1019(66.0)	37(15.7)	714(39.9)	<0.001
	>=50K & <100K	4497(42.6)	3582(51.3)	183(11.9)	144(61.3)	588(32.8)	
	>=100K	3013(28.5)	2129(30.5)	341(22.1)	54(23.0)	489(27.3)	
Hispanic*							
	No	8563(81.1)	5806(83.1)	1467(95.1)	216(91.9)	1074(60.0)	<0.001
	Yes	1992(18.9)	1180(16.9)	76(4.9)	19(8.1)	717(40.0)	
Maternal smoking during pregnancy*		23.04(149.51)	12.27(109.52)	48.09(213.49)	114.83(319.24)	31.41(173.88)	<0.001

*p<0.05 for comparison of racial groups

Table 2: Fit across models without and with interactions.

	Model 1 Main Effects	Model 2 With Interaction(Education)	Model 3 With Interaction(Income)	Model 3 With Interaction(Marital Status)
N	10555	10555	10555	10555
R-squared	0.02369	0.03572	0.03728	0.02768
ΔR-squared	0.00085	0.03317	0.03462	0.02659
ΔR-squared%	0.08%	3.32%	3.46%	2.66%

posure. While a large body of research has previously shown MDRs for other outcomes, the unique contribution of this study includes moving beyond the comparison of African Americans and Whites and testing MDRs of SES indicators on childhood prenatal exposure to tobacco.

These results replicate and extend the previously described MDRs. Similar MDRs are documented for various SES resources, age groups, health or developmental outcomes, and marginalizing identities [41,42]. Similar MDRs are shown for family income, parental education, marital status, subjective SES, and other SES indicators [44,57-59]. In a similar fashion, depression [60], anxiety [46], stress [34,61], poor diet [62], and higher body mass index [49,59,63,64] are shown in high SES African American children

This paper suggests that clinicians should expect higher-than-expected prenatal tobacco exposure in children from racial minorities, regardless of family structure, similar to previously shown higher-than-expected stress, obesity, anxiety, depression, suicide, and health problems in high SES African American children [44,57,58,59] and adults [30,31,65-67]. This result is significant because prenatal tobacco exposure contributes to many poor health outcomes [8]. Many explanations can be given to explain our findings. One is residential segregation which may reduce the returns of SES resources such as family structure for African American families. African American families have a higher tendency to remain in poor neighborhoods and attend worse schools across SES lines [68,69]. As a result of staying in a high-risk environment and social context, families of color and children from high SES backgrounds may remain at risk of environmental exposures to risk factors. In such a high-risk and low-resource social context, children may be exposed to increased-risk peers, aggression, danger, and other stressors [70,71].

While MDRs are well described, the societal and contextual processes that explain MDRs are still unknown. Some researchers have attributed MDRs to structural and institutional racism [41,72]. Childhood poverty may also be a mechanism that reduces later returns of SES when the individual is an adult [73]. Prejudice and discrimination may interfere with the expected benefits of education, employment, income, and marriage for minority families [31,66,67]. Multilevel economic and societal mechanisms may carry the effects of MDRs across generations [41,72].

More studies are needed on the role of neighborhoods, relatives, friends, and family members in explaining the sustained risk in the lives of African American children with married families. For example, it is unknown to what degree neighborhoods explain residual adverse live conditions of high-SES African Americans and to what degree such additional exposures translate to behavioral, cognitive, or emotional risk for children and adults [74]. Also, while policy can manipulate social environments, the remaining question is to what degree and what policies can equalize the returns of SES indicators and what are the best solutions to reduce the harmful effects of segregation in the lives of high-income African American families [75].

Table 3: Summary of regressions of without and with interactions.

	Estimate		SE	Pr(> | t|)	
Model 1					
Family Education					
Less than HS Diploma					
HS Diploma/GED	-0.02115	9.65093	0.00	0.9982512	
Some College	8.90790	8.84003	1.01	0.3136327	
Bachelor	15.48112	9.42038	1.64	0.1003374	
Post Graduate Degree	19.02727	9.54919	1.99	0.0463362	*
Age	0.25091	0.16919	1.48	0.1381099	
Sex(Male)	-4.36258	2.76649	-1.58	0.1148396	
Race					
White					
African American	55.89298	5.29031	10.57	<1e-6	* * *
Asian	114.39387	10.35629	11.05	<1e-6	* * *
Other/Mixed	22.84808	4.40914	5.18	<1e-6	* * *
Married	-11.70518	4.13402	-2.83	0.0046428	* *
Family Income					
<50K					
>=100K	20.69559	5.49735	3.76	0.0001677	* * *
>=50K& <100K	16.05014	4.87585	3.29	0.0009989	* * *
Hispanic	19.45467	4.71649	4.12	3.74e-05	* * *
Model 2					
Family Income					
<50K					
>=100K	-4.44013	6.35623	-0.70	0.4848499	
>=50K & <100K	-4.39527	6.07675	-0.72	0.4695159	
Age	0.25261	0.16759	1.51	0.1317681	
Sex(Male)	-4.30253	2.74497	-1.57	0.117045	
Family Education					
<HS Diploma					
HS Diploma/GED	0.78494	9.60683	0.08	0.9348817	
Some College	6.12214	8.80372	0.70	0.4868174	
Bachelor	11.92383	9.38803	1.27	0.2040738	
Post Graduate Degree	15.36000	9.51291	1.61	0.1064169	
Race					
White					
African American	13.65585	7.19836	1.90	0.057845	.
Asian	-9.66500	25.27878	-0.38	0.7022195	
Other/Mixed	2.69041	7.35377	0.37	0.7144809	
Married Family	-13.25676	4.12025	-3.22	0.0012972	* *
Hispanic	14.24167	4.73748	3.01	0.0026519	* *
Family Income >=100Kx African American	143.75600	13.88080	10.36	< 1e-6	* * *
Family Income >=50K& < 100K x African American	48.35012	11.53351	4.19	2.79e-05	* * *
Family Income >=100K x Asian	123.94260	28.36148	4.37	1.25e-05	* * *
Family Income >=50K& < 100K x Asian	212.95351	32.57505	6.54	< 1e-6	* * *
Family Income >=100K x Other/Mixed	35.70407	10.17426	3.51	0.0004512	* * *
Family Income >=50K& < 100K x Other/Mixed	14.12379	10.67841	1.32	0.1859808	
Model 3					
Family Income					
<50K					
>=100K	19.50836	5.48810	3.55	0.0003801	* * *

Implications

Our findings suggest that there is a need for expansion of eligibility for policies and programs for African Americans across SES lines, to reduce the harmful effects of diminished SES returns for high-SES African American families. First, we should focus on reducing racism that is the primary reason why we observe diminished returns of SES on health and well-being of African American families and their children. Racism is the key mechanism that explains why family SES does not generate the same health outcomes for racial minorities, particularly African Americans. Therefore, it is important to reduce anti-African American racism and discrimination in the US. Policies should promote equity and inclusion in all aspects of life, such as education, employment, policing, and banking. The second is to increase availability of smoking session programs for pregnant African American women across the full SP spectrum. Screening may result in early detection of prenatal tobacco exposure and a reduction of associated health risk in African American populations. Such prevention and screening should not be limited to low-SES families, as high-SES families are also at risk of tobacco use during pregnancy. Programs should also increase knowledge of African American communities about the risk of tobacco use during pregnancy. We need to increase the literacy of African American community members regarding the risks that remain high in middle-class communities of color. Such programs can leverage community involvement and family engagement to promote healthy behaviors and reduce health risk in middle-class communities of color.

Limitations

This study had a few methodological limitations. First, our study was cross-sectional, so we cannot infer any causal associations from our observed associations. We only analyzed the role of race as the marginalizing identity. Other marginalizing identities such as ethnicity, religion, sexual orientation, nativity, citizenship, and gender identity may also reduce the SES returns for children and their families [57,76-78]. Similarly, this study only investigated individual- and family- level SES indicators, with very few control variables. Neighborhood-level SES indicators such as neighborhood poverty may also show differential returns. In addition, we did not have access to other SES indicators, such as wealth. By including contextual data from neighborhoods, schools, friends, and families, mechanisms of diminished returns of family SES for racial minorities could be better understood.

Conclusion

Compared to Whites, African American children from married families have higher risk of prenatal tobacco exposure. High prenatal exposure to tobacco in African American children with married families may be one of the many mechanisms that explain high health problems of African Americans across SES levels. This finding is alarming and is another indication of health risk of high-SES African American children and their families. This finding can be explained by racialization of African American families that reduces the return of their resources and assets.

Author Statements

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>=50K& <100K	12.40468	4.87732	2.54	0.0109941	*
Age	0.22227	0.16825	1.32	0.1865125	
Sex(Male)	-4.57938	2.75049	-1.66	0.0959554	
Family Education					
<HS Diploma					
HS Diploma/GED	11.70657	15.34539	0.76	0.4455568	
Some College	6.90048	13.69647	0.50	0.6144024	
Bachelor	-3.97523	13.94114	-0.29	0.7755395	
Post Graduate Degree	-5.88957	13.95615	-0.42	0.6730294	
Race					
White					
African American	23.40717	19.34524	1.21	0.2263174	
Asian	-2.82269	57.67112	-0.05	0.9609643	
Other/Mixed	9.35169	18.58690	0.50	0.614881	
Married Family	-12.30866	4.11890	-2.99	0.0028115	**
Hispanic	15.37517	4.75627	3.23	0.0012304	**
HS Diploma/GED x African American	-21.97452	22.48301	-0.98	0.3284019	
Some College x African American	-2.81795	20.59726	-0.14	0.8911821	
Bachelor x African American	61.09037	22.18157	2.75	0.0058954	**
Post Graduate Degree x African American	108.23402	22.13293	4.89	1e-06	***
HS Diploma/GED x Asian	-22.56400	104.02562	-0.22	0.8282842	
Some College x Asian	-5.01753	67.66937	-0.07	0.9408943	
Bachelor x Asian	81.05172	60.70280	1.34	0.1818326	
Post Graduate Degree x Asian	166.46486	59.13660	2.81	0.004888	**
HS Diploma/GED x Other/Mixed	-18.21106	23.27945	-0.78	0.4340673	
Some College x Other/Mixed	-9.54188	20.06372	-0.48	0.6343842	
Bachelor x Other/Mixed	26.77675	20.46865	1.31	0.1908396	
Post Graduate Degree x Other/Mixed	28.30965	20.21654	1.40	0.1614465	
Model 4					
Family Income					
<50K					
>=100K	19.98303	5.49325	3.64	0.0002763	***
>=50K & <100K	14.02667	4.87891	2.87	0.0040489	**
Age	0.23458	0.16874	1.39	0.1645095	
Sex(Male)	-4.13859	2.76119	-1.50	0.1339442	
Family Education					
<HS Diploma					
HS Diploma/GED	-1.00668	9.64176	-0.10	0.9168474	
Some College	6.31038	8.83945	0.71	0.4753119	
Bachelor	12.62014	9.42460	1.34	0.1805789	
Post Graduate Degree	16.86724	9.54694	1.77	0.0772958	.
Race					
White					
African American	30.36204	6.88912	4.41	1.06e-05	***
Asian	160.16395	26.44296	6.06	< 1e-6	***
Other/Mixed	14.52836	7.42101	1.96	0.0502877	.
Married Family	-23.44117	5.12442	-4.57	4.8e-06	***
Hispanic	17.35587	4.72530	3.67	0.0002409	***
Married x African American	62.45309	10.15069	6.15	< 1e-6	***
Married x Asian	-52.90598	28.57536	-1.85	0.0641322	.
Married x Other/Mixed	10.59556	8.97534	1.18	0.2378203	

.p<.01, *p<.05, **p<.001, ***p<.00001

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Availability of Data and Material

ABCD data are available at the NIH NDA Website:

https://nda.nih.gov/abcd/

Code Availability

Codes are available in the appendix.

Authors' Contributions

Conceptual Design: Shervin Assari. Analysis: Shervin Assari. Data: ABCD Researchers; First Draft: Shervin Assari. Revision: Shervin Assari. Final Approval: Shervin Assari.

Ethics Approval

Fully de-identified data were utilized for this paper. This study was exempt from a full IRB review. The original ABCD study protocol was approved by the University of California San Diego (UCSD). ABCD data are available to all at NIH NDA web-

site. All adult participants provided consent. Participating children provided assent.

Consent to Participate

All children provided assent. All adults provided consent.

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