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Research Article

Income Gradient in Children's Physical Activity: Diminished Returns in Black Families

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Abstract

Background: While socioeconomic status (SES) indicators, such as family income, are among the primary drivers of individual health behaviors, the effects of these indicators on health behaviors may be weaker for racial/ethnic minorities, as described by the Marginalization related Diminished Returns (MDRs) phenomenon.

Objectives: Built on the MDRs framework, this study used a national sample of 9 and 10 year old children with the following two aims: First, to test the association between household income and physical activity, and second, to test racial/ethnic variation in these associations.

Methods: This cross-sectional study used the Adolescent Brain Cognitive Development (ABCD) baseline data. Participants included 9358 individuals who were either Black or White. Age, sex, racial/ethnicity, family structure (parental marital status), and frequency of physical activity were measured. Linear regression was used for data analysis.

Results: Overall, high family income showed a positive association with physical activity in the overall population. We documented a statistically significant interaction between race/ethnicity and household income on frequency of physical activity, showing weaker effects of family income on children's physical activity in Black than White families.

Conclusion: We observed that household SES indicators, such as family income, have a larger effect on increasing children's physical activity in White than Black families. Due to the existing MDRs, defined as weaker effects of family SES for racial/ethnic minority than White families, Black children from high SES families engage in less healthy behaviors than their White counterparts. MDRs sustain racial/ethnic disparities across class and SES lines.

Keywords: Educational attainment, physical activity, exercise, socioeconomic status, population groups

Introduction

Theory and empirical data provided by several scholars such as Marmot [1,2], Hayward [3-5], Link and Phelan [6], Ross and Miroswky [7-9], Lantz and House [10], Williams [11], Braveman [12], and others [13] have shown that socioeconomic status (SES) indicators such as family income promote population health and well-being. SES is one mechanism through which education and income exerts a positive impact on health, improving health behaviors such as physical activity and exercise [14-21]. Healthy behaviors such as physical activity lower the risk of obesity, diabetes, heart disease, and mortality [14,22,23].

Recently, the Marginalization-related Diminished Returns (MDRs) phenomenon [24,25] has indicated that SES effects tend to be weaker for racial/ethnic minorities than non-Latino White families [26,27], in part because racial/ethnic minorities are still segregated and their high SES does not provide the very same access to options and opportunities that can enhance healthy behaviors of diverse racial/ethnic groups. In summary, MDRs [24,25] refer to racism-related weaker effects of educational attainment and household income on behavioral and health outcomes of racial/ethnic minorities than their non-Latino White counterparts [28-34]. Similar MDRs are shown for a variety of other indicators of health, including exercise, diet [27], smoking [35-39], obesity [40,41], heart disease [42], disability [43], chronic disease [44], hospitalization [45], mortality [46-49]. While stress, labor market discrimination, segregation, food access, neighborhood quality, and various aspects of the social environment are all potential mechanisms, one of the proximal mediators of the MDRs might be dietary behaviors. We expect that pro-health diet to be less influenced by educational attainment and income in racial/ethnic minority families because they face many barriers in their lives given racism and social stratification [50-52]. In addition, because racial/ethnic minorities live in marginalized communities and are more likely to be under the influence of parents who had spent their childhood in poverty, their family SES may not have had large effects on their physical activity. Multiple scholars have described the MDRs phenomenon as a product of both race/ethnicity and SES. Kaufman has discussed the poor overlap between SES across racial/ethnic groups that result in residual and unmeasured confounding as well as not-comparability of SES across racial/ethnic groups [53].

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Navarro has described this as race/ethnicity and SES, rather than race/ethnicity or SES effects due to the complex interplay between race/ethnicity and SES [54-56]. Ceci has mentioned that the Have-Nots (ethnic minorities) may gain health less than the Haves (non-Latino Whites) from the same resources (SES indicators) due to their lower readiness to uptake and navigate the complex social systems [57]. Most recently, a study showed that SES indicators better reduce cardiometabolic risk of White than Black families [58].

However, most of the existing literature is on diminished returns of parental education and own education than other SES indicators such as household income. Thus, there is a need to study the MDRs of a wider range of SES indicators such as household income. To better understand whether MDRs observed in the ABCD data for brain outcomes [59-65] might be in part due to MDRs in health behaviors such as physical activity, we conducted a secondary analysis of the ABCD data to determine the association between household income and physical activity and variation in this effect by race/ethnicity. We hypothesize a positive association between household income and exercise of individuals. We, however, expect, built on the MDRs framework, that this positive association would be weaker for Black and Latino than non-Latino White children. As a result, we expect higher exercise of non-Latino White families with high SES than racial/ethnic minority families with similar SES, indicating a diminished effect of household income on exercise in Black and Latino families (due to access shaped by segregation). Then at least some of the MDRs in exercise and diet [26,27] would partially explain the MDRs in brain development [59-65].

Materials and Methods

Design and setting

This study is a secondary analysis of the first two years (waves 1 and 2) of data (2016/2018 to 2018/2020) of the Adolescent Brain Cognitive Development (ABCD) study [66-70]. The ABCD is a state-of-the-art and national longitudinal study of children's development in the United States [66,71].

Sampling and participants

In the ABCD study, participating children were 9/10-year-old at the time of recruitment which was between 2016 and 2018. Recruitment occurred across 21 study sites in multiple cities across 15 US states in US. The primary recruitment strategy was through school systems [72]. The original/overall study included 10,875 children at baseline.

Eligibility and analytical sample

From the 10,875 participants, we included children at wave 1 who were either Latino or non-Latino White or Black. Race/ethnicity was based on parents' reports. We did not include other racial/ethnic groups such as Asian, Native American, Mixed, Other, or unknown racial/ethnic groups. Participants were only included if they had data on SES, race/ethnicity, physical activity, and covariates (n=9358).

Study variables

Primary outcome: The ABCD study has used multiple measures of physical activity [73] including a three-item measure. The outcome in this variable was the frequency of physical activity and exercise. This variable was the average of the following three items: (1) During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time); (2) On how many of the past 7 days did you do exercises to strengthen or tone your muscles, such as push-ups, sit-ups, or weight lifting? and (3) In an average week when you are in school, on how many days do you go to physical education (PE) class? Response items for the first two questions were 0 = 0 days; 1 = 1 day; 2 = 2 days; 3 = 3 days; 4 = 4 days; 5 = 5 days; 6 = 6 days; 7 = 7 days. The response items for the last question were 0 = 0 days; 1 = 1 day; 2 = 2 days; 3 = 3 days; 4 = 4 days; 5 = 5 days. The total score ranged from 1 to 6. The measure was a quantitative score which showed a close to normal distribution. A higher score indicated more physical activity. This measure has acceptable validity and reliability and previously used in research [74].

Independent variable

Socioeconomic status: This study used household income as the SES indicator of interest. Household income was treated as a continuous measure. Annual family income had a range between 1 and 10 that referred to the following income levels: 1 = less than $5000; 2 = $5000; 3 = $12,000; 4 = $16,000; 5 = $25,000; 6 = $35,000; 7 = $50,000; 8 = $75,000; 9 = $100,000; 10 = $200,000+.

Moderator

Race/Ethnicity: Race/ethnicity was composed of two categorical variables which were identified by the parents. All participants were non-Hispanic or Hispanic White or Black.

Confounders

Demographic covariates included age, sex, and family structure. Parents reported the child's age. Child age was a continuous variable calculated in months. The sex of the child was a dichotomous variable: 1 = male and 0 = female. Family structure was married or unmarried.

Data analysis

We used the SPSS 25.0 for data analysis. After ruling out multi-collinearity between our variables and confirming a near to normal distribution of our outcome, we applied chi square and independent t test to compare race/ethnic groups for study variables. We used multivariable linear regression models with household income as the independent variable, physical activity as the outcome, and race/ethnicity as the moderator, and age, sex, and family structure. Overall, we ran four models. Model 1 and Model 2 were performed in the pooled sample. Model 1 did not include an interaction term but included all the confounders. Model 2, however, did include interaction terms between household income and race/ethnicity. All models also controlled for same confounders. Model 3 and Model 4 were run in Whites and Blacks, respectively. We reported the values b, SE, 95% CI, and p from our regression models.

Ethical considerations

This analysis was exempt from a full IRB review by Charles R Drew University of Medicine. The study of origin (ABCD) was approved by the Institutional Review Board (IRB) at the University of California, San Diego (UCSD). Assent and consent were received from children and their parents, respectively [71].

Table 1: Descriptive data overall.

	All		White (N=7362)		Black (N=1996)	
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***
Child Age (Years)	9.48	0.51	9.48	0.5	9.48	0.51
Household Income	7.33	2.37	7.86	1.95	5.36	2.69
Exercise / Physical Activity	2.88	1.26	2.86	1.23	2.94	1.37
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***
Ethnicity						
Non-Hispanic	7880	84.2	6065	82.4	1815	90.9
Hispanic	1478	15.8	1297	17.6	181	9.1
Race						
White	7362	78.7	7362	100	-	-
Black	1996	21.3	-	-	1996	100
Sex						
Female	4453	47.6	3468	47.1	985	49.3
Male	4905	52.4	3894	52.9	1011	50.7
Family Marital Status						
Spouse Not Present	2815	30.1	1518	20.6	1297	65
Spouse Present	6543	69.9	5844	79.4	699	35

Results

Overall, 9358 individuals entered this secondary analysis. Our participants were either White (n=7362) or Black (n=1996). Table 1 shows the summary of descriptive statistics overall and by race/ethnicity.

Linear regression models in the pooled sample

As shown by Table 2, while household income increased children's frequency of exercise. However, this effect was weaker for Black than White children.

Linear regression models in White and Black sample

As shown by Table 3, household income increased frequency of exercise for White but not Black children.

Discussion

High family income was associated with more physical activity; however, race/ethnicity moderated this association. We observed weaker associations for Black than White children. As a result, children in high-income Black families reported lower exercise than non-Latino White children with the same family income. Lower-than-expected physical activity of high SES Black children contributes to the development of obesity, chronic disease, and poor mental health of high SES Black children.

The association between high SES and more exercise is aligned with fundamental cause theory [6,75-79], social determinants of health framework [1,2,80-82], and other SES and SDoH theories that suggest high SES is linked to pro-health behaviors such as exercise. Health behavior is a mechanism that explains why high SES such as family income impacts population and individual health [5,83,84]. Such healthier behavior may partially explain why family income is linked to lower risk of obesity, diabetes, and other cardiovascular conditions [22,23]. According to the CDC, high SES is associated with more physical activity among US children [74].

The second finding which showed a weaker effect of family income on exercise frequency of Black than White children is in line with the MDRs phenomenon, defined as weaker SES effects on health of Black than White families. Family SES is shown to have stronger effects on exercise [85], diet [26,27], obesity [40,41], hypertension [86], heart disease [42], and substance use [35-39,87-94] among Black than White Americans. According to MDRs, Black people remain at risk at education levels at which non-Latino White people show benefits of their educational attainment. For example, in the ABCD data and other data sets, weaker SES effects on memory [61,95], academic performance [31,32,96-98], emotion regulation [99], mental health [100], and several other intermediate factors [40,41] are seen for Black than White children.

Our finding extends what we know about MDRs. Past work has shown similar MDRs for mental [101-103], behavioral [35,90], and physical health [43], as well as healthcare use [104,105], sleep [106], tobacco use [46,107], and substance use [35,108,109] for high SES Black people.

As a result of low exercise and other related behaviors of high SES Black families, we observe high cardiometabolic disease in high SES Black people, while the same risk remains low in high SES White people [58]. Similarly, the risks of disability [110], poor self-rated health [111-113], chronic diseases [44,114,115], depression [116], anxiety [117], suicide [99,100,118], disability [110], hospitalization [45], and mortality [119-121] remain high for high SES Black individuals, while the same risks remain low in high SES non-

Table 2: Summary of linear regression models without (M1) and with (M2) interactions.

	M1 All (No Interaction)						M2 All (M1 + Interaction)					
	B	**SE(B)**	**Beta**	**95% CI**		**p**	**B**	**SE(B)**	**Beta**	**95% CI**		**p**
Black	0.131	0.037	0.043	0.059	0.203	0	0.307	0.097	0.099	0.117	0.496	0.001
Hispanic	0.002	0.037	0	-0.071	0.074	0.967	0.022	0.115	0.006	-0.203	0.248	0.845
Age	0.152	0.026	0.061	0.102	0.203	0	0.152	0.026	0.061	0.102	0.203	0
Sex (Male)	0.12	0.026	0.047	0.069	0.171	0	0.12	0.026	0.048	0.069	0.171	0
Family Married	0.013	0.035	0.005	-0.056	0.081	0.716	0.013	0.035	0.005	-0.056	0.081	0.718
Household Income	0.017	0.007	0.032	0.004	0.031	0.014	0.028	0.01	0.052	0.008	0.047	0.005
Household Income x Black							-0.028	0.014	-0.055	-0.055	-0.001	0.043
Parental Education x Latino							0	0.016	-0.001	-0.032	0.031	0.977

Table 3: Summary of linear regression models in White and Black children.

	M3 White						M4 Black					
	B	SE(B)	Beta	95% CI		p	B	SE(B)	Beta	95% CI		p
Hispanic	0.028	0.04	0.009	-0.051	0.106	0.49	-0.027	0.107	-0.006	-0.237	0.183	0.799
Sex (Male)	0.166	0.028	0.068	0.11	0.222	0	0.102	0.06	0.038	-0.015	0.22	0.086
Age	0.108	0.029	0.044	0.052	0.164	0	0.166	0.061	0.061	0.046	0.286	0.007
Family Married	0.014	0.04	0.005	-0.063	0.092	0.719	0.011	0.075	0.004	-0.135	0.158	0.878
Household Income	0.028	0.009	0.044	0.011	0.044	0.001	0.001	0.013	0.002	-0.025	0.027	0.945

Latino White families. Thus, the health returns of investments that exclusively rely on equalizing SES across racial/ethnic groups is smaller than expected [57].

Many structural, social, and behavioral mechanisms may explain these MDRs. We are, however, unaware of any studies that have successfully decomposed the mechanisms and processes that reduce the health returns of SES for racial/ethnic minorities. Poor employment conditions, poor residential conditions, poor schools, which are all related to segregation, may have some role. Due to multilevel discrimination and social stratification, SES generates fewer opportunities for racial/ethnic minorities [24,25]. High SES minority people work in jobs with lower pay and lower occupational prestige than non-Latino Whites [107]. High SES Black families experience higher level of stress and are exposed to high levels of environmental hazards and toxins despite their SES [122]. Due to racial/ethnic segregation in labor market, schools, and neighborhoods, high SES Black families experience high levels of discrimination because their high SES takes them to predominantly White areas [123]. As a result, high SES Black families [24,25] remain at risk of economic insecurity [124], stress [125], neighborhood disorder [126], and low accumulation of wealth [127], a pattern which is in contrast with high SES White families who show lowest levels of risk.

Limitations

This study had a few limitations. Although household income precedes exercise frequency, because this study was a cross-sectional study, our results should not be inferred as causal. These links should be interpreted with caution as associations. This study had many unmeasured confounders. We did not include SES indicators other than household income and parental education. We also did not include racial/ethnic minority groups other than Blacks and Whites. We need to test the same hypotheses for other racial/ethnic groups.

Implications

To eliminate racial/ethnic inequalities in cardiometabolic risk, policies, practices, and programs are needed that go beyond closing the racial/ethnic gap in SES and poverty. While SES equality should be a goal, there is also a need for policies and programs that equalize the individuals' living conditions and reduce the obstacles in the lives of racial/ethnic minority families. Health, economic, social, and public policies are needed to reduce racial/ethnic disparities that do not emerge due to low SES but MDRs. Such disparities may be resistant to our efforts to equalize SES. MDRs operate independently of the average of group differences in SES. Potential contributors to the MDRs are segregation and differential access to healthy options, parks, and green areas that promote health. However, segregation differentially exposes various populations to risk factors such as obesogenic environments [52,128,129]. Acknowledging the role of MDRs as a contributor to racial/ethnic disparities is needed because solutions that address MDRs (lower returns of SES indicators for racial/ethnic minorities) are different from solutions that emphasize the SES gap-closing. Multilevel policies and interventions should address various mechanisms that increase the health returns of SES (undo MDRs) for racial/ethnic minority families. This includes enhancing the built environment and access to healthy food options for middle-class Black communities. Suppose policies exclusively focus on closing the SES gap and ignore the fact that the very same SES may generate more outcomes for the Haves than the Have-Nots; marginalized groups may see less improvement in their health from these SES resources than one might expect due to MDRs, thus we would have failed to fully and efficiently close the health gap. Thus, it is important to go beyond universal intervention and those which focus on access and also guarantee the uptake of the policies and resources by racial/ethnic minority and marginalized populations. To do so, we need to reduce stigma and address structural causes of racial/ethnic health inequalities that operate across the SES and class lines. Otherwise, universal interventions that only increase the average SES of the overall community may increase rather than decrease the existing gap in health.

Conclusion

High household income does not show a similar effect on children's exercise across diverse racial/ethnic groups. Children in high-income Black families have lower than expected physical activity given their SES, a pattern different from children in high-income non-Latino White families who show high exercise. As a result, racial/ethnic disparities in cardiovascular and metabolic conditions may sustain across the full SES spectrum. Given the existing MDRs, racial/ethnic health disparities should not be reduced to the problem of poverty or low SES. While group differences in SES is a major contributor, due to social stratification, structural racism, and marginalization, diminished SES effects are also another reason we see a health paradox in middle-class Black families.

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