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ORIGINAL PAPER

Beyond Race/Ethnicity: Skin Color and Cardiometabolic Health Among Blacks and Hispanics in the United States

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Abstract We investigated whether darker interviewer-ascribed skin color is associated with worse cardiometabolic health among young adult Blacks and Hispanics in the United States. Our sample was comprised of 2,128 non-Hispanic Blacks and 1603 Hispanics aged 24-32, who were in high school in the United States in 1994. We used logistic and OLS regression to predict obesity, hypertension, diabetes, and cardiometabolic risk. We tested the interaction between Hispanic immigrant generation and ascribed skin color. Darker ascribed skin color predicted worse cardiometabolic health among both young adult Blacks and Hispanics. Among Hispanics, the associations were strongest among third and higher generation respondents. Our findings suggest that among US Blacks and Hispanics how individuals are perceived by others via their skin color is significantly associated with their health and well-being. Gradients in cardiometabolic health in young adulthood will likely contribute to gradients in cardiovascular disease and all-cause mortality later in life.

Keywords Race/ethnicity · Skin color/tone · Cardiometabolic health · Hispanic/Latino · Black

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Background

Cardiometabolic health, which refers to a constellation of conditions that are collectively associated with the onset of metabolic syndrome, higher risk of cardiovascular disease, and higher all-cause mortality, has worsened dramatically in the United States since the 1990s [1–4]. Extensive research has revealed key disparities in cardiometabolic health across racial/ethnic groups [3]. Non-Hispanic Blacks (Blacks) and Hispanics, the country's two largest racial/ethnic groups, experience high age-adjusted rates of three important indicators of poor cardiometabolic health—obesity (49.5 and 39.1 %), hypertension (40.4 and 26.1 %), and diabetes (13.2 and 12.8 %) [5–7]. Whites, by contrast, experience lower rates of obesity (34.3 %) and diabetes (7.6 %) than both Blacks and Hispanics, and hypertension (27.4 %) at a rate lower than Blacks, but similar to Hispanics. Although personal lifestyle factors including diet and exercise are important cardiometabolic risk (CMR) factors, medical practitioners and policy makers must also consider structural inequalities and differential stress exposures when addressing racial/ethnic health disparities.

We employ the terms race/ethnicity and racial/ethnic because Hispanics do not fall within US racial categories [8, 9]. Self-reported race/ethnicity, the most common indicator of racial/ethnic disparities used in health research, reflects individuals' shared cultural and ancestral backgrounds, their perceptions of social position, and their beliefs about how others perceive them [10]. Explanations of racial/ethnic health disparities generally emphasize disparities in factors such as socioeconomic status (SES), which affect access to resources such as health care, creating health disparities that widen across the life course [11, 12]. Additionally, racial/ethnic discrimination can incur chronic stress and initiate physiological changes, leading to elevated blood sugar and blood pressure [8, 11, 13, 14].

Racial/ethnic groups are very heterogeneous. How researchers conceptualize and measure race/ethnicity has implications for how we understand and address racial/ethnic inequalities in health [15]. In particular, wide skin color variation exists US Blacks and Hispanics [16, 17]. Despite the frequent treatment of Blacks and Hispanics as homogenous racial/ethnic groups, scholars have found that how Blacks and Hispanics are perceived by others affects their SES, exposure to racial discrimination, and health [18–22]. Skin color represents a salient indicator of the association between appearance and experience among US Blacks and Hispanics. Darker skin color is associated with fewer years of education, lower household income, greater exposure to racist events, and poorer mental health [18–20, 22]. Among Blacks darker skin color is also associated with higher blood pressure and body-mass-index (BMI) [22, 23]. One study conducted among Puerto Ricans found that darker interviewer-ascribed skin color, but not actual skin pigmentation measured with a narrow-band reflectometer, was associated with higher blood pressure [21].

Following Gravlee et al., we argue that externally-ascribed skin color captures a critical aspect of how individuals are perceived by others, which we expect to be associated with physical health [21]. Studies that have measured the association between skin color and one or more aspects of cardiometabolic health, using geographically limited, non-nationally representative samples of US Blacks, have found that darker skin color is associated with higher blood pressure and BMI [23, 24]. Although less is known about the association between skin color and cardiometabolic health among US Hispanics, darker skin color is associated with poorer self-rated health among Hispanics in the United States and four Latin American countries [15, 25].

Our study makes four contributions. First, we expand the research on skin color and health among Blacks by evaluating a wider variety of cardiometabolic health indicators within a nationally representative sample. Second, we provide one of the first assessments of the association between skin color and cardiometabolic health among Hispanics. Third, we identify gradients in CMR by skin color. Fourth, we explore whether the association between skin color and cardiometabolic health varies by immigrant generation among Hispanics—the data did not contain sufficient first/second generation Blacks to conduct similar analyses. Among first and second generation Hispanic immigrants, who interact primarily with co-ethnics, there is evidence that darker skin color may provide a sense of "ethnic legitimacy" [26]. Ayers et al. found that "indigenous appearance" was associated with lower substance abuse among second generation Mexican youth, but higher substance use within the third generation [27]. Thus, we expect that perceived skin color may be a more salient risk factor among later-generation Hispanics.

Methods

Data

We conducted cross-sectional analyses using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health). Add Health used a multistage, stratified sampling design that randomly selected 80 high schools and their feeder schools in different communities across the United States, creating a baseline sample of 20,745. Three follow-up interviews have been administered, most recently in 2008–2009. We used data from Blacks and Hispanics who participated in Waves I (1994–1995), III (2001–2002), and IV (2008–2009). Wave I interviews provided basic demographic information: self-identified race/ethnicity, gender, and immigrant generation; interviewers recorded perceived skin color at Wave III; all other variables, including cardiometabolic health, were measured at Wave IV.

For this analysis, we included those respondents who self-identified as "Black or African American" and did not select Hispanic ethnicity (Blacks) and those respondents who self-identified as ethnically Hispanic regardless of race (Hispanics). The response rates at Waves III and IV were 77 and 80 % respectively. Analysis of non-response at Wave IV revealed little bias on health measures after sample weights were applied [28]. Thus, our results are representative of cardiometabolic health among Black and Hispanic young adults, aged 24–32, who were attending middle or high school in the United States in 1994–1995.

There were 2491 non-Hispanic Blacks and 1913 Hispanics who were interviewed at Waves I, III, and IV with non-missing sampling weights. We excluded 5 % of Blacks who were either first or second generation immigrants. We deleted observations with missing data on cardiometabolic health measures (13 %) and on independent variables (2 %), leaving an analytic sample of 2128 third-generation non-Hispanic Blacks and 1603 Hispanics. Table 1 summarizes our variables among Blacks and Hispanics.

Measures

Cardiometabolic Health Measures

At Wave IV, trained interviewers collected anthropometric measures, cardiovascular indicators, and glucose homeostasis. We included three clinical indicators of cardiometabolic health—obesity, hypertension, and diabetes. We identified

Table 1 Summary statistics among Blacks and Hispanics in the analytic sample: Add Health, 2008

	Third-generation Blacks (N = 2128) Mean/% (SE)	Hispanics (N = 1603) Mean/% (SE)
Health measures		
Mean BMI (kg/m^2)	30.94 (0.19)	29.98 (0.18)
% Obese (BMI ≥ 30)	46.62 (1.11)	41.70 (1.23)
Mean systolic blood pressure	126.72 (0.33)	124.45 (0.35)
% Hypertensive[a]	29.72 (1.02)	24.86 (1.08)
Mean blood sugar (HbA1c)[b]	6.00 (0.03)	5.67 (0.02)
% Diabetic	15.87 (0.81)	8.96 (0.71)
Mean CMR[c]	0.07 (0.02)	0.03 (0.02)
Skin color		
% White	0.41 (0.14)	42.02 (1.23)
% Light brown	10.61 (0.69)	41.53 (1.23)
% Medium brown	31.33 (1.03)	13.12 (0.84)
% Dark brown	30.02 (1.02)	2.76 (0.41)
% Black	27.62 (1.00)	0.57 (0.19)
Discrimination and SES		
% Experienced discrimination	31.39 (1.03)	25.38 (1.09)
% Graduated college	21.28 (0.91)	20.82 (1.01)
Mean household income (10,000s)	4.42 (0.08)	6.30 (0.09)
% Experienced economic hardship	37.51 (1.08)	23.84 (1.06)
Demographic controls		
Mean age	29.16 (0.04)	29.00 (0.05)
% 1st/2nd generation immigrant	–	62.05 (1.21)
% Female	53.58 (1.11)	48.73 (1.25)
% Married/cohabitating	50.52 (1.11)	64.56 (1.20)
% Has health insurance	73.57 (0.98)	78.49 (1.03)
% Urban	65.34 (1.06)	85.27 (0.89)
% US West	5.92 (0.53)	13.54 (0.85)
% US Midwest	19.83 (0.89)	9.01 (0.72)
% US South	69.32 (1.03)	42.06 (1.23)
% US Northeast	4.92 (0.48)	35.39 (1.19)

The Estimates were weighted and standard errors were adjusted for survey design. The Black sample was restricted to third-generation U.S. natives

[a]SBP ≥ 140, DBP ≥ 90, previously diagnosed hypertensive, or taking hypertension medications

[b]HbA1c ≥ 6.4, previously diagnosed diabetic, or taking diabetes medications

[c]CMR was calculated using principal components analysis of BMI, systolic blood pressure, and blood sugar (HbA1c)

respondents with a BMI (kg/m^2) of 30 or higher as obese. We identified all individuals with systolic blood pressure of at least 140, diastolic blood pressure of at least 90, a previous hypertension diagnosis, or prescribed blood pressure medication as hypertensive. We identified diabetes based on a continuous measure of HbA1c (blood sugar) that was derived using dried capillary whole blood spots. We categorized respondents with blood sugar greater than 6.4, those who reported a prior diagnosis, and those currently taking diabetes medications as diabetic.

We used principal components analysis (PCA) to create a composite measure of CMR based on three continuous indicators of cardiometabolic risk—BMI, systolic blood pressure, and blood sugar. PCA weights the different measures to capture the greatest possible proportion of variation in disease risk [29]. The composite variable had an eigenvalue of 1.3 and explained 44 % of the variance across the three measures. Because the PCA did not incorporate prescribed medications or prior diagnoses, it reflects gradients in uncontrolled CMR, unlike the clinical indicators described above. Assessing gradients in risk within a population of young adults provides a forecast of future disparities, which can inform targeted interventions. We standardized composite CMR with a mean of zero and a standard deviation of one. Thus, a value below zero indicates below average CMR, while a value above zero indicates above average CMR.

Skin Color

At Wave III, interviewers ascribed respondents' skin colors on a five-point scale: black, dark-brown, medium-brown, light-brown, white. Interviewers were mostly non-Hispanic White (71 %) or non-Hispanic Black (21 %) and college educated (91 %). Only 5 % were Hispanic. The results were substantively unchanged when we included an interviewer fixed effect (available upon request). Like other studies that use similar measures, we treat skin color as a categorical variable [16, 18]. Even in studies that utilize melatonin or color palettes to measure skin color continuously, researchers often group values into nominal categories that accord with societally ascribed racial/ethnic profiles [21, 25].

We observed substantial variation in skin color among both Blacks and Hispanics (Table 1). Among Blacks, interviewers ascribed a white or light-brown skin color to 11 % of respondents and a black skin color to 28 % of respondents, with the remainder in the middle. Among Hispanics, interviewers ascribed 42 % white, 42 % light-brown, and 17 % medium-brown to black. Because there were relatively few Blacks (0.48 %) who interviewers reported as having a "white" skin color, we combined the white and light-brown skin colors among Blacks. Similarly, we combined Hispanic respondents who were ascribed black or dark-brown skin-colors (3 %) with those who were classified as medium-brown.

Discrimination and SES

Because others have found that exposure to racial discrimination and access to resources vary by skin color, we adjusted for these factors in our regression models. We adjusted for perceived discrimination using the following item: "In your

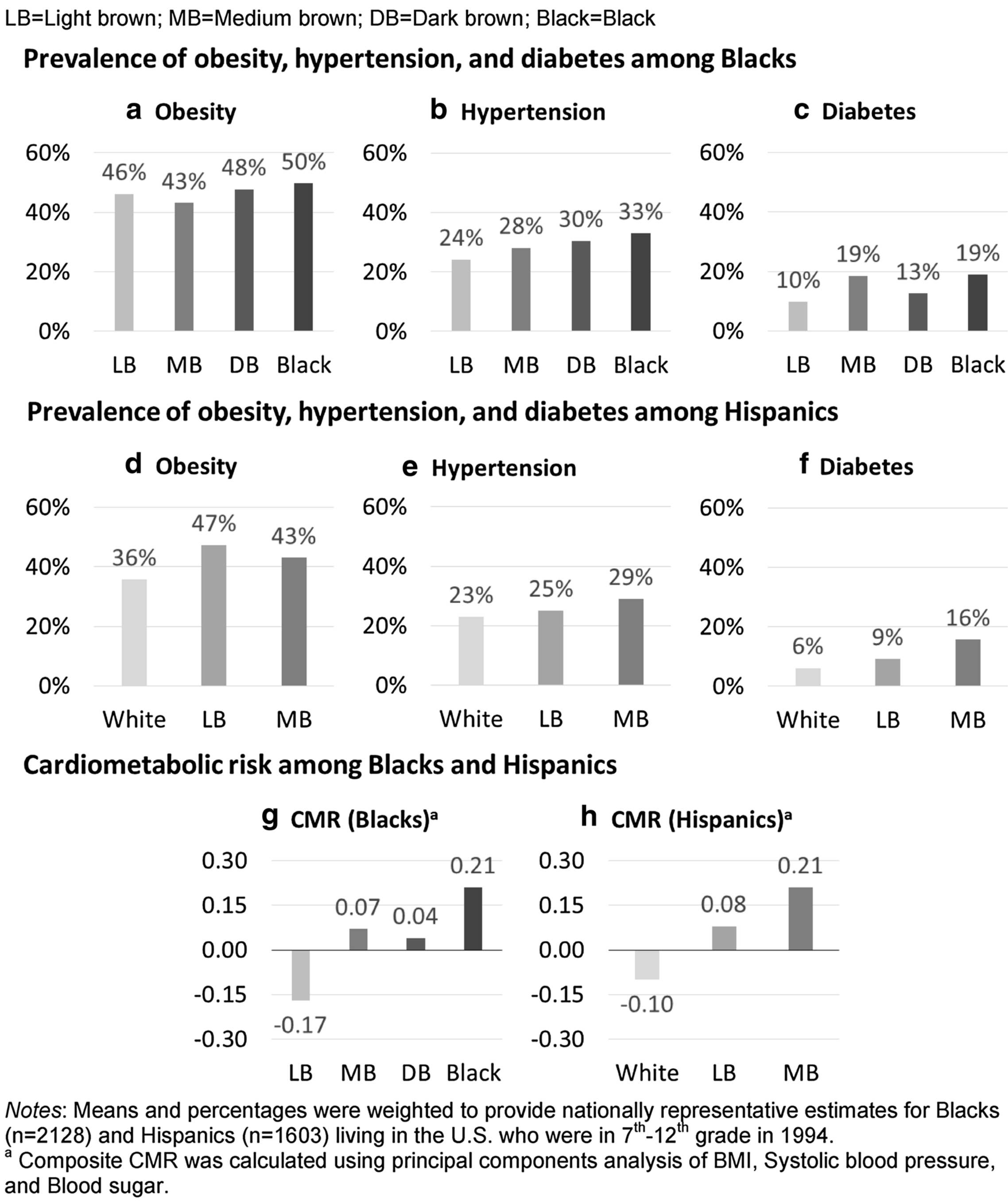

Fig. 1 Prevalence of obesity, hypertension, diabetes, and composite CMR among young adult Blacks and Hispanics (aged 24–32) living in the US: Add Health, 2008. *LB* light brown, *MB* medium brown, *DB* dark brown, *Black* Black. Means and percentages were weighted to provide nationally representative estimates for Blacks. (n = 2128) and Hispanics (n = 1603) living in the U.S. who were in 7th–12th grade in 1994. *a* Composite CMR was calculated using principal components analysis of BMI, systolic blood pressure, and blood sugar

day-to-day life, how often do you feel you have been treated with less respect or courtesy than other people: never, rarely, sometimes, or often?" We coded respondents who reported sometimes or often as having experienced discrimination. Add Health does not include a multi-item discrimination scale [30]. Thus, we may not fully capture the prevalence of discrimination experiences in our sample.

We adjusted for three aspects of SES—educational attainment (college graduation), annual household income (reported on a 12-point scale from $5000 to $150,000), and economic hardship. Respondents indicated if at any time during the previous 12-months they were: without phone service, unable to pay rent, evicted, unable to pay utilities, lost access to utilities, and/or worried about food shortage.

Table 2 Results from OLS and logistic regressions on obese, hypertensive, diabetic, and CMR among third-generation US-born Blacks aged 24–32: Add Health, 2008 (n = 2128)

	Obese[a]		Hypertensive[a]		Diabetic[a]		CMR[a]	
	OR	(95 % CI)	OR	(95 % CI)	OR	(95 % CI)	Beta	(95 % CI)
Light brown (ref)	1.00	–	1.00	–	1.00	–	0.00	–
Medium brown	1.03	(0.59 1.79)	1.17	(0.74 1.85)	2.05	(1.13 3.73)	0.25	(0.07 0.43)
Dark brown	1.30	(0.79 2.13)	1.30	(0.79 2.13)	1.36	(0.88 2.10)	0.22	(0.06 0.38)
Black	1.65	(1.04 2.64)	1.45	(0.86 2.45)	2.23	(1.24 4.00)	0.39	(0.21 0.58)

All models were weighted and standard errors were adjusted for sampling design. The sample was restricted to third-generation U.S. natives

[a]Model adjusted for perceived discrimination, college attainment, household income, and economic hardship, as well as age, gender, married or cohabitating, urban location, U.S. region, health insurance coverage, and 1st/2nd generation immigrant. Data was imputed on income for 169 respondents

Consistent with prior studies, we coded respondents who experienced at least one aspect of hardship as experiencing economic hardship [31].

Demographic Factors

All regressions controlled for gender, age, married or cohabiting, urban residence, US region (West, Midwest, South, or West), and health insurance coverage. We defined immigrant generation: first-generation (born outside the United States), second-generation (at least one parent born outside the United States), and third-generation (both parents born in the United States). Because Hispanics' ethnic origin is associated with health and varies by skin color, we adjusted for ethnic origin among Hispanics: Mexican, Cuban, Central-South American, Puerto Rican, other.

Analytic Approach

We first present weighted bivariate bar graphs of the associations between skin color and our cardiometabolic measures separately for Blacks and Hispanics (Fig. 1). We next assess the statistical association between skin color and cardiometabolic health among Blacks (Table 2) and Hispanics (Table 3) using ordinary-least-squares regression for CMR and logistic regression for obese, hypertensive, and diabetic. All the regression models were adjusted for demographic characteristics, perceived discrimination, and SES. Results (not shown) revealed no substantive differences between unadjusted models and those presented.

To assess whether immigrant generation modifies the association between skin color and cardiometabolic health, we included an interaction term between native born (third-generation-plus) and skin color among Hispanics. We computed the full effect of skin color among first/second generation and third and higher generation Hispanics and present these results in Table 3. We used Wald tests to assess the interaction coefficients' joint significance.

All regressions were weighted and standard errors were adjusted for Add Health's complex design [32]. We imputed missing income values for 9 % of cases using chained equations.

Results

Skin Color and Cardiometabolic Health

We observed gradients in cardiometabolic health by skin color among Blacks and Hispanics. Among Blacks, the prevalence of each clinical outcome was greatest for those ascribed black skin color (Fig. 1a–c). The percent obese and the percent diabetic both increased with darker ascribed

Table 3 Results from OLS and logistic regressions on obese, hypertensive, diabetic, and CMR among US Hispanics aged 24-32 by nativity: Add Health, 2008 (n=1603)

	Obese[a]		Hypertensive[a]		Diabetic[a]		CMR[a]	
	OR	(95 % CI)	OR	(95 % CI)	OR	(95 % CI)	Beta	(95 % CI)
First/second generation[b]								
White (ref)	1.00	–	1.00	–	1.00	–	0.00	–
Light brown	1.30	(0.88 1.92)	0.87	(0.52 1.45)	1.35	(0.55 3.32)	0.06	(−0.11 0.24)
Medium brown	1.00	(0.67 1.50)	0.88	(0.53 1.47)	2.03	(0.80 5.15)	−0.11	(−0.26 0.05)
Third generation[c]								
White	0.66	(0.41 1.06)	0.91	(0.53 1.56)	0.49	(0.21 1.16)	−0.21	(−0.37 −0.04)
Light brown	2.08	(1.16 3.72)	1.78	(0.95 3.31)	1.92	(0.62 5.98)	0.33	(0.11 0.55)
Medium brown	2.32	(1.03 5.21)	1.89	(0.86 4.16)	4.62	(1.73 12.36)	0.74	(0.16 1.31)
Wald test (p)[d]	1.81	(0.17)	2.31	(0.10)	0.86	(0.42)	4.02	(0.02)

All models were weighted and standard errors were adjusted for sampling design

[a] Model adjusted for perceived discrimination, college attainment, household income, and economic hardship, as well as age, gender, married or cohabitating, urban location, U.S. region, health insurance coverage, and 1st/2nd generation immigrant. Data was imputed on income for 97 respondents. All models include the interaction term color*third-plus generation

[b] First/second generation reports the coefficients on skin color in the interacted model

[c] Third generation coefficients were calculated by combining the interaction coefficient color*nativity with the coefficient on color and the coefficient on nativity to measure the fully effect of color among native-born Hispanic young adults

[d] Wald tests report the joint significance of the interaction terms: light brown*third-generation and medium brown*third-generation. *P*-values for Wald tests are reported in the parentheses

skin color, but they exhibited non-linear trends. Among Hispanics, we observed linear increases associated with darker skin color for hypertension and diabetes, but not obesity (Fig. 1d–f).

We observed strong gradients in CMR among Blacks (Fig. 1g) and Hispanics (Fig. 1h). Within both groups, CMR increased among those ascribed darker skin colors.

Regression Results Among Blacks

We found that among young adult Blacks (Table 2), darker skin color was significantly associated with the risk of obesity and diabetes, but not hypertension.

After adjustment for demographic characteristics, perceived discrimination, and SES, ascribed black skin color was associated with an increase in CMR of 0.39 standard deviations (95% CI 0.21–0.58) relative to respondents ascribed light-brown or white skin color. The robust linear increase in CMR, which drew upon related, but not identical, measures of cardiometabolic health, suggests that incorporating multiple aspects of disease risk, may provide a stronger indication of overall cardiometabolic health risk than testing multiple outcomes separately. Similar measures may provide important insights to researchers and policymakers interested in long-term health risk within younger populations.

Regression Results Among Hispanics

Among young adult Hispanics (Table 3), darker ascribed skin color was significantly associated with greater risk of obesity and diabetes and greater CMR among third or higher generation respondents. At the same time, among third and higher generation respondents, white ascribed skin color had a significant protective effect on CMR (−0.21). By contrast, skin color was not significantly associated with cardiometabolic health or CMR among first and second generation Hispanics.

We found mixed evidence in support of the hypothesized interaction between skin color and immigrant generation among Hispanics. In our regressions for obesity, hypertension, and diabetes, the interactions effects were not jointly significant. However, all of the odds ratios for the interaction effects were in the expected direction. Moreover, the results revealed a robust interaction between ascribed skin color and nativity as they relate to CMR ($p < 0.05$).

We also estimated separate models (not shown) among first and second generation and the third and higher generation Hispanic young adults. Among first and second generation Hispanic respondents, ascribed skin color was not significantly associated with any of our outcomes and the direction of the coefficients varied. In contrast, among third and higher generation Hispanics, darker ascribed skin color was strongly and significantly associated with poorer cardiometabolic health for all of our outcome measures.

Discussion and Conclusion

We assessed the association between interviewer-ascribed skin color and three clinically defined indicators of cardiometabolic health—obesity, hypertension, and diabetes. Skin color was positively associated with these three outcomes, but the size and robustness of the associations varied across the three measures. Our nationally representative results are consistent with research on skin color and health, which has found gradients in hypertension and BMI among Blacks in geographically limited samples [23, 24]. Ours was the first study to incorporate diabetes, an important indicator of cardiometabolic syndrome. Among both Blacks and Hispanics, we found the strongest associations between ascribed skin color and diabetes risk. Diabetes is an essential consideration in studies of cardiometabolic health as cardiometabolic syndrome with diabetes is associated with higher all-cause mortality, relative to cardiometabolic syndrome without diabetes [4].

Exposure to stress and racial discrimination associated with darker perceived skin color, as well as economic insecurity, which is highest among darker skinned Blacks and Hispanics, may contribute to the elevated diabetes risk. In response to perceived threats and stressors, the brain activates the sympathetic nervous system (SNS) and the hypothalamic–pituitary–adrenal axis (HPA axis) [33, 34]. The SNS triggers the release of glucose and fats for immediate energy. The HPA axis releases the stress hormone cortisol, which also increases glucose and inhibits insulin production. Thus, frequent stress and perceived threat due to skin color among darker skinned Blacks and Hispanics may create a glucose-insulin imbalance, leading to poorer cardiometabolic health.

Additionally, we demonstrated that using a composite indicator to capture variance across related, but not identical, indicators of cardiometabolic health, provides an important indication of the association between how individuals are perceived by others and their cardiometabolic risk. Unlike our clinical measures, which incorporated doctors' diagnoses and prescriptions, our risk indicator captures uncontrolled CMR. We found a strong and linear association between darker ascribed skin color and greater CMR among third and higher generation Blacks and Hispanics. In contrast, we found no association between ascribed skin color and CMR among first and second generation Hispanics. These findings suggest that how individuals are perceived by others has significant implications for their cardiometabolic health.

We also found that the association between skin color and cardiometabolic health is modified by immigrant generation among Hispanics. Consistent with prior research on substance use across Mexican immigrant generations [27], we found that the association between darker ascribed skin color and cardiometabolic health was significantly stronger among later-generation Hispanic immigrants. These findings suggest that greater "ethnic legitimacy," which is associated with darker skin color among first and second generation Hispanics, might buffer newer Hispanic immigrants against the consequences associated with darker ascribed skin color that are prevalent among third and higher generation Hispanics [17].

Though this investigation advances our understanding of disparities in cardiometabolic health among Blacks and Hispanics, it also highlights the need for further investigation in several areas. First, because Add Health only measured cardiometabolic health at a single point in time, we were unable to assess the association between ascribed skin color and change in cardiometabolic health across the life course. Second, although our measure provided a strong indicator of how individuals are perceived by others, it did not provide the same precision or flexibility as more complex color scales, such as that designed by Telles and Steele [35]. Third, while researchers recommend multi-item measures of perceived discrimination, the best available indicator was a single question measuring perceived discriminatory treatment [30]. A more robust indicator may have revealed greater attenuation in the association between ascribed skin color and cardiometabolic health. It is our hope that these important findings will stimulate further analysis of ascribed skin color and other factors that may affect cardiometabolic health among Blacks and Hispanics to better understand disparities in health within these large and heterogeneous racial/ethnic groups.

This study has provided an important contribution to the examination of health disparities among Blacks and the first analysis (to our knowledge) of the association between ascribed skin color and objectively measured physical health among Hispanics. We found significant gradients in cardiometabolic health by skin color among Blacks and Hispanics. These results support more widespread measurement of ascribed skin color and other aspects of how individuals are perceived by others, as scholars, policymakers, and medical practitioners move beyond race/ethnicity to better understand and address health disparities in the United States.

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