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Kendall Pollard March 25th, 2024

Weighing Inequality: A Comprehensive Analysis of Racial and Gender Disparities in Childhood Overweight and Obesity from 2003 to 2019

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Abstract

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Addressing adolescent obesity and overweight in the United States is a critical public health concern, exacerbated by significant racial and gender disparities that impose disproportionate burdens on affected groups. Self-perception of weight may influence one's actual weight, and seeing how this perception and children's actual weight has been changing over time is important to understand these racial and gender gaps and their roots. This study investigates the dynamics of gender and racial differentials in both actual weight status and self-perception of weight over the time period from 2003 to 2019. Raw data analyses prove that boys are more obese than girls in every year, and Blacks are more obese than Whites. Regression analyses conclude that Black girls are more likely to be obese than Black boys, and girls in general are always more likely to perceive themselves as slightly/very overweight than boys. Black girls are also more likely to report being slightly/very overweight more than Black boys, controlling for actual weight status. Over time, all groups are becoming more overweight/obese, with the gender gap narrowing for Whites and the Black-White gap narrowing for girls. These findings impose a double burden on Black girls, both in terms of actual weight and misperception of weight. There is a great need for public health interventions to rectify these disparities, perhaps focusing on social media's influence on self-perception of weight, and in turn actual weight.

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Contents

Weighing Inequality: A Comprehensive Analysis of Racial and Gender Disparities in Childhood Overweight and Obesity from 2003 to 2019

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March 2024

1 Introduction

Obesity and overweight among adolescents in the United States have become pressing public health concerns, with far-reaching implications for the well-being of individuals and society at large. The prevalence of obesity among children ages 2-19 from pre-pandemic data from the CDC is 19.7% (Bryan et al., 2021). Beyond the immediate health implications, research suggests that the impact of obesity and overweight in childhood disproportionately affects marginalized communities (Hernandez and Pressler, 2014; Inyang A. Isong et al., 2018; Kimm et al., 1996; Ruopeng An and An, 2017).

Racial and ethnic disparities in obesity rates also exist for adults, and the roots of these disparities often take hold during adolescence. The CDC has reported that there are racial disparities in childhood obesity, where 24.8% of Black children are obese, and 16.6% of White

children are obese (Bryan et al., 2021). According to the CDC, in most race groups, boys are more likely to be obese. Non-Hispanic White boys, non-Hispanic Asian boys, Hispanic boys, and Mexican American boys are all more obese than their female counterparts, usually by around 5 percentage points (Bryan et al., 2021). For Black children, this gradient is reversed, and it is revered to the degree of 10 percentage points, where Black girls are almost 15 percentage points more likely to be obese than Black boys (Bryan et al., 2021). The Black gender gap burdens girls instead of boys, and their difference is much higher than any other gender gradient in other groups. These statistics exclude overweight, which also has implications on health as it can lead to obesity.

Race is often correlated with factors such as socio-economic status, healthcare access, and environmental conditions, and these correlations can significantly influence health outcomes, leading to reduced quality of life, increased illness, and other adverse effects for specific demographic groups. This paper seeks to analyze the historical evolution of overweight and obesity and trends among different racial and gender groups, particularly focusing on the disparities highlighted by the CDC. By examining longitudinal data spanning the past two decades, I aim to uncover whether the observed gaps in obesity rates between Black boys and girls, compared to the same gap for Whites, have widened or shrunk over time.

Additionally, my study aims to explore how self perception of weight may be changing over time, especially concerning Black girls. The perception of one's weight during adolescence plays a role in shaping health-related behaviors. Adolescents' self-perceived weight status is linked to the dietary choices, physical activity levels, and overall health-seeking behaviors that emerge within the contexts of their environments (Arlene E. Chung et al., 2013; Dues et al., 2020; Teresia Mbogori et al., 2019). The impact of these behaviors is shaped not solely by individual choices, but by the complex interplay of societal, familial, and environmental factors that surround them.

This thesis will explore the evolving landscape of adolescent overweight and obesity in the United States, exploring the connections between racial disparities, health outcomes,

and the interplay between actual and perceived weight status. This paper is asking: Are there significant racial disparities in childhood overweight and obesity status, as well as self-perception of one's weight, as revealed by data from the Youth Risk Behavior Surveillance System (YRBSS)? And how have these outcomes been evolving from 2003 to 2019?

2 Literature Review

2.1 Racial Disparities in Adolescent Obesity

Several studies to date have documented persistent racial disparities in weight outcomes. Researchers identified a positive correlation between community poverty, single parenthood, family poverty, racial minority groups, and obesity/overweight, emphasizing the significance of socioeconomic factors in this context (Ruopeng An and An, 2017). Nuha Mahmood et al. (2022) highlighted significant disparities in overweight/obesity prevalence across racial groups, where White children had an overall 28% prevalence of obesity, whereas Black children had 42%. Hussam Al Hennawi et al. (2023)'s findings using the CDC WONDER database, which revealed an alarming number of obesity-related deaths, particularly observing substantial changes in mortality rates among non-Hispanic Black/African American individuals at an age-adjusted mortality rate of 4.4, when the average across all races was 2.7. Due to the higher rate of death in Blacks compared to other race groups, it is important to address the impact of obesity on various racial groups from an early age to narrow these gaps in health outcomes. Wang et al. (2007) underscored substantial racial/ethnic differences in obesity prevalence from the early 2000s, particularly among women. Non-Hispanic Black women exhibited higher obesity rates compared to White women, emphasizing longstanding disparities that could potentially influence current trends. Collectively, these studies highlight the persistent and concerning pattern of racial disparities in adolescent and adulthood obesity and overweight prevalence, stressing the urgent need for targeted interventions and

policies addressing the socioeconomic, racial, and ethnic factors contributing to these disparities in health outcomes. Building on these findings, this paper focuses on racial disparities in terms of gender, and how perception of one's weight also has been changing over time.

2.2 Black Women and Girls

Less literature exists about Black women and girls, but there are efforts of research on the topic. One study showcased that racial minorities, particularly Blacks, often encounter more stressors, leading to poorer mental health (Jason D. Boardman and Alexander, 2011). Meghan Tipre and Carson (2022) focused on stressors among Black women, revealing concerns about child safety, raising Black children, family leadership, and finances as significant stress factors. These stressors can cause obesity or overweight outcomes through mechanisms such as unhealthy coping strategies through food, disrupted sleep patterns, limited access to nutritious food, and insufficient time for physical activity. Stressors faced by Black mothers might influence their children's health, so understanding early obesity in Black girls is crucial due to its potential long-term impact.

Exploration of factors related to obesity identified disparities in Black adolescent girls, which correlated with lower physical activity, fewer eating occasions, and dissatisfaction with weight (Megan R. Winkler et al., 2017). However, uncertainties remain regarding temporal changes for obesity and overweight in Black girls and how perception of their weight may contribute to adverse health outcomes among Black girls. The limited exploration of these factors complicates understanding the precise reasons for this disparity, emphasizing the need for more evidence to confirm and comprehend the disproportionate risk of obesity among Black girls. The largest gap in the literature pertains to the specific disparities that may exist between Black girls and Black boys in comparison to the White population.

2.3 Perception of Weight

Various studies address how one's perception of their weight is influenced by culture, social norms, parental guidance, and exposure to social media. Scholars like Ignacio Jáuregui-Lobera et al. (2018), Kristen M. Lucibello et al. (2021), and Tobia Darimont et al. (2020) examine the connections between weight perception, self-image, and outcomes such as depression, self-conscious emotions, and specific weight control behaviors. Socio-economic status and food scarcity further mold self-perception, evident in studies highlighting preferences for overweight bodies among women in food-scarce environment (Jonathan N. Maupin et al., 2021). Research by Ganga Mahat et al. (2020) using Add Health data reveals that participants' self-perception significantly influences physical activities. Another study indicates that adolescents who misperceived their weight were less likely to participate in healthy dietary behaviors (Dues et al., 2020).

Alicia Carter et al. (2021)'s results suggest that perceived body weight is more influential than actual body weight in predicting body weight shame. Further proving that self-perception is influenced by gender, Youngshin Song et al. (2020)'s research shows that age, income, perceived health status, and health behaviors are significantly associated with distorted body weight perception in middle-aged men, while psychological factors play a role in distorted body weight perception in middle-aged women. NHANES data underscores the link between misperceived body weight and sedentary behavior among overweight and obese Black women (Adeyemi Okunogbe et al., 2022). The collective findings underscore the necessity for targeted interventions to improve accurate weight perception and encourage positive health behaviors in specific demographic groups. This paper contributes to the field by exploring the evolving trends in weight perception over time and comparing them with actual weight status, with a particular emphasis on at-risk Black girls who may be prone to obesity or overweight.

3 Data

3.1 Youth Risk Behavior Surveillance System

The Youth Risk Behavior Surveillance System (YRBSS) is a research instrument conducted by the Centers for Disease Control and Prevention (CDC) to gather comprehensive data on various health-related behaviors and risk factors among American adolescents. This nationally representative survey collects information on a wide range of variables, including but not limited to physical activity, dietary habits, tobacco use, alcohol consumption, substance abuse, sexual behaviors, and mental health (Centers for Disease Control and Prevention).

The YRBSS is a cross-sectional paper survey distributed by teachers and completed by participating students in their classrooms. This survey is based on a multi-stage cluster design that uses participating schools (public and private) to represent the non-institutionalized, adolescent population. The sampling frame for this survey is participating schools within the US and District of Columbia. The sampling units are individual students participating in the survey within each school. The YRBSS population consists of representative samples of students typically in grades 9–12. Each year, there are around 15,000 questionnaires completed for around 150 schools (these numbers fluctuate every year). Almost all 50 states participate, with some exclusions every year - frequently Washington, Oregon, Wyoming, and Minnesota.

This paper uses the YRBSS as the main source of data, specifically focusing on sex, race, overweight/obesity, and self-perception of weight. The years of focus for this paper are 2003 to 2019, excluding COVID-19 pandemic data.

3.2 Variable Construction

In total from 2003-2019, 113,181 questionnaires were completed across all states. Missing values in any or more of the variables mentioned were dropped. The resulting total number of questionnaires for this study comprised a total of 90,218 participants from 2003-2019.

The gender variable comes from Question 2 (Q2) on the survey that states, "What is your sex?" and participants choose A. Female or B. Male. The Q2 (sex) variable was mapped as boy = 1 and girl = 0 for this paper. In this study, the gender distribution revealed 49.3% boys and 50.7% girls.

The race variable comes from Question 5 (Q5) for years 2007-2019 which asks "What is your race? (Select one or more responses.)" and participants select A. American Indian or Alaska Native, B. Asian, C. Black or African American, D. Native Hawaiian or Other Pacific Islander or E. White. The Q5 (race) variable was cleaned to include only participants that selected C (Black) or E (White) at all. Since the focus of this paper is on the Black-White health gap, I removed children of other races. This means that if they selected C, E, or C or E with any combination of another race, they were kept in the dataset. If they were mixed race White, they were labeled White. If they were mixed race Black, they were labeled Black. If they were mixed race White and Black, they were labeled Black. Black was =1 and White = 0.

Q4 in 2007-2019 asked about ethnicity, but in 2003 and 2005, the "race" variable was called Q4. In 2003 and 2005, Q4 was reduced to combining race and ethnicity and therefore some Black or White students may be lost if they are mixed race. It is impossible to differentiate what races are involved in the two answer choices that are "mixed," and therefore they were dropped. Q4 in 2003 and 2005 asks: How do you describe yourself? 1 American Indian or Alaska Native 2 Asian, 3 Black or African American, 4 Hispanic or Latino, 5 Native Hawaiian or Other Pacific Islander, 6 White, 7 Multiple - Hispanic, 8 Multiple - Non-Hispanic. Because there was no ethnicity designation in 2003 or 2005, ethnicity had to be dropped as a variable

for the first set of regressions before robustness checks. After cleaning, all the years use the label of "Q5" as the race variable and the White and Black designations are set the same way as described above for all years including 2003 and 2005. Among the answers to the race questions, 29.7% identified as Black, while 70.2% identified as White. Specifically, 14.3% were Black boys and 15.4% were Black girls, while 34.9% were White boys and 35.3% were White girls.

The obesity and overweight variables are calculated using other variables in the dataset. Age (Q1), Sex (Q2), and BMI are used to determine Overweight (QNOWT) and Obese (QNOBESE). The student is considered overweight, and QNOWT is set to "1", when BMI percentile is at or above the 85th percentile and below the 95th percentile for BMI by age and sex. The student is considered obese, and QNOBESE is set to "1", when BMI percentile is at or above the 95th percentile for BMI by age and sex. Exclusion criteria included students who were above the age of 17 and reported a BMI of below 12 or above 55, as these indicate extreme underweight, morbid obesity, or a respondent or coding error. The QNOBESE and QNOWT variables were combined into one binary variable, binary_weight, with a value 1 for being obese or overweight and 0 otherwise. 26,428 participants, constituting 29.3%, were categorized as overweight or obese.

This study also uses perception of one's weight as another outcome variable. The YRBSS asked "How do you perceive your weight?" and the answer choices are "very underweight," "slightly underweight," "about the right weight," "slightly overweight," or "very overweight." This variable, "perception_weight" was used to generate a binary variable with a value 1 for slightly/very overweight and 0 otherwise. 25,513 participants, or 28.7% perceive themselves to be slightly/very overweight.

The other variables to control for fixed effects are Grade (Q3) and Year. Q3 asked participants what grade they are in on the survey. This paper's regression label's all grades as dummy variables for Grade 9th, Grade 10th, 11th, and 12th, with 9th as the reference group. The years include every other year from 2003-2019, with 2003 as the reference year.

In robustness checks, Q4 was asked in the survey as Are you Hispanic or Latino? 1. Yes and 2. No. In this paper, Hispanic was labeled as 1 and non-Hispanic was labeled as 0. Ethnicity controls for mixed race interference and the fact that 2003 and 2005 combined race and ethnicity as one question. In robustness checks, 2003 and 2005 were excluded. All of this cleaning mentioned above took place in Python.

3.3 Data Limitations

A limitation of the data is the exclusion of state and geographic location as a control. Because the primary focus of the YRBSS is to gather information at the national level, data is not available publicly at a state level. State-level factors, such as variations in healthcare access, local policies, socioeconomic conditions, and cultural norms, can play a substantial role in shaping health outcomes. By omitting state as a control, the analysis may fail to account for the influence of these regional factors, potentially leading to omitted variable bias and an incomplete understanding of the disparities. Despite the challenge of not including state as a control variable in the regression analysis, the study can still provide valuable insights into racial disparities in childhood overweight and obesity.

Another data constraint is the omission of ethnicity as a variable either as a control or a contribution to overweight and obesity rates. Because 2003 and 2005 combined race and ethnicity into one question, I had to drop ethnicity and return to it in robustness checks, running regressions excluding 2003 and 2005. Finally, another data limitation is due to the COVID-19 pandemic. In light of the unprecedented challenges introduced by the COVID-19 pandemic, I have made the decision to exclude data from the post-2019 period in this study. The disruptions caused by the pandemic have significantly impacted data collection processes, health behaviors, healthcare services, and economic stability, introducing complexities that may compromise the reliability and comparability of the data. Therefore, the study includes only years 2003 to 2019.

4 Methodology

Using Ordinary Least Squares (OLS) regression and packages in Python, I assessed the association between race as well as gender and overweight and obesity status. I used the same equations to establish similar relationships with gender and race and self- perception of weight. To establish pooled relationships among variables for all the years combined, Python packages combined all the data from each year into one dataset and three regressions were run on the data for all years combined.

For the understanding of the Boy variable and the relationship between gender and overweight/obesity and perception of weight, the first regression is:

$$Y_{it} = \alpha + \beta_1 \text{Boy}_{it} + \theta X_i + \epsilon_{it} \tag{1}$$

where Y_{it} is overweight/obesity rates for the first set of regressions and self-perception of being slightly/very overweight for the second set, and β_1, the gender gap. Control variables include grade fixed effects, as when children are growing, obesity becomes difficult to define in terms of different age groups, and year fixed effects to control for variation across years with 2003 being the reference year. This equation sought to determine the average gender differential between boys and girls.

The next regression found the gender differential conditional on race and the racial differential between Whites and Blacks. The equation was:

$$Y_{it} = \alpha + \beta_1 \text{Boy}_{it} + \beta_2 \text{Black}_{it} + \theta X_i + \epsilon_{it} \tag{2}$$

where β_2 is the Black-White gap conditional on gender. This equation uses the same set of controls.

The last regression determines the race-gender interaction. The controls remain the same.

$$Y_{it} = \alpha + \beta_1 \text{Boy}_{it} + \beta_2 \text{Black}_{it} + \beta_3 \text{Boy*Race}_{it} + \theta X_i + \epsilon_{it} \tag{3}$$

where Y_{it} is overweight/obesity rates, or self-perception of being slightly/very overweight, β_1, the gender gap for Whites, β_2, the Black-White gap for girls, and β_3 is the additional obesity penalty for Black boys. These coefficients are inclusive of the entire group of years.

Next, using the equation above, the combined dataset was used to filter each year and run its own regression on each individual year. Because these are year-specific data, the year fixed effects were removed.

To account for potential heteroskedasticity in the dataset, I calculated heteroskedasticity-robust standard errors using the HC3 (Heteroskedasticity-Consistent Covariance matrix estimator 3) method.

5 Results

5.1 Raw Data Analysis

Figure 1 presents averages of overweight and obesity status by year and gender group.

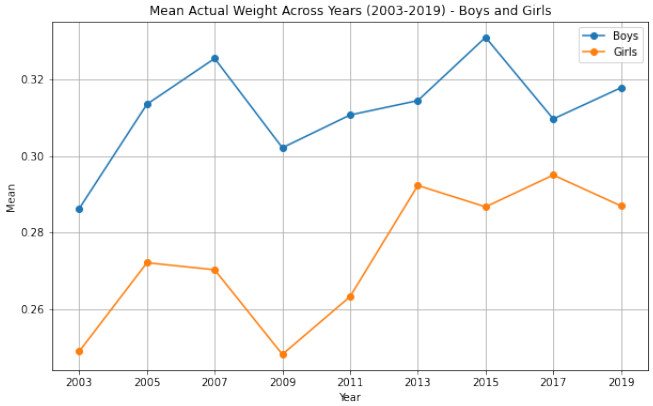

Figure 1: Mean Actual Weight by Gender from 2003 to 2019

Across all years, boys are more likely to be overweight or obese. In 2003 the average rate was around 29%, and in 2015, it increased to about 33.5%. In 2019, it dropped to 32%. These fluctuations are small, so on average boys stayed about the same throughout all years. Compared boys to girls, girls are always less likely to be overweight or obese. In 2003, the average rate for girls was around 24%, which is about 5 percentage points less than the average for boys. In 2015, the average rate for girls increased to 29%, closing the gender gap to about 2 percentage points less than boys. In 2019, the gender gap increases again to about about 3 percentage points, with girls' average at 29%. Overall, both genders are getting more overweight/obese on average. The gender gap seems to be shrinking in more recent years, however, more years of data after 2019 need to be considered to see if the closure of the gap is due to girls' rates increasing at a faster rate than boys'.

Figure 2 presents averages of overweight and obesity status by year and race group.

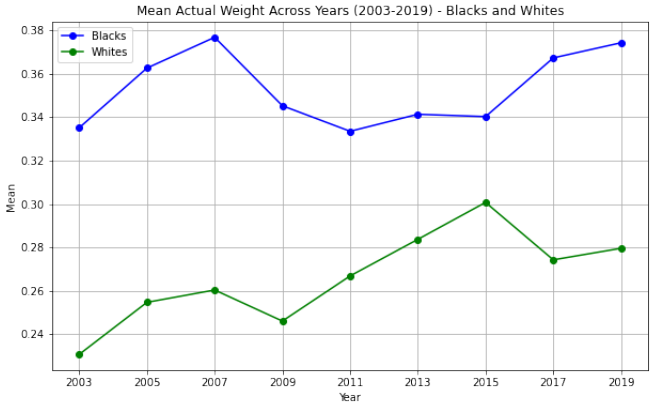

Figure 2: Mean Actual Weight by Race from 2003 to 2019

By race, Blacks are more likely to be overweight or obese than Whites in every year. Both races show a steady overall increase in average rate, although it seems that the increase is not more than 5 percentage points for either race. In 2003, around 33% of Blacks were overweight or obese, in 2015, this increased to 34% and in 2019, the average rate reached 37%. Whites in 2003 had an average overweight or obesity rate of 23%, in 2015 it reached 30%, and in 2019 it marginally decreased to 28%. Comparing Blacks to Whites, Blacks in 2003 had a 10 percentage points higher rate than Whites, and in 2015 the gap closed to only 4 percentage points, but then increased again in 2019 to around 10 percentage points. Therefore, the racial gap has remained relatively static with a few fluctuations.

Figure 3 shows averages for perception of weight status equal to selecting very/slightly overweight among girls and boys across each year.

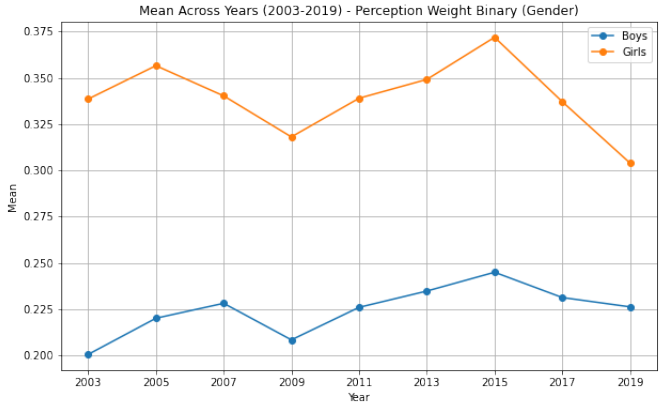

Figure 3: Mean Perception of Weight from 2003 to 2019

Compared to actual weight status, the gender differential is reversed. Girls are always more likely to select that they are slightly/very overweight compared to boys. In 2003, girls were 14 percentage points more likely to perceive themselves as overweight/obese compared to boys, as girls' average was 34% and boys was 20%. In 2015, girls' average was 37.5%, boys' was 24%, and therefore the gap was about 15 percentage points. Finally, in 2019, the gender gap was narrowed to only 7.5 percentage points, with girls' average at 30% and boys at 22.5%. This narrowed gap looks like it is a result of a decreasing of girls' average along with slight increase in boys' average. However, more data after 2019 is necessary to see the magnitude of the girls' decline and if it holds. Overall, these averages are interesting because from the raw data above, boys are in actuality more obese, although they are less likely to perceive themselves that way.

Figure 4 shows averages for perception of weight status equal to selecting very/slightly overweight among Blacks and Whites across each year.

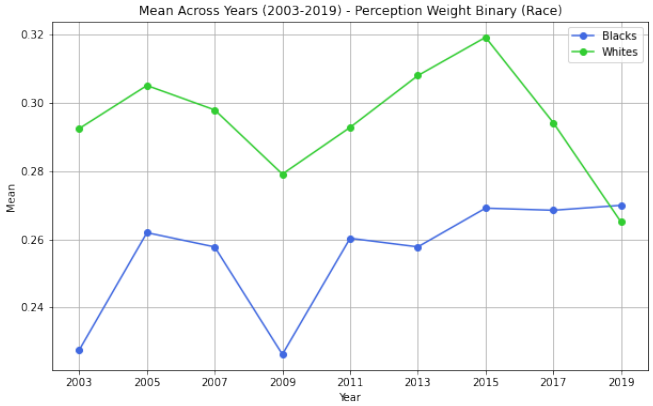

Figure 4: Mean Perception of Weight from 2003 to 2019

For race and perception of weight, Whites are more likely to perceive themselves as overweight/obese in all years except a marginal reverse in 2019. In 2003, the average self perception of being overweight or obese for Blacks was 22.5%, while it was 29.5% for Whites, a 7 percentage point gap. In 2015, the gap slightly narrowed to 5 percentage points, with Blacks' average being 27% and Whites being 32%. In 2019, the gap dissolves, where Blacks and Whites' averages are both 27%. Overall, the average for Blacks somewhat increases, and the Whites' average goes through a series of fluctuations, ending at a decrease in 2019 than the start in 2003. This is interesting because the gap is narrowing, where Blacks are becoming more sensitive to the perception of their weight, and it seems that Whites are becoming less. Regression analyses later combine race and gender to see the interaction of the two.

5.2 Statistical Analysis

This section presents the findings from the OLS regressions that examine the associations between race, gender, and actual and perceived weight. The results are organized as follows: first, I provide an overview of the main findings from the regression analyses for both

actual weight status and perceived weight. Then, I discuss a regression of perception of weight, conditional on actual weight status. Additionally, I discuss temporal trends in overweight/obesity rates and self-perception of weight among different racial and gender groups from 2003 to 2019. Finally, I run robustness checks on the results.

The regression analyses aimed to establish the relationships among variables and the outcome of one's actual weight status and their perception of their weight for all the years combined, utilizing a consolidated dataset from each year into a single dataset. Three regression models were employed on the data, separately for actual and perceived weight. In all regressions, controls included survey year fixed effects, and dummy variables were created for each year, with 2003 serving as the reference year.

5.2.1 Regression Analyses: Actual Weight

Table 1: Association between gender, race and actual weight of children (2003-2019)

Variables	(1)	(2)	(3)
Boy	0.0388***	0.0400***	0.0734***
	(0.003)	(0.003)	(0.004)
Black		0.0878***	0.1425***
		(0.003)	(0.005)
Boy×Black			-0.1123***
			(0.007)
Mean of Dependent Variable			0.29
Observations			90,218

Standard errors, calculated using heteroskedasticity-robust methods (HC3) and controls are year fixed effects and grade fixed effects.

Gender Differential and Overweight/Obesity Status

The OLS regression analysis using equation (1) revealed the average gender differential between boys and girls concerning overweight/obesity across all years. The coefficient for Boy, β_1, was estimated at 0.0388, which is statistically significant with a p-value close to zero. This positive coefficient suggests that, on average, boys tend to have higher over-

weight/obesity rates compared to girls. The effect size of this coefficient compared to the average overweight/obesity rate across the population, which was 29%, is 13%.

Gender Differential and Overweight/Obesity Status Conditional on Race

Using equation (2), the coefficient for Boy, β_1, remained statistically significant with a coefficient of 0.0400, indicating that, on average, boys exhibited higher overweight/obesity rates compared to girls ($p \leq 0.001$). Additionally, Race, β_2 , played a role in this association, signifying the racial differential between Whites and Blacks, with a coefficient value of 0.0878, and this coefficient was also statistically significant ($p \leq 0.001$). The effect size for Blacks is 30%. As noted above, the effect size of the gender gap was only 13%, so the racial gap is over double the size of the gender gap. Blacks are disproportionately affected by overweight/obesity; the burden on Blacks compared to Whites is greater than the burden on boys versus girls.

Impact of Being a Black Boy on Overweight/Obesity Status

In equation (3), the coefficient on White boys, β_1, remained statistically significant, with a coefficient of 0.0734, stating that on average, boys exhibit higher obesity rates compared to girls ($p \leq 0.001$) for Whites. Additionally, the coefficient for Race, β_2, was significant, reflecting the racial differential between Whites and Blacks for girls, with a coefficient value of 0.1425 ($p \leq 0.001$).

From the first regression analysis, the gender differential for the whole population was 0.0388, and for Whites, from the third regression, the differential jumps to 0.0734. This means that the gender differential for Whites is almost twice as larger as the average gender differential across the population, with boys being more overweight/obese by only 3.88 percentage points for the whole population and 7.34 percentage points for Whites. Whites face a greater gender gap, which implies the White boys are much more obese than White girls, compared to the same comparison for the total population.

Similarly for race, the racial gap across gender from the second regression equation is 0.0878, where the racial gap for girls from the third equation is 0.1425. Blacks are 8.78 percentage points more likely to be obese than Whites across both gender, but focusing on race, Black girls are 14.25 percentage points more likely to be obese/overweight compared to White girls, about a 75% difference from the population. This means that Black girls face a heavier burden of being obese compared to White girls, compared to the racial differential for both genders.

The coefficient, β_3, representing the differential effect for Black boys compared to Black girls compared to the gender gap for Whites, revealing the additional obesity penalty for Black boys, was -0.1123. This value indicates a significant negative difference in obesity rates when Black boys were compared to Black girls ($p \leq 0.001$). Therefore, Black boys are 11.23 percentage points less likely to be overweight/obese than Black girls compared to the gender differential for Whites. Economically, this effect size is around 39%.

5.2.2 Regression Analyses: Perception Weight

The next set of regressions used a similar process for the OLS regressions dealing with actual weight status, but the outcome is now perception of one's weight, with value 1 for selecting slightly or very overweight and 0 otherwise.

Gender Differential and Weight Perception

The OLS regression analysis using equation (1) revealed the average gender differential between boys and girls in the perception of their weight across all years. The coefficient for Boy, β_1, was estimated at -0.1146, which is statistically significant with a p-value close to zero. This negative coefficient suggests that, on average, boys tend to select slightly or very overweight less than girls.

The effect size of this coefficient, comparing it to the average rate of selecting slightly/very

Table 2: Perception of Weight (2003-2019)

Variables	(1)	(2)	(3)
Boy	-0.1146^{***}	-0.1152^{***}	-0.1050^{***}
	(0.003)	(0.003)	(0.004)
Black		-0.0419^{***}	-0.0252^{***}
		(0.003)	(0.005)
Boy×Black			-0.0342^{***}
			(0.006)
Mean of Dependent Variable			0.28
Observations			90,218

Standard errors, calculated using heteroskedasticity-robust methods (HC3) and controls are year fixed effects and grade fixed effects.

overweight across the population which was 28%, is 40.9%. This large effect size reflects that the influence of gender on perception of weight is large.

Gender Differential and Weight Perception Conditional on Race

In equation (2), the coefficient for Boy, β_1, remained statistically significant with a value of -0.1152, indicating that, on average, boys exhibited lower rates of selecting slightly or very overweight compared to girls ($p \leq 0.001$). Additionally, Race, β_2, played a role in this association, signifying the racial differential between Whites and Blacks with a coefficient value of -0.0419, and this coefficient was also statistically significant ($p \leq 0.001$).

The effect size of this coefficient is somewhat influential, at 14.9%. This means that race plays an smaller role on perception of weight than gender goes, where Whites are 14.9% points more likely to select slightly/very overweight than Blacks but girls are 40.9% more likely to select than boys.

Impact of Being a Black Boy on Weight Perception

Using equation (3), the coefficient on White boys, β_1 remained statistically significant, with a coefficient of -0.1050, meaning on average, boys are less likely to select being slightly or very overweight compared to girls ($p \leq 0.001$) for Whites. Comparing the White gender

gap to the population gender gap, there is only a 1 percentage point difference from around 11% points in the population to 10% in Whites. Therefore, there is not much of an additional burden on White girls as compared to the total population of girls.

Additionally, the coefficient for Race, β_2, was significant, reflecting the racial differential between Whites and Blacks for girls, with a coefficient value of -0.0252 ($p \leq 0.001$). There is a 2 percentage point difference for the racial gap for girls and for the racial gap across the population, again an negligible difference.

The coefficient β_3, representing the differential effect for Black boys compared to Black girls compared to the gender gap for Whites was -0.0342. This value indicates a significant negative difference in perception of being slightly or very overweight when Black boys were compared to Black girls ($p \leq 0.001$). Therefore, Black boys are 3.4 percentage points less likely to perceive themselves to be overweight/obese than Black girls compared to the gender differential for Whites. The effect size of the β_3 coefficient is 12%, which is not as influential as the racial or gender gaps, at around 40%.

5.2.3 Perception Weight Conditional on Actual Weight

Using the same three regression equations, but now controlling for actual weight status (being overweight/obese = 1, else =0), the coefficients for the variables on the effect on perception of weight conditional on actual weight status are as follows:

Gender Differential on Weight Perception Controlling for Actual Weight Status

The first regression model examined the association between gender (Boy) and perception of weight, controlling for actual weight status, providing insights into the average gender differential between boys and girls on selecting slightly or very overweight when describing themselves.

The OLS regression analysis using equation (1) controlling for actual weight revealed the

Table 3: Perception of Weight (2003-2019) Conditional on Actual Weight Status

Variables	(1)	(2)	(3)
Boy	-0.1354^{***}	-0.1370^{***}	-0.1450^{***}
	(0.002)	(0.002)	(0.003)
Black		-0.0896^{***}	-0.1028^{***}
		(0.003)	(0.004)
Boy×Black			-0.0269^{***}
			(0.005)
Mean of Dependent Variable			0.28
Observations			90,218

Standard errors, calculated using heteroskedasticity-robust methods (HC3) and controls are year fixed effects and grade fixed effects.

average gender differential between boys and girls concerning the perception of their weight across all years. The coefficient for Boy, β_1 was estimated at -0.1354, which is statistically significant with a p-value close to zero. This negative coefficient suggests that, on average, boys tend to select slightly or very overweight less than girls, controlling for their actual weight status.

Compared to the unconditional regression, without controlling for actual weight, the coefficient was 2 percentage points lower. This means that actual weight status has limited additional explanatory power of the gender gap for choosing slightly/very overweight.

Gender Differential and Weight Perception Conditional on Race Controlling for Actual Weight Status

The second regression model explored the gender differential conditional on race and the racial differential between Whites and Blacks, controlling for actual weight status. The coefficient for Boy, β_1 remained statistically significant with a coefficient of -0.1370, indicating that, on average and controlling for actual weight status, boys exhibited lower rates of selecting slightly or very overweight compared to girls ($p \leq 0.001$). Additionally, Race, β_2, played a role in this association, signifying the racial differential between Whites and Blacks, controlling for actual weight status, with a coefficient value of -0.0819, and this coefficient

was also statistically significant ($p \leq 0.001$).

The coefficient, β_2, conditional on actual weight increased 4 percentage points compared to the unconditional equation without actual weight status. Therefore, actual weight status has some additional explanatory power on perceived weight for the racial gap.

Impact of Being Black Boy on Weight Perception Controlling for Actual Weight Status

The final regression model examined the overall impact of being a Black boy, including the interaction term, on one's perception of their weight, controlling for actual weight status. The coefficient on White boys, β_1, remained statistically significant, with a coefficient of -0.1450, reinforcing the observation that, on average, boys are less likely to select being slightly or very overweight compared to girls ($p \leq 0.001$) for Whites filtering out those who are actually overweight/obese. Additionally, the coefficient for Race, β_2, was significant, reflecting the racial differential between Whites and Blacks for girls, with a coefficient value of -0.1028 ($p \leq 0.001$). This signifies that Black girls are less likely to perceive themselves to be slightly/very overweight compared to White girls, conditional on actually being overweight/obese.

The coefficient β_3, representing the differential effect for Black boys compared to Black girls compared to the gender gap for Whites, was -0.0269. This value indicates a significant negative difference in a false perception of being slightly or very overweight when Black boys were compared to Black girls ($p \leq 0.001$). Therefore, Black boys are 2.6 percentage points less likely to perceive themselves to be overweight/obese than Black girls compared to the gender differential for Whites, conditional on actual weight status by filtering out those who are overweight/obese.

The comparison of this coefficient to the unconditional β_3 value is interesting. The conditional β_3 value increases, meaning that the actual weight status has some explanatory power in the unconditional equation. Because the coefficients for the previous regressions decreased, the perception of being overweight or obese among Black boys compared to Black

girls diverges significantly from the gender gap observed among White individuals. This suggests a distinct sociocultural influence on body image perceptions within the Black community, which remains significant even when controlling for actual weight status. Overall, Black girls are more likely to perceive themselves as overweight/obese compared to Black boys when controlling for actual weight status, relative to the gender gap in Whites.

Weight Perception Controlling for Actual Weight Status Additional Analysis

Across all regressions, the coefficient on actual weight status, γ, is approximately 0.55, suggesting a positive relationship between actual weight and the perception of being slightly or very overweight. The fact that γ is not equal to 1 implies a certain degree of misperception of perceived weight, indicating that individuals may not fully align their perception of weight with their actual weight.

I ran another regression adding an interaction term between Boy×Actual Weight, and the coefficient on this new interaction term was -0.0648 ($p \leq 0.001$). This is explaining how much of the gender gap is explained by the actual weight differences between boys and girls. The significant negative coefficient, being smaller than the unconditional coefficient on the gender differential by about 4 percentage points, means that actual weight does have explanatory power.

5.2.4 Temporal Changes from 2003 to 2019

5.2.5 Actual Weight Status Changes Over Time

Next, the dataset was utilized to conduct separate regression analyses for each individual year. The following graph shows how the differentials are changing over time for actual weight status:

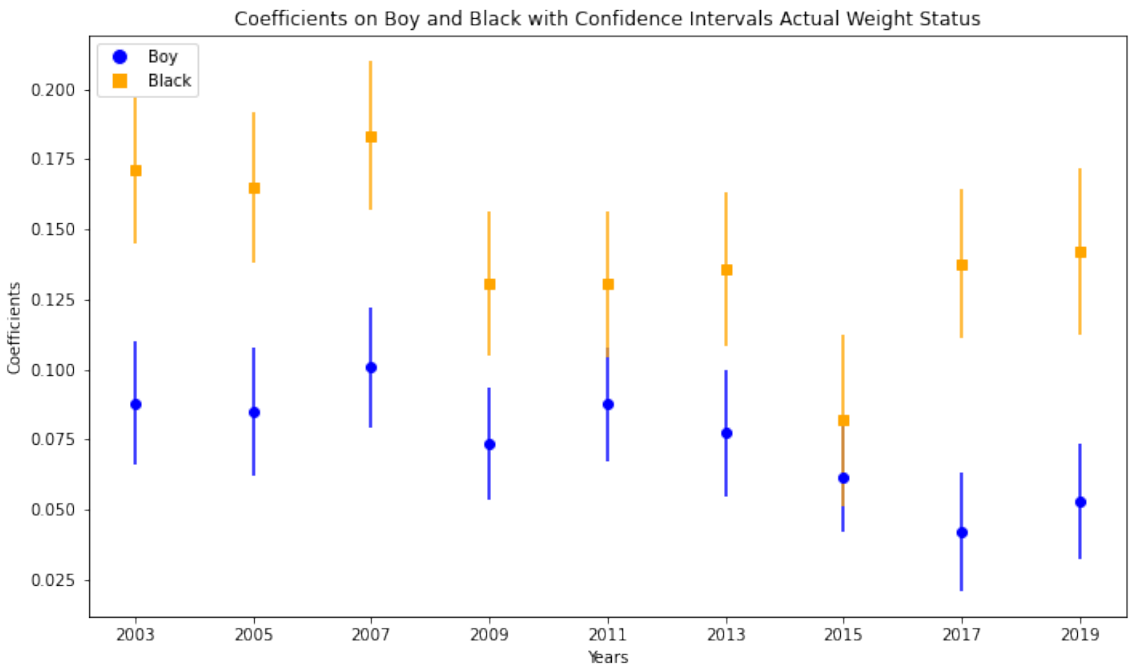

Figure 5: Gender and Race Differentials for Actual Weight Status Over Time

Standard errors, calculated using heteroskedasticity-robust methods (HC3) and controls include grade fixed effects.

Using equation (3), the interactive model, the graph above shows the coefficients of the variables Boy (β_1, showing the gender differential for Whites) and Black (β_2, reflecting the racial differential between Whites and Blacks for girls) plotted separately, and how they have been changing over the 9 cohorts. The blue line, Boy, shows a slightly declining trend, showing how the gender differential has declined for Whites from around 0.85 in 2003 to 0.65 in 2015, to 0.5 in 2019. Therefore, the gender gap has steadily declined for Whites, with boys always being more obese than girls. One hypothesis is that White girls are getting more overweight/obese at a faster rate than White boys. For the orange line, or the Black variable, the trend seems to be declining, showing how the gap between Whites and Blacks for girls seems to be decreasing. Starting at 0.175 in 2003, to 0.08 in 2015, back up to 0.130 in 2019, there is a slight decline with fluctuations of even bigger declines. This means that the racial gap for girls seems to be shrinking, with a similar hypothesis to above that White

girls, while still less overweight/obese compared to Black girls, may be increasing their rates at a higher speed.

The next graph shows how the interaction term is changing over time for actual weight status:

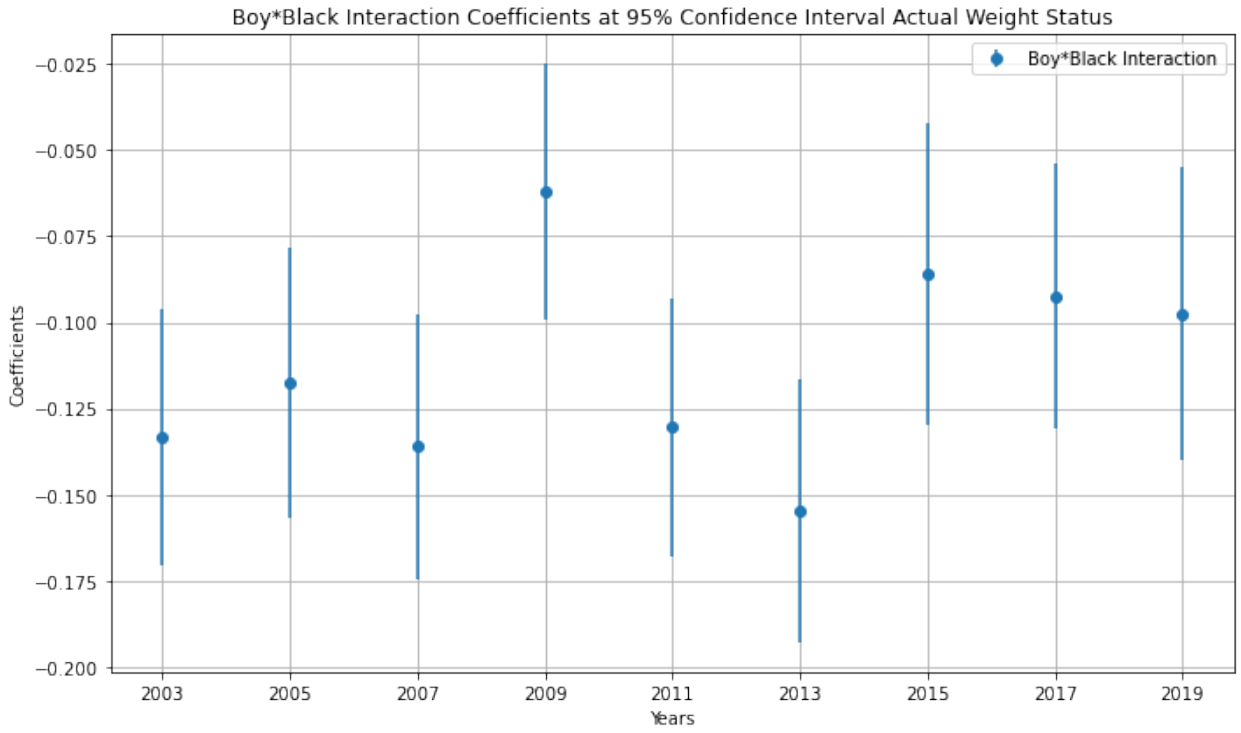

Figure 6: Interaction Term for Actual Weight Status Over Time

Standard errors, calculated using heteroskedasticity-robust methods (HC3), and controls include grade fixed effects.

This visualization depicts the change of the coefficients of the interaction variable over the years 2003 to 2019. The trend becomes overall slightly less negative. The confidence interval from 2003 contains the value of the coefficient in 2019, so the trend is not significant, but there seems to be a slight increase. Over these 9 cohorts, the Black boy-girl gender gap, compared the white gender differential, is slightly shrinking. The source of the discontinuity from 2013 to 2015 is unclear.

5.2.6 Perception of Weight Changes Over Time

The following graphs shows how the differentials are changing over time for perception of weight:

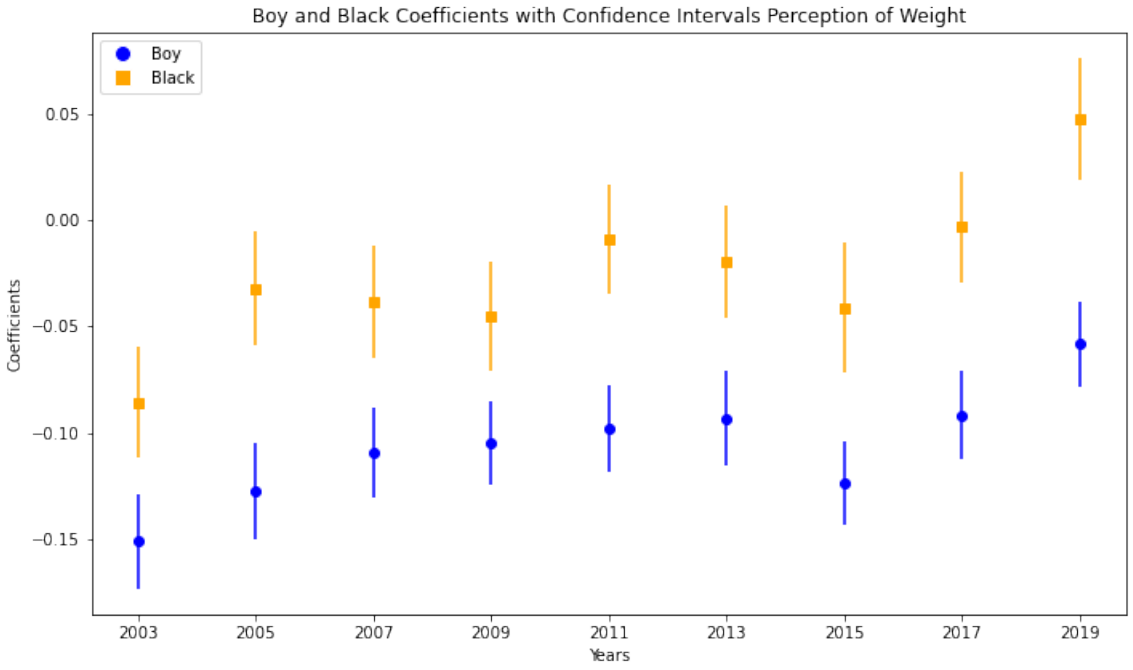

Figure 7: Gender and Race Differentials for Perception of Weight Over Time

Standard errors, calculated using heteroskedasticity-robust methods (HC3) and controls include grade fixed effects..

Using equation (3), the interactive model, girls are more likely to perceive themselves as being overweight or obese, as indicated by the consistently negative Boy coefficient lines in blue, relative to boys for Whites. In 2003, boys had a 15-percentage-point lower probability of selecting slight/very overweight. However, in 2019, this difference diminished by two-thirds to only 5 percentage points. This is intriguing because, while girls still tend to report being slightly or very overweight more often, the gender gap appears to be closing for Whites. Examining the raw data in Figure 2 reveals that while boys are becoming more likely to report being slightly/very overweight, girls' rates of self-reporting these outcomes

may be decreasing for Whites. This shift contributes to the weakening of the gender gap. Nevertheless, it's important to note that girls of both races consistently remain more likely to select slightly/very overweight compared to boys.

Turning to racial differences, a similar pattern emerges between Blacks and Whites for girls. The racial gap for girls is becoming less negative, as it was -0.09 in 2003, then -0.04 in 2015, and up to 0.04 in 2019. This 10 percentage point jump is intriguing because it shows that Black girls are becoming more likely to select being slightly/very overweight compared to White girls compared to where they started in 2003. From the raw data, Whites are more likely compared to Blacks in every year (except for 2019), but it appears that Blacks are increasing their likelihood to perceive themselves as slightly/very overweight, and therefore closing the gap.

The next graph shows how the interaction term is changing over time for perception of weight:

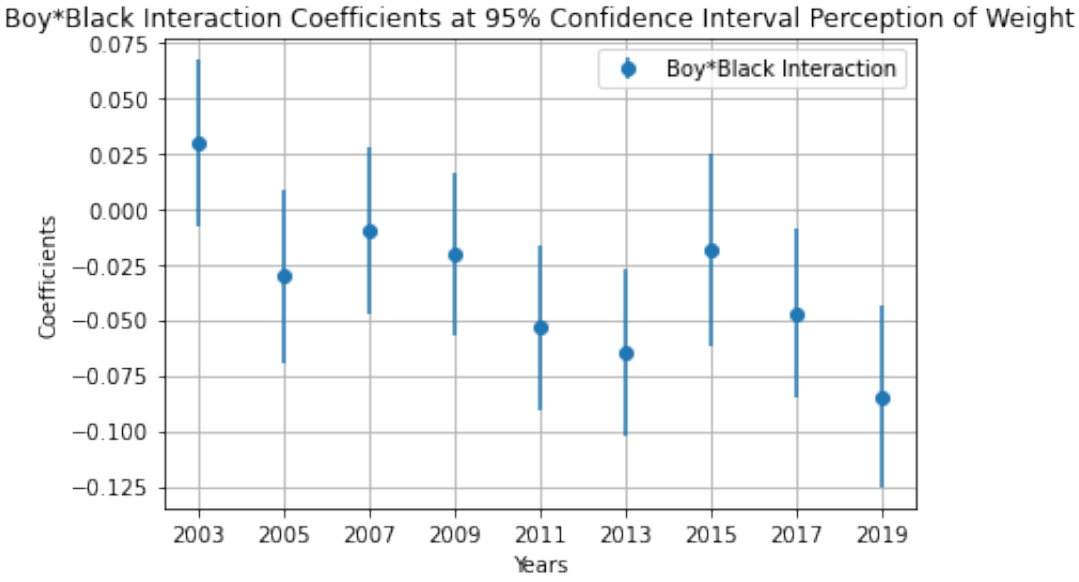

Figure 8: Interaction Term for Actual Weight Status Over Time

Standard errors, calculated using heteroskedasticity-robust methods (HC3), and controls include grade fixed effects.

There appears to be a consistent decline in the interaction term coefficient. This trend suggests that Black boys are progressively less likely to choose being slightly/very overweight compared to Black girls, relative to the gender gap observed in Whites. In each year, this observation aligns with the raw data, where White girls seem to be decreasing their likelihood in the final years of the study. Simultaneously, Black girls are on the rise, with Black boys experiencing only marginal increases compared to Black girls. Black boys may be getting less and less sensitive to their perception of overweight/obesity, and Black girls may be getting more sensitive. Interestingly, Black boys are not getting less and less overweight/obese in actuality, just their perception is changing to be less sensitive.

For economic effects, Table 4 shows the effect size across every year. The effect size continues to get bigger every year, resulting at 30% in 2019. These large and increasingly larger effect sizes demonstrates that there is a great negative influence of being a Black boy on perception of weight, compared to the average across the population.

Table 4: Effect Sizes of Perception of Weight by Year

Year	Coefficient of $Boy \times Black$	Average Rate of Population (%)	Effect Size
2003	0.0297	26.96	11.02%
2005	-0.0303	29.01	-10.44%
2007	-0.0098	28.52	-3.44%
2009	-0.0206	26.38	-7.81%
2011	-0.0533	28.32	-18.82%
2013	-0.0651	29.06	-22.40%
2015	-0.0187	30.92	-6.05%
2017	-0.0471	28.66	-16.43%
2019	-0.0845	26.63	-31.7%

5.3 Robustness with Ethnicity

Table 5: Actual Weight (2007-2021) – Robustness

Variables	(1)	(2)	(3)
Boy	0.0387***	0.0394***	0.0704***
	(0.003)	(0.003)	(0.003)
Black		0.0822***	0.1354***
		(0.004)	(0.005)
Boy×Black			−0.1090***
			(0.006)

Table 6: Actual Weight with Ethnicity (2007-2021) – Robustness

Variables	(1)	(2)	(3)
Boy	0.0388***	0.0396***	0.0710***
	(0.003)	(0.003)	(0.003)
Black		0.0862***	0.1404***
		(0.004)	(0.005)
Boy×Black			−0.1108***
			(0.006)

The results prove to be robust when ethnicity is included as a control. Regression analysis reran excluding years 2003 and 2005, which did not have ethnicity designations. Gender differentials persist, with only a negligible 0.0001 difference in coefficients, showcasing the stability of boys' increased likelihood (0.0388***) to be overweight or obese. The race differentials, capturing the higher likelihood among Black individuals, remain statistically significant, with only a slight adjustment from 0.0822 to 0.0862***. Simultaneously, the interaction term for being Black boy maintains its significant decrease (-0.1108***), emphasizing the consistency of the observed patterns. The marginal differences observed in the original regression coefficients for gender (0.0001) and race (0.004) underscore the robustness of the examined relationships, even when considering ethnicity, providing added confidence in the reliability of the study's conclusions regarding actual weight over the studied time

frame.

Table 7: Perception of Weight (2007-2021) – Robustness

Variables	(1)	(2)	(3)
Boy	-0.1088^{***}	-0.1092^{***}	-0.0972^{***}
	(0.003)	(0.003)	(0.003)
Black		-0.0370^{***}	-0.0163^{***}
		(0.003)	(0.005)
Boy×Black			-0.0424^{***}
			(0.006)

Table 8: Perception of Weight with Ethnicity (2007-2021) – Robustness

Variables	(1)	(2)	(3)
Boy	-0.1087^{***}	-0.1090^{***}	-0.0965^{***}
	(0.003)	(0.003)	(0.003)
Black		-0.0332^{***}	-0.0117^{***}
		(0.003)	(0.005)
Boy×Black			-0.0440^{***}
			(0.006)

Similarly, when ethnicity was added as a control for the perception of oneself regressions, there were only marginal differences. Gender differentials remain virtually unchanged, with a minimal 0.0001 difference (-0.1087***). The race differential sees a modest adjustment from -0.0370 to -0.0332***. The interaction term retains its significance, portraying a continued decrease in likelihood (-0.0440***). The marginal differences observed in the original regression coefficients for gender (0.0001), race (0.004) and the interaction (0.002) emphasize that the model is robust. These results affirm that, even when accounting for ethnicity, the patterns in perceived weight persist, highlighting the robustness of the study's conclusions over the examined time frame.

6 Discussion

Regression analysis indicates that Black girls consistently face a higher likelihood of obesity compared to Black boys, relative to the same gender gap in Whites. In contrast, this pattern is reversed for White individuals, and these findings confirm the CDC knowledge to date.

Moreover, even when controlling for actually being overweight/obese, girls are more prone to perceiving their weight as overweight/obese, compared to boys. Notably, Black girls face a double burden – not only do they experience overweight/obesity disparities in actuality, they also grapple with a higher likelihood of perceiving themselves as overweight or obese compared to Black boys and relative to the White gender gap, controlling for actual weight.

Turning to temporal changes, although White boys are more likely to be overweight/obese in every year than White girls, the gender gap for Whites may be shrinking. Similarly, Black girls are more likely to be overweight/obese compared to White girls, but the racial gap for girls may be shrinking over time. One hypothesis is that White girls are increasing their likelihood of being overweight/obese at a faster rate compared to other groups.

An examination of the temporal changes data unveils evolving gender disparities in weight perception. Historically, girls have tended to perceive themselves as more overweight or obese than boys. However, this gender gap appears to be narrowing. In 2013, the probability of boys selecting slight/very overweight was 15 percentage points less than that of girls. By 2019, this difference had diminished to only 5 percentage points. Boys may be increasing their likelihood of self-perceiving as overweight/obese, and girls may be decreasing their likelihood over time. Overall, however, girls are still reporting being slightly/very overweight at a higher rate than boys, even when controlling for actual weight status. For Blacks, Black girls are increasing their likelihood of perceiving as overweight/obese over time compared to Black boys. This may pose a significant burden on Black girls, as evidenced by their increased tendency to select themselves as slightly or very overweight, even when considering their

actual weight status. From the existing literature, misperceptions of weight can have far-reaching effects on behaviors and overall health outcomes. Given the observed trend of Black girls increasingly selecting themselves as slightly or very overweight, coupled with the understanding that they may misperceive their weight, this situation exacerbates the burden they face from their higher likelihood of being overweight/obese compared to Black boys, realtive to the gender gap in Whites.

The emergence of various social media platforms like Facebook (2004), Instagram (2010), and TikTok (2016), facilitated by the widespread adoption of smartphones since 2007, has the potential to significantly alter how individuals perceive their weight. In January 2024, CEOs from Meta, TikTok, X, and other social media platforms testified before the Senate Judiciary Committee, addressing concerns about the impact of social media on adolescents' lives. Lawmakers and parents express apprehensions about the design methods, pursuit of user engagement, and the failure to safeguard users from harmful content on these platforms. Evidence from diverse cross-sectional, longitudinal, and empirical studies consistently establishes a connection between smartphone usage, social media engagement, and adverse outcomes such as increased anxiety, depression, self-harm tendencies, and suicidal thoughts among youth (Carol Vidal et al., 2020; Jacqueline Nesi and Nesi, 2020; J Gao et al., 2020). Notably, a dose–response relationship has been identified, with the impact being particularly pronounced among girls (Elia Abi-Jaoude et al., 2020). In this paper, the results show that Black girls may face a burden of over time starting to perceive themselves as more and more overweight/obese. Figure 8 shows that Black boys are getting less likely to select being slightly/very overweight compared to Black girls, starting from Black boys being 2.5 percentage points more likely to be select slightly/very overweight in 2003, declining to 8 percentage points less likely to select compared to Black girls, compared to the same gender gap for Whites. Black girls are already at a disproportionate rate of being actually overweight/obese, so this self perception gap creates even more problems like anxiety, depression, etc. Because of the increase in social media usage in recent years, Black girls may be a group that is adversely affected more than other groups.

This study aimed to investigate whether there are temporal changes in both the actual weight status and the subjective perception of one's weight. Both indicators could be influenced by individuals' exposure to social media, shaping their actual weight and their self-image. The repercussions of these influences extend to mental health, lifestyle choices, long-term health outcomes, and potentially socio-economic status in later life. The temporal changes revealed in the results section shed light on the dynamic nature of weight disparities and perception shifts over the years. The concerning trend of elevated rates of overweight and obesity among Black girls, as demonstrated by the actual weight status data, persists throughout the examined period. Notably, regression analysis indicates a consistent higher likelihood of obesity for Black girls compared to Black boys, relative to the White gender gap, creating a persistent disparity. The narrowing gender gap in weight perception, as evidenced by a decline in the difference between boys and girls reporting slight/very overweight, adds another layer that boys may be more affected by social media or other societal influences.

The rise in the perception of weight across most groups may reflect the increasing use of social media, with harmful usage patterns contributing to a rise in false perceptions. Many literature focus on girls and body positivity, but there is a gap in knowledge around harmful body discussion about boys. Understanding these dynamics is crucial, as they have far-reaching implications for mental health, lifestyle choices, long-term health outcomes, and potentially socio-economic status in later life.

Addressing the alarming trend of obesity disparities among Black girls and the evolving gender disparities in weight perception requires strategic policy interventions. Implementing equity-centered school health policies could aid in reducing the disproportionate rates of overweight and obesity among Black girls. These policies should go beyond generic health initiatives and incorporate culturally sensitive programs, nutrition education, and physical activity interventions tailored to the unique needs and challenges faced by Black girls. Simultaneously, the rise of social media's influence on body image and mental health necessitates a comprehensive approach. Policymakers should collaborate with social media platforms

to regulate content, discouraging harmful body discussions and protecting adolescents from potentially damaging content. Educational programs in schools that promote media literacy and critical understanding of body image portrayal on social media can empower adolescents to navigate these platforms more healthily. By integrating these policies, policymakers can address both the tangible health disparities and the issue of body perception.

7 Limitations

One significant limitation of this study is the absence of control for socioeconomic status (SES) as a potential confounding variable. SES can play a crucial role in shaping individuals' attitudes towards weight, access to resources, and lifestyle choices. The lack of consideration for SES in the analysis limits the generalizability of the findings and prevents a comprehensive understanding of the intricate interplay between socioeconomic factors and weight perception. While SES is an essential determinant of health outcomes, its unavailability as a control variable does not inherently diminish the quality or relevance of the analysis. These results are still valuable in elucidating relationships between variables such as gender, race, and actual weight status or self-perception of weight.

This study uses Body Mass Index (BMI) to aid in measuring obesity and overweight status. BMI, while widely used to provide a rough sense of population health, lacks precision when applied to individual cases and is deemed impractical in clinical settings due to its failure to account for essential factors such as gender, age, muscle mass, and body fat, according to the CDC. This limitation underscores the inadequacy of BMI as a comprehensive health measure, particularly when considering the intersections of identity elements. The observation that Black women in the US have the highest BMI raises questions about the broader implications. It serves as an indicator of social exclusion and potentially reflects disparities in healthcare accessibility, highlighting the intricate relationship between racism, intersectionality, and BMI within the realm of social science research focused on Black women. However, at a

population level, there are few other measures that hold an adequate amount of data and surveillance, and BMI has proven to be suitable for aggregate-level analysis.

The study predominantly focuses on gender and racial disparities within a specific demographic, the Black-White racial and gender differentials. The findings may not be entirely representative of other demographic groups or diverse cultural contexts.

Finally, while this study establishes associations between gender and race, and weight perception and overweight/obesity, it does not establish causation. The observational nature of the study design prevents making definitive claims about the causal relationships between these variables.

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