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UNIVERSITY OF CALIFORNIA SAN DIEGO
SAN DIEGO STATE UNIVERSITY

The Impact of Discrimination on Adolescent Adiposity: Individual, Structural, and Intersectional
Perspectives from the ABCD Study

A Dissertation submitted in partial satisfaction of the requirements
for the Doctor of Philosophy degree

in

Public Health (Epidemiology)

by

Maria D. Lopez-Gurrola

Committee in charge:

University of California San Diego
Professor Gretchen Bandoli, Chair
Professor Angela Bazzi
Professor Chadwick Campbell

San Diego State University
Professor John Alcaraz
Professor Heather Pines

2026

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Chair

University of California San Diego
San Diego State University

2026

DEDICATION

This dissertation is dedicated to the individuals whose support, guidance, and unwavering belief in me made this journey possible.

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ABSTRACT OF THE DISSERTATION

The Impact of Discrimination on Adolescent Adiposity: Individual, Structural, and Intersectional
Perspectives from the ABCD Study

by

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Doctor of Philosophy in Public Health (Epidemiology)

University of California San Diego
San Diego State University, 2026

Professor Gretchen Bandoli, Chair

Background: Adolescent obesity remains a significant public health concern in the United States and disproportionately affects youth from socially marginalized populations. Increasing evidence suggests that obesity is shaped by social determinants such as stigma and discrimination. Stigma operates across multiple levels, ranging from individual experiences of discrimination to structural conditions embedded within policies, institutions, and societal norms. This dissertation examined whether stigma at individual and structural levels was associated with adolescent adiposity within the Adolescent Brain Cognitive Development (ABCD) Study.

Methods: Three complementary longitudinal analyses were conducted using the ABCD study. Chapter 1 examined the prospective association between perceived racial/ethnic discrimination and adiposity and evaluated racial centrality as a potential moderator. Chapter 2 investigated whether exposure to state-level structural stigma, measured through indicators of racism, sexism, and sexual orientation stigma, was associated with subsequent adiposity. Chapter 3 examined multiple domains of perceived discrimination, including race/ethnicity, nativity, sexual orientation, and weight discrimination were associated with adiposity. Across studies, modified regression models with inverse probability of censoring weights were used to estimate risk ratios.

Results: In Chapter 1, perceived racial/ethnic discrimination was not associated with subsequent overweight/obesity (aRR =1.03, 95% CI:0.91–1.18) or abdominal adiposity (0.97, 0.80–1.17). In Chapter 2, state-level structural sexism (1.04, 0.99–1.10), structural sexual orientation stigma (1.04, 0.99–1.09), and structural racism (1.07, 1.00–1.15) were not independently associated with overweight/obesity after adjustment, and none of the structural stigma measures were associated with abdominal adiposity. In Chapter 3, race/ethnicity

discrimination (1.05, 0.86–1.28), nativity (1.04, 0.82-1.32), and sexual orientation (1.19, 0.97-1.46) were not associated with overweight/obesity. Weight discrimination was associated with abdominal adiposity (1.20, 1.01–1.43), whereas the remaining discrimination domains were not associated with either adiposity outcome after adjustment.

Conclusions: After accounting for baseline adiposity and sociodemographic characteristics, neither perceived discrimination nor structural stigma consistently predicted subsequent adolescent adiposity. Overall, these findings suggest that associations are largely explained by underlying demographic and socioeconomic differences rather than independent effects of discrimination. Future research should examine longer-term pathways linking interpersonal and structural stigma to adiposity across adolescence and identify opportunities for intervention at the individual, institutional, and structural levels.

Chapter 1 INTRODUCTION

Adolescent obesity remains one of the most pressing public health challenges in the United States, affecting approximately one in five youth and contributing substantially to long-term morbidity and mortality (CDC, 2026). Excess adiposity during adolescence is associated with numerous adverse health outcomes, including hypertension, insulin resistance, type 2 diabetes, cardiovascular disease, and poor psychosocial functioning, while also increasing the likelihood of obesity persistence into adulthood (Kansra et al., 2021; Wójcik et al., 2023). Although traditional obesity research has emphasized behavioral determinants such as dietary intake and physical activity, growing evidence demonstrates that obesity is also shaped by broader social, political, and environmental conditions that influence health across the life course (Adamou et al., 2025a; Hemmingsson et al., 2023; Yang et al., 2021). Consequently, increasing attention has been directed toward understanding how social inequities and chronic psychosocial stressors contribute to obesity disparities during childhood and adolescence.

Among these social determinants, stigma and discrimination have emerged as important contributors to population health inequities. Stigma has been conceptualized as a social process involving labeling, stereotyping, separation, status loss, and discrimination that occurs within systems characterized by unequal distributions of power (Link & Phelan, 2001). These processes operate across multiple levels of society, ranging from interpersonal experiences of unfair treatment to institutional policies and cultural norms that systematically disadvantage certain populations. As a result, stigma is increasingly recognized not simply as an individual experience but as a multilevel social determinant capable of shaping health trajectories throughout the life course (Hatzenbuehler & Link, 2014).

Adolescence represents a particularly important developmental period for understanding the health consequences of stigma and discrimination. During this stage, youth undergo substantial biological, psychological, and social transitions while simultaneously developing greater awareness of their social identities and position within broader social hierarchies (National Academies of Sciences et al., 2019). Experiences occurring during adolescence may therefore become biologically embedded and influence future health trajectories. Chronic exposure to stigma-related stress has been associated with activation of the hypothalamic-pituitary-adrenal (HPA) axis, elevated cortisol secretion, inflammatory dysregulation, and alterations in metabolic functioning that may contribute to adiposity accumulation and cardiometabolic risk (Danese & McEwen, 2012; Tomiyama, 2019). Stigma may additionally influence obesity risk through behavioral pathways, including emotional eating, sleep disruption, physical inactivity, and reduced engagement with health-promoting resources (Scott et al., 2012; Tomiyama et al., 2018).

Much of the existing literature has focused on interpersonal or perceived discrimination. Perceived discrimination refers to individuals' experiences of unfair treatment, exclusion, prejudice, or negative social interactions based on socially stigmatized identities or characteristics (Vines et al., 2017). Research consistently demonstrates that perceived discrimination is associated with poorer mental health, increased psychological distress, substance use, sleep disturbances, and adverse physical health outcomes among youth (Benner et al., 2018; Priest et al., 2013). In particular, racial and ethnic discrimination has been linked to obesity-related outcomes through chronic stress pathways and maladaptive coping behaviors (Cuevas et al., 2023; Goosby et al., 2018). However, adolescents often experience discrimination across multiple domains simultaneously. Experiences related to race and ethnicity may intersect

with discrimination based on nativity, sexual orientation, gender, or body weight, creating complex patterns of stress exposure that are rarely captured by single-domain measures.

Several forms of discrimination may be particularly relevant during adolescence. Racial and ethnic discrimination remains one of the most commonly reported forms of discrimination among youth and has been associated with adverse psychological and physical health outcomes (Benner et al., 2018; Nagata et al., 2021). Adolescents from immigrant families may also experience nativity-related discrimination stemming from language, country of origin, immigration status, or perceptions of foreignness (Esses, 2021). Sexual minority youth frequently encounter stigma, victimization, and discrimination related to sexual orientation, experiences that have been linked to poorer mental and physical health outcomes through minority stress processes (Gower et al., 2018). Additionally, weight discrimination represents a unique form of stigma that may paradoxically contribute to obesity through emotional eating, avoidance of physical activity, and chronic physiological stress responses (Puhl & Heuer, 2010; Tomiyama et al., 2018). Despite increasing recognition of these multiple discrimination domains, relatively few longitudinal studies have examined their prospective relationships with objectively measured adiposity outcomes during adolescence.

Beyond interpersonal experiences, stigma also operates through broader social systems. Structural stigma refers to societal-level conditions, institutional policies, cultural norms, and social practices that systematically disadvantage specific populations (Hatzenbuehler, 2016). Unlike individual experiences of discrimination, structural stigma is embedded within laws, institutions, and social environments that shape opportunities and constraints for entire groups. Structural stigma has been linked to a range of adverse mental health outcomes among marginalized populations, including depression, anxiety, suicidality, and psychological distress

(Gordon et al., 2024; Martino et al., 2025) . Emerging evidence suggests that structural stigma may also influence physical health by shaping access to educational opportunities, economic resources, neighborhood environments, healthcare systems, and other determinants of health. Through these pathways, structural stigma may contribute to obesity risk even in the absence of directly perceived discrimination.

Importantly, stigma and discrimination do not affect all adolescents equally. Intersectionality theory posits that social identities and systems of oppression—including racism, sexism, heterosexism, xenophobia, and weight stigma—operate simultaneously rather than independently (Bauer et al., 2021; Crenshaw, 1989). Consequently, adolescents who occupy multiple marginalized social positions may experience unique forms of disadvantage that cannot be understood through single-axis approaches. For example, the health consequences of discrimination may differ for Black girls compared with White girls, Hispanic boys, or sexual minority youth because these groups occupy distinct social locations within broader systems of power and privilege. Increasingly, public health researchers have called for intersectionality-informed approaches to better understand how multiple dimensions of stigma interact to influence health outcomes and contribute to disparities.

Although substantial evidence links discrimination to mental health outcomes, important gaps remain regarding its relationship with adolescent adiposity. Existing studies have often relied on cross-sectional designs, focused on single discrimination domains, or failed to account for the broader structural contexts within which discrimination occurs. Furthermore, relatively little research has examined how interpersonal discrimination and structural stigma may independently or jointly contribute to obesity-related outcomes during adolescence.

Understanding these relationships is particularly important because obesity disparities emerge early in life and may set the stage for lifelong patterns of health inequity.

The overarching goal of this dissertation is to examine stigma as a multilevel social determinant of adolescent adiposity using longitudinal data from the Adolescent Brain Cognitive Development (ABCD) Study. Specifically, this dissertation investigates how interpersonal and structural forms of stigma contribute to obesity-related outcomes among U.S. adolescents. Chapter 1 examines the prospective association between perceived racial/ethnic discrimination and adiposity and evaluates the potential moderating role of racial centrality. Chapter 2 examines whether exposure to state-level structural stigma is associated with subsequent adiposity and explores differences across intersecting social identities. Chapter 3 expands this work by examining multiple domains of perceived discrimination, including racial/ethnic, nativity, sexual orientation, and weight discrimination, and evaluates whether associations vary across intersections of race/ethnicity and sex. Collectively, these studies provide a comprehensive examination of how stigma operating across multiple levels influences adolescent adiposity and contributes to health inequities during a critical developmental period (Figure 1).

Conceptual Framework: Stigma as a Multilevel Social Determinant of Adolescent Adiposity

An Intersectionality-Informed, Multilevel Stress Pathway Model

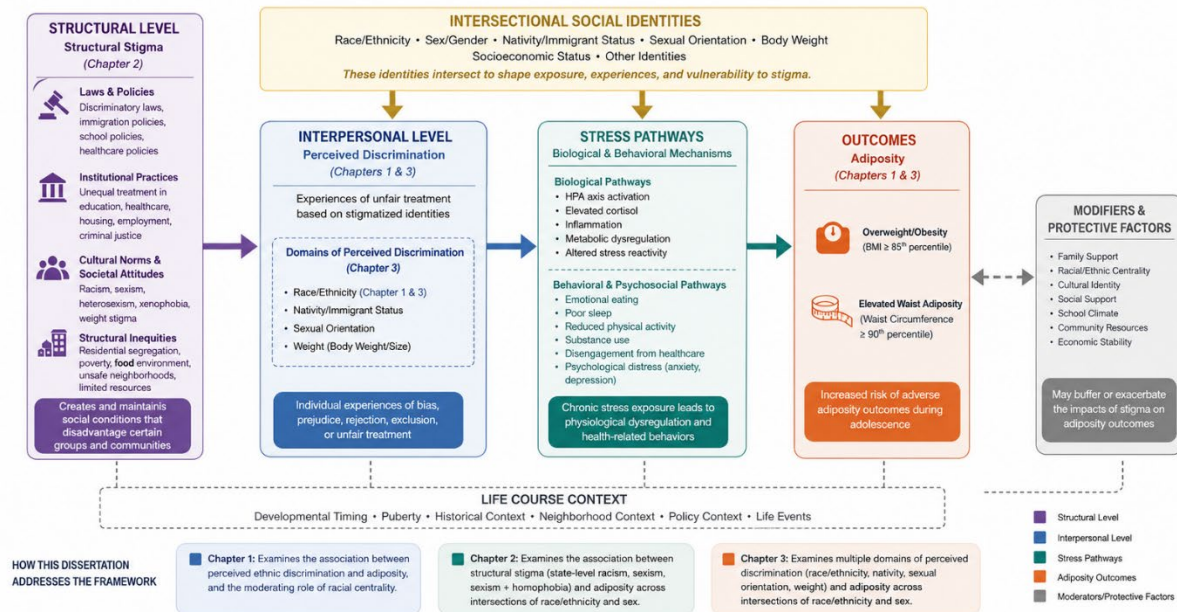


Figure 1. Conceptual Framework: Stigma as a Multilevel Social Determinant of Adolescent Adiposity.

Note. This figure was generated using OpenAI from a prompt written by the author and subsequently edited by the author.

Chapter 2 ASSOCIATION OF ETHNIC BASED DISCRIMINATION AND ADOLESCENT ADIPOSITY

ABSTRACT

Background: Racial/ethnic discrimination has been identified as a chronic psychosocial stressor associated with adverse health outcomes; however, longitudinal evidence examining its relationship with adolescent adiposity (excess body fat) remains limited. This study examined the prospective association between perceived racial/ethnic discrimination and adiposity among adolescents and explored potential differences across intersecting social identities (sex and race/ethnicity) and racial centrality.

Methods: Data were obtained from the Adolescent Brain Cognitive Development (ABCD) Study. Perceived racial/ethnic discrimination measured at Year 1 follow-up (2017–2019) served as the primary exposure, and adiposity outcomes at Year 2 follow-up (2018–2020) included body mass index (BMI)-defined overweight/obesity and waist circumference-defined abdominal adiposity. High discrimination was defined as scores at or above the 90th percentile of the Perceived Discrimination Scale. Sex was categorized as male or female, race/ethnicity as White, Black, Hispanic, or Asian/Other, and racial centrality was measured using the Multigroup Ethnic Identity Measure–Revised (MEIM-R), with higher scores indicating greater importance of racial/ethnic identity to self-concept. Inverse probability of censoring weighted (IPCW) modified Poisson regression models estimated risk ratios (RRs) and 95% confidence intervals (CIs). Effect modification was evaluated through sex-stratified analyses, racial centrality-stratified analyses, and interaction terms for discrimination $\times$ sex, discrimination $\times$ race/ethnicity, and discrimination $\times$ sex $\times$ race/ethnicity. Sensitivity analyses were also conducted.

Results: Adolescents reporting high discrimination demonstrated greater risk of overweight/obesity (RR=1.26, 95% CI: 1.16–1.37) and abdominal adiposity (RR=1.27, 95% CI: 1.14–1.42) in unadjusted analyses. Associations were attenuated after adjustment for baseline adiposity and sociodemographic characteristics. Most interaction terms were not statistically significant; however, a significant three-way interaction was observed for discrimination, female sex, and Asian/Other race/ethnicity in relation to waist adiposity (RR=3.46, 95% CI: 1.47–8.15).

Conclusions: In multivariable analyses, perceived racial/ethnic discrimination was not associated with greater adiposity burden. Further analyses suggested that relationships between discrimination and adiposity may vary across intersecting social identities.

INTRODUCTION

Adolescent obesity remains a significant public health concern in the United States and continues to affect approximately one in five youth (CDC, 2026). Excess adiposity during adolescence is associated with numerous adverse health outcomes, including cardiovascular disease risk factors, metabolic syndrome, insulin resistance, and type 2 diabetes, while also increasing the likelihood of obesity persistence into adulthood (CDC, 2026; Kansra et al., 2021). Obesity is also associated with poorer psychosocial functioning and reduced quality of life (Rankin et al., 2016; Wójcik et al., 2023). Adolescent obesity also represents a public health equity issue because its burden disproportionately affects youth from historically marginalized populations, highlighting the importance of social and structural determinants beyond individual behaviors. Increasing evidence suggests that obesity risk is influenced not only by behavioral factors such as diet and physical activity, but also by broader social and environmental experiences that shape developmental trajectories across the life course (Adamou et al., 2025a; Hemmingsson et al., 2023; Rubeis et al., 2025; Yang et al., 2021).

Among the social factors increasingly recognized as contributors to obesity risk is chronic psychosocial stress. Adolescence represents a particularly sensitive developmental period during which social experiences may exert long-term biological and behavioral effects (National Academies of Sciences et al., 2019; Orben et al., 2020). Repeated exposure to stressors may contribute to dysregulation of physiological systems involved in stress response, including the hypothalamic-pituitary-adrenal axis and inflammatory pathways (Ghasemi et al., 2024; Herman et al., 2016; Mbiydzanyuy & Qulu, 2024). Chronic activation of these systems has been associated with elevated cortisol levels, altered metabolic functioning, and accumulation of adipose tissue, particularly abdominal adiposity (Aschbacher et al., 2014; *Stress and Obesity*,

n.d.; Tomiyama et al., 2014). Stress may also influence obesity risk through behavioral pathways such as emotional eating, sleep disruption, and reduced physical activity.

Perceived racial/ethnic discrimination has emerged as an important chronic social stressor with implications for adolescent health and development (A. Benner, 2017; A. D. Benner et al., 2018). Racial/ethnic discrimination refers to experiences of unfair treatment, exclusion, prejudice, or negative interactions based on an individual's ethnic background or membership in an ethnic group (Vines et al., 2017). These experiences occur across settings such as schools, peer environments, and communities and may be especially influential during adolescence, when awareness of social identity and sensitivity to peer acceptance increase (Cheon et al., 2020).

Experiences of racial/ethnic discrimination are common among youth and appears to disproportionately affect racial and ethnic minority adolescents (A. D. Benner et al., 2018; Mattingly et al., 2025). Findings from the ABCD Study indicated that a substantial proportion of early adolescents report experiences of racial/ethnic discrimination, with rates differing considerably across demographic groups (Nagata et al., 2021). Although discrimination has been consistently associated with adverse mental health outcomes, including depression, anxiety, poorer self-esteem, and behavioral difficulties (A. D. Benner et al., 2018).

A growing body of literature suggests that racial/ethnic discrimination may contribute to obesity-related outcomes through both biological and behavioral mechanisms. Chronic exposure may disrupt neuroendocrine functioning and promote fat accumulation, while also increasing maladaptive coping behaviors such as emotional eating and physical inactivity (Hobson et al., 2022; Merabet et al., 2022). Previous studies have reported associations between discrimination experiences and increased body mass index, obesity prevalence, and adverse eating behaviors among both adolescents and adults (Nagata et al., 2025; Tomiyama et al., 2018). However, much

of the existing literature has relied on cross-sectional study designs, limiting the ability to establish temporal relationships between racial/ethnic discrimination exposure and subsequent obesity outcomes.

Additionally, relatively few studies have examined whether the relationship between racial/ethnic discrimination and adiposity differs across intersecting social identities (Cuevas et al., 2023; Y. Sharma et al., 2025). Guided by intersectionality theory, which recognizes that race/ethnicity, sex, and other social identities operate simultaneously to shape health, examining these intersecting identities may improve understanding of obesity disparities among adolescents (Bauer et al., 2021; Mosley et al., 2025).

Racial or ethnic identity may also shape adolescents' responses to discrimination. Racial centrality, the extent to which racial/ethnic is central to an individual's self-concept (Charmaraman & Grossman, 2010; Oyarvide Tuthill, 2021), has been proposed as a psychosocial resource that may protect against adverse effects of discriminatory experiences by promoting adaptive coping, social support, and cultural connectedness (Moore et al., 2022; Pascoe & Richman, 2009). However, little research has examined whether racial centrality moderates associations between ethnic discrimination and adolescent adiposity.

To address these gaps, the present study examined the prospective association between perceived racial/ethnic discrimination and adiposity among adolescents using longitudinal data from the ABCD Study. Adiposity was assessed using both body mass index-defined overweight/obesity and waist circumference-defined abdominal adiposity to capture general and central obesity outcomes. In addition, this study examined whether these relationships differed across sex and racial/ethnic identities using an intersectionality framework and explored racial centrality as a potential effect modifier.

We hypothesized that adolescents reporting high levels of perceived racial/ethnic discrimination would demonstrate increased risk of subsequent overweight/obesity and abdominal adiposity relative to adolescents reporting low levels of racial/ethnic discrimination. We further hypothesized that these associations would vary across intersecting social identities and that stronger racial centrality would attenuate the association between racial/ethnic discrimination and adiposity outcomes.

METHODS

Study Design and Data Source

This study employed a prospective longitudinal design to examine the relationship between perceived racial/ethnic discrimination and adiposity among adolescents using data from the Adolescent Brain Cognitive Development Study (v5.1). The ABCD Study is an ongoing multisite longitudinal cohort study designed to investigate brain development and child health trajectories across the United States (Barch et al., 2018). Participants were recruited from 21 research sites using probability-based sampling approaches intended to approximate the demographic composition of U.S. children. The ABCD Study collects comprehensive assessments of physical health, psychosocial functioning, environmental exposures, and neurodevelopment through annual follow-up visits.

The present analyses utilized perceived discrimination measured at Year 1 follow-up (2017–2019, age mean 10.9, SD 0.64) as the primary exposure and adiposity outcomes measured at Year 2 follow-up (2018–2020, age mean 11.9, SD 0.65).

Study Sample

Participants were eligible for inclusion if they had available data on perceived discrimination at Year 1 and adiposity outcomes at Year 2. Participants with missing data on primary exposure variables, outcome variables, or key covariates (collected at baseline, Year 0) were excluded from complete case analyses.

The analytic sample was derived from participants enrolled in the ABCD Study who had available anthropometric and covariate data across study waves. Of the 11,868 participants initially available, 735 were excluded due to missing height or weight measurements at Year 1, resulting in a sample of 11,133 participants. An additional 2,261 participants were excluded because height or weight measurements were unavailable at Year 2, leaving 8,872 participants. Three participants were further excluded due to missing responses on the perceived discrimination questionnaire, resulting in 8,869 participants. Finally, one participant was excluded because baseline age data were unavailable, yielding a final analytic sample of 8,868 adolescents.

Measures

Perceived Discrimination

The primary exposure variable was perceived discrimination assessed using the Perceived Discrimination Scale (PDS) administered at Year 1 follow-up (Xu et al., 2025). The PDS is a validated measure designed to assess experiences of unfair treatment and discrimination among adolescents. The measure captures experiences of discrimination occurring across multiple contexts and social interactions. The full PDS includes 11 items, consisting of four binary items assessing past-year experiences of discrimination based on race/ethnicity, immigration status, sexual orientation, and weight, and seven Likert-scale items assessing the frequency of

racial/ethnic -based unfair treatment across social contexts. For the present study, we focused on the seven-item racial/ethnic discrimination subscale, which asks participants how often they experienced unfair treatment because of their racial/ethnic background from teachers, other adults, other students, and society more broadly. Responses ranged from 1 (“almost never”) to 5 (“very often”), with higher scores indicating more frequent experiences of perceived racial/ethnic discrimination.

For the present analyses, a dichotomized discrimination variable was created to represent adolescents experiencing high levels of perceived racial/ethnic discrimination relative to adolescents reporting none or low levels of discrimination. The discrimination score was calculated as the mean of the seven racial/ethnic discrimination items, requiring valid responses for at least four items. Consistent with prior work using ABCD data, participants with discrimination scores at or above the 90th percentile were classified as experiencing high racial/ethnic discrimination exposure. This threshold was selected to identify adolescents reporting the most frequent and potentially chronic experiences of racial/ethnic discrimination, while recognizing that discrimination scores in population-based adolescent samples are typically concentrated at lower levels (Argabright et al., 2022). The 90th percentile cutoff therefore distinguishes youth with relatively elevated exposure who may be at greater risk for adverse health consequences associated with sustained discrimination experiences. Participants with scores below the 90th percentile were classified as experiencing none or low discrimination exposure (Argabright et al., 2022). Higher scores reflected greater perceived racial/ethnic discrimination experiences. Sensitivity analyses additionally examined an alternative threshold using the 85th percentile cutoff to evaluate the robustness of findings.

Adiposity Outcomes

Adiposity outcomes included body mass index (BMI)-defined overweight/obesity and waist circumference-defined abdominal adiposity. Anthropometric measures were collected by trained research staff using standardized procedures (Barch et al., 2018).

For BMI measurement, height was recorded to the nearest 0.1 cm and weight was measured to the nearest 0.1 kg with participants wearing light clothing and no shoes. Body mass index was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Age- and sex-specific BMI percentiles and z-scores were derived using Centers for Disease Control and Prevention growth chart reference standards. Participants were categorized according to established pediatric definitions, including underweight (<5th percentile), healthy weight (5th to <85th percentile), overweight (85th to <95th percentile), and obesity ($\geq$ 95th percentile). For analytical purposes, BMI was dichotomized into healthy weight (<85th percentile) and overweight/obesity ($\geq$ 85th percentile) (CDC, 2024).

Waist circumference was measured in triplicate at the level of the iliac crest using standardized procedures, and the mean value across the three measurements was used for analyses (Barch et al., 2018). Age- and sex-specific waist circumference percentiles were calculated using National Health and Nutrition Examination Survey reference values based on the LMS method (A. K. Sharma et al., 2015). Abdominal adiposity was defined as waist circumference at or above the 90th percentile.

To estimate prospective changes in adiposity over time, baseline adiposity measurements were included in all longitudinal models as adjustment variables.

Racial Centrality

Racial centrality was examined as a potential effect modifier of the association between perceived ethnic discrimination and adiposity outcomes. Racial centrality was assessed at the

Year 1 follow-up using six items from the Multigroup Ethnic Identity Measure–Revised (MEIM-R), a validated instrument designed to assess the extent to which individuals view their racial or ethnic identity as an important component of their self-concept (Phinney & Ong, 2007). Items assessed feelings of belonging to one's ethnic group, understanding of ethnic group membership, engagement in activities to learn about one's ethnic background, and attachment to one's ethnic group. Example items included: “I have a strong sense of belonging to my own ethnic group,” “I understand pretty well what my ethnic group membership means to me,” and “I feel a strong attachment toward my own ethnic group.”

Responses were recorded on a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Consistent with ABCD Study scoring procedures, items were reverse coded so that higher values reflected stronger ethnic identity and greater racial centrality. A summary score was calculated by averaging responses across the six items, resulting in a continuous measure ranging from 1 to 5, with higher scores indicating greater racial centrality.

For analyses examining effect modification, racial centrality was dichotomized using a mean score threshold of ≥ 4 to indicate high racial centrality and < 4 to indicate low/moderate racial centrality.

Covariates

Covariates were selected a priori based on theoretical frameworks and previous literature examining relationships between discrimination and obesity-related outcomes among adolescents (Arubuolawe et al., n.d.; Hooper et al., 2022; Raney et al., 2023). Demographic variables included age, sex assigned at birth, race/ethnicity, and nativity status (collected at baseline). Socioeconomic and family-level characteristics included parent educational attainment, parent

marital status, household income, and parent nativity (collected at baseline). Baseline adiposity measures were additionally included to account for preexisting differences in weight status.

Statistical Analysis

All analyses were conducted using R statistical software version 4.2.0. Descriptive statistics were calculated to characterize the study population overall and according to discrimination status. Means and standard deviations were calculated for continuous variables, and frequencies and percentages were calculated for categorical variables. Group differences between adolescents reporting high versus none/low discrimination were evaluated using independent sample t tests for continuous variables and chi-square tests for categorical variables.

To minimize potential bias resulting from differential loss to follow-up and missing outcome data, inverse probability of censoring weights (IPCW) were applied to all multivariable analyses (Figure 2). IPCW were conducted using perceived discrimination, baseline demographic and socioeconomic predictors of study retention. Stabilized weights were calculated using the marginal probability of remaining under observation at Year 2 follow-up as the numerator and the predicted probability of remaining under observation from a logistic regression model as the denominator. The censoring model included baseline age, neighborhood safety score, body mass index (BMI), and anxiety/depression status. To reduce the potential influence of extreme weights and improve estimator stability, stabilized weights were truncated at the 1st and 99th percentiles. Weight distributions were examined prior to analysis and demonstrated minimal variability, indicating no evidence of substantial extreme weights or violations of the positivity assumption. The resulting weights were incorporated into analyses using the survey package in R.

The primary analyses examined the prospective association between perceived discrimination and adiposity outcomes using IPCW-weighted generalized linear models with a Poisson distribution and log link function to estimate risk ratios (RRs) and corresponding 95% confidence intervals (CIs). Models were estimated using the survey package in R, which applies robust (sandwich) variance estimators to account for the weighting structure and provide valid standard errors and confidence intervals.

Three nested models were estimated for each adiposity outcome. Model 1 estimated the unadjusted association between discrimination and adiposity outcomes. Model 2 adjusted for age, sex, and baseline adiposity measures. Model 3 represented the fully adjusted model and included age, sex, race/ethnicity, parent nativity, parent educational attainment, parent marital status, and baseline adiposity.

Separate models were estimated for overweight/obesity and waist circumference-defined abdominal adiposity. Missing data was dropped in a complete-case analysis.

Sex-stratified analyses were conducted to examine whether associations differed between male and female adolescents. Additional intersectionality analyses evaluated whether relationships between discrimination and adiposity outcomes varied across combinations of social identities. To the models described above (model 1-3), the following interaction terms were added one at a time, two-way (sex x discrimination and race/ethnicity x discrimination) and three-way interaction terms (sex x race/ethnicity x discrimination) to assess whether the effects of discrimination on adiposity outcomes were modified by intersecting social identities. Predicted probabilities were calculated and visualized to facilitate interpretation of significant interaction effects. For the three-way interaction between perceived ethnic discrimination, sex, and race/ethnicity, predicted risks were estimated for each combination of discrimination status

and race/ethnicity and displayed separately for male and female adolescents. Estimates were plotted using ggplot2, with race/ethnicity on the x-axis, predicted adiposity risk on the y-axis, and separate lines representing discrimination status.

Sensitivity analyses were conducted to assess the robustness of findings using alternative operational definitions of discrimination exposure (unstratified analysis without interaction terms). Specifically, high discrimination was redefined using the 85th percentile threshold rather than the primary 90th percentile cutoff, and all primary models were re-estimated.

Finally, analysis examined racial centrality as a potential effect modifier of the association between discrimination and adiposity (Overweight/Obesity and waist adiposity). Stratified IPCW-weighted models were estimated separately for adolescents reporting low/moderate and high racial centrality. Interaction terms between discrimination and racial centrality were additionally evaluated to assess potential buffering effects of racial identity on adiposity outcomes.

RESULTS

Participant Characteristics

Tables 1 and 2 present demographic, health, family, and neighborhood characteristics stratified by perceived discrimination status (none/low versus high discrimination).

Of the 8,868 adolescents included in the analysis, 7,958 (89.7%) were classified as experiencing none or low levels of perceived race/ethnic discrimination, whereas 910 (10.3%) were classified as experiencing high levels of perceived race/ethnic discrimination. This classification was based on the 90th percentile threshold of the perceived race/ethnic discrimination scale.

Adolescents reporting high discrimination differed from those reporting none/low discrimination across several demographic and health characteristics. Mean age did not differ between groups (119.12 months [SD = 7.48] vs. 118.76 months [SD = 7.45], $p = .169$). However, sex distributions differed, with females comprising a smaller proportion of the high discrimination group (38.2%) than the none/low discrimination group (48.2%).

Race/ethnicity distributions also differed. Adolescents reporting high discrimination were less likely to identify as White (33.6% vs. 58.8%) and more likely to identify as Black (27.3% vs. 11.1%) or Hispanic (25.6% vs. 17.9%). Small differences were observed in nativity status, while educational grade did not differ between groups.

Differences were observed in depression symptom categories, with adolescents reporting high discrimination having slightly higher proportions of borderline (6.2% vs. 4.5%) and clinical symptoms (3.4% vs. 2.6%). Obesity status also differed. Adolescents reporting high discrimination had higher proportions of obesity (24.1% vs. 15.8%) and lower proportions of healthy weight status (57.7% vs. 66.6%). Physical activity levels were lower among adolescents reporting high discrimination compared with those reporting none/low discrimination (3.21 [SD = 2.35] vs. 3.57 [SD = 2.30]).

Family and neighborhood characteristics also differed by discrimination status (Table 1b). Parent educational attainment, marital status, and household income differed across groups. Adolescents reporting high discrimination were more likely to have parents with lower educational attainment and lower household income.

Neighborhood measures also differed significantly. Adolescents reporting high discrimination reported lower neighborhood safety scores (3.66 vs. 3.95, $p < .001$), greater neighborhood disadvantage (0.15 vs. 0.10), and poor healthy food environment scores (5.92 vs.

4.00) (Higher scores mean less access to healthy foods). Neighborhood walkability did not differ between groups.

Association Between Perceived Discrimination and Adiposity

Table 3 presents IPCW-weighted modified Poisson regression models examining associations between perceived discrimination and adiposity outcomes.

For overweight/obesity, adolescents reporting high discrimination had higher risk in the unadjusted model (41.75% vs. 33.36%, RR = 1.26, 95% CI: 1.16–1.37). After adjustment for age, sex, and baseline BMI, the association was attenuated (RR = 1.02, 95% CI: 0.88–1.18). Similar estimates were observed in the fully adjusted model (RR = 1.03, 95% CI: 0.91–1.18).

A similar pattern was observed for waist adiposity. In unadjusted analyses, high discrimination was associated with increased risk of abdominal adiposity (29.23% vs. 22.45%, RR = 1.27, 95% CI: 1.14–1.42). The association was attenuated following adjustment for age, sex, and baseline BMI (RR = 0.89, 95% CI: 0.70–1.13) and remained attenuated in the fully adjusted model (RR = 0.97, 95% CI: 0.80–1.17).

Sex-Stratified Analyses

Table 4 presents sex-stratified IPCW-weighted modified Poisson regression models. Among males, high discrimination was associated with greater risk of overweight/obesity in unadjusted analyses (39.1% vs. 34.2%, RR = 1.15, 95% CI: 1.02–1.28), although estimates were attenuated in adjusted models (Model 3: RR = 1.01, 95% CI: 0.87–1.18). Similar attenuation was observed for waist adiposity (27.0% vs. 22.8%, Model 1: RR = 1.16, 95% CI: 1.00–1.35; Model 3: RR = 1.02, 95% CI: 0.82–1.26).

Among females, high discrimination was associated with increased risk of overweight/obesity in unadjusted analyses (46.0% vs. 32.4%, RR = 1.44, 95% CI: 1.27–1.63).

The magnitude of association decreased after adjustment (Model 3: RR = 1.04, 95% CI: 0.82–1.32). A similar pattern was observed for waist adiposity (32.8% vs. 22.1%, Model 1: RR = 1.45, 95% CI: 1.23–1.72; Model 3: RR = 0.79, 95% CI: 0.55–1.14).

Intersectionality Analyses

Table 5 presents multiplicative interaction terms to assess whether the effects of discrimination on adiposity outcomes were modified by intersecting social identities.

For overweight/obesity, none of the discrimination-by-sex, discrimination-by-race/ethnicity, or three-way interaction terms reached statistical significance. The interaction terms for Discrimination × Female (RR = 1.15, 95% CI: 0.85–1.56), Discrimination × Black (RR = 0.83, 95% CI: 0.64–1.06), Discrimination × Hispanic (RR = 0.96, 95% CI: 0.75–1.23), and Discrimination × Asian/Other (RR = 0.74, 95% CI: 0.47–1.18) all included the null value.

For waist adiposity, the interaction between discrimination and Asian/Other race/ethnicity was associated with lower risk of waist adiposity relative to White adolescents (reference group) (RR = 0.37, 95% CI: 0.18–0.75). Additionally, the Female × Hispanic interaction was associated with increased risk of waist adiposity (RR = 1.26, 95% CI: 1.04–1.52).

For waist adiposity, the Discrimination × Asian/Other interaction term was statistically significant (RR = 0.37, 95% CI: 0.18–0.75). The Female × Hispanic interaction term was also statistically significant (RR = 1.26, 95% CI: 1.04–1.52), as was the three-way interaction between discrimination, female sex, and Asian/Other race/ethnicity (RR = 3.46, 95% CI: 1.47–8.15). All other two-way and three-way interaction terms were not statistically significant.

Figure 3 displays adjusted predicted risks derived from the interaction models across combinations of perceived ethnic discrimination status, sex, and race/ethnicity. For

overweight/obesity (Figure 3 - Up), predicted risks were generally similar across racial/ethnic groups and discrimination categories among both male and female adolescents, consistent with the non-significant three-way interaction terms observed in Table 5. For waist adiposity (Figure 3 - Bottom), greater variation in predicted risk was observed across sex, race/ethnicity, and discrimination categories. The largest differences were observed among female adolescents in the Asian/Other racial/ethnic category, for whom predicted risk of waist adiposity was higher among those reporting high discrimination compared with those reporting none/low discrimination.

Sensitivity Analyses

Table 6 presents sensitivity analyses using an alternative exposure definition in which high discrimination was classified using the 85th percentile threshold.

For overweight/obesity, adolescents classified as experiencing high discrimination demonstrated increased risk in unadjusted analyses (RR = 1.25, 95% CI: 1.17–1.35). Estimates were attenuated after adjustment for age, sex, and baseline BMI (RR = 1.05, 95% CI: 0.93–1.18) and remained similar in fully adjusted models (RR = 1.06, 95% CI: 0.94–1.19).

Comparable findings were observed for waist adiposity. High discrimination was associated with increased risk in unadjusted analyses (RR = 1.29, 95% CI: 1.17–1.42), with attenuation following adjustment (Model 3: RR = 1.06, 95% CI: 0.91–1.25).

Racial Centrality as an Effect Modifier

Table 7 presents stratified analyses examining racial centrality as a potential effect modifier of the association between perceived discrimination and waist adiposity.

Among adolescents with low/moderate racial centrality, discrimination was associated with increased risk of waist adiposity in unadjusted analyses (RR = 1.38, 95% CI: 1.20–1.59),

although estimates were attenuated following adjustment (Model 3: RR = 1.13, 95% CI: 0.94–1.35). Among adolescents with high racial centrality, associations between discrimination and waist adiposity were smaller in magnitude across all models (Model 3: RR = 0.84, 95% CI: 0.52–1.34).

The discrimination-by-racial centrality interaction term was negative ($\beta = -0.41$, $p = .107$), indicating lower estimated discrimination effects among adolescents with higher racial centrality; however, the interaction term did not reach statistical significance.

DISCUSSION

This study examined the prospective association between perceived discrimination and adiposity among adolescents using longitudinal data and IPCW-weighted models to account for potential bias due to attrition. This study additionally explored whether sex, intersecting social identities, and racial centrality modified the relationship between discrimination and adiposity outcomes. Although adolescents reporting high discrimination demonstrated greater prevalence of overweight/obesity and waist adiposity in unadjusted analyses, these associations were substantially attenuated after adjustment for baseline adiposity and sociodemographic characteristics. Overall, findings suggest that perceived discrimination was associated with adiposity burden at the descriptive level; however, discrimination did not independently predict subsequent adiposity after accounting for existing differences in demographic, socioeconomic, and baseline health characteristics. Nevertheless, important subgroup differences emerged in intersectionality analyses and racial centrality models, suggesting that the relationship between discrimination and adiposity may operate differently across social contexts and identities.

The descriptive findings demonstrated substantial social patterning of discrimination exposure. Adolescents reporting high discrimination were disproportionately Black and

Hispanic, were more likely to come from lower-income households, had parents with lower educational attainment, and lived in neighborhoods characterized by greater disadvantage and lower perceived safety. These findings align with theoretical frameworks conceptualizing discrimination as a socially patterned stressor embedded within broader systems of structural inequity rather than an isolated individual experience (Gee & Ford, 2011; Goosby et al., 2018). Consistent with the Intersectionality framework, experiences of discrimination frequently co-occur with multiple forms of social disadvantage, including economic hardship, neighborhood conditions, and marginalization based on race and ethnicity (Bauer et al., 2021; Mosley et al., 2025). The clustering of these characteristics suggests that adolescents exposed to discrimination may simultaneously experience multiple contextual risk factors associated with obesity development.

In unadjusted analyses, adolescents reporting high discrimination demonstrated approximately 26–29% greater risk of overweight/obesity and waist adiposity compared with peers reporting none or low discrimination. These findings are consistent with prior literature suggesting that discrimination functions as a chronic psychosocial stressor associated with obesity-related outcomes (Hunte & Williams, 2009; Scott et al., 2012). Chronic exposure to ethnic discrimination has been hypothesized to influence adiposity through both physiological and behavioral pathways (Kwarteng et al., 2016). Physiologically, repeated stress exposure may activate neuroendocrine stress systems including the hypothalamic–pituitary–adrenal axis, resulting in elevated cortisol production and subsequent metabolic alterations that favor central fat accumulation. Behaviorally, discrimination-related stress may also influence eating behaviors, sleep patterns, physical activity, and emotional coping strategies, all of which have been linked to obesity risk.

However, the observed associations were no longer statistically significant after adjustment for baseline BMI and sociodemographic factors. Several interpretations may explain these findings. First, baseline adiposity appeared to account for a substantial portion of the observed relationship. This suggests that adolescents experiencing discrimination may already have entered adolescence with elevated obesity risk profiles before the follow-up period examined in the present study. Consequently, discrimination may contribute to earlier adiposity development rather than producing measurable short-term changes over the study interval.

Sex-stratified analyses suggested stronger crude associations among females than males. Female adolescents reporting high discrimination demonstrated approximately 44–45% greater risk of overweight/obesity and abdominal adiposity in unadjusted models, whereas males demonstrated smaller increases in risk. Although these differences were attenuated after adjustment and formal evidence of effect modification was limited, the pattern remains noteworthy. Previous literature suggests that adolescent females may experience greater psychological consequences associated with social stressors and may exhibit heightened physiological stress responses compared with males. Furthermore, girls frequently encounter multiple forms of appearance-related, gender-based, and social discrimination during adolescence that may influence body-related behaviors and stress coping mechanisms (Nesi et al., 2022; Ordaz & Luna, 2012; Ricci et al., 2026). The absence of significant adjusted sex differences in the present study may reflect limited statistical power for subgroup analyses.

The intersectionality analyses provided additional insight into how discrimination may operate across multiple social identities. Consistent with expectations, Black and Hispanic adolescents demonstrated higher risks of overweight/obesity independent of discrimination exposure (Kansra et al., 2021; Pinerros-Leano et al., 2022). However, evidence for multiplicative

interaction effects on BMI outcomes was generally limited. In contrast, more pronounced intersectional differences emerged for waist adiposity outcomes.

Most notably, female adolescents categorized as Asian/Other who reported high discrimination appeared to have greater risk of abdominal adiposity compared with the reference group. Although this pattern may indicate potential heterogeneity in the association between discrimination and adiposity across intersecting social identities, the finding should be interpreted cautiously. Central adiposity may be particularly sensitive to chronic psychosocial stress processes because abdominal fat accumulation has been closely linked to stress-related physiological pathways (Aschbacher et al., 2014). However, the confidence intervals surrounding this estimate were wide, and the Asian/Other category represents a heterogeneous grouping of racial and ethnic identities. Consequently, this result should be viewed as hypothesis-generating rather than definitive evidence of increased vulnerability and warrants replication in studies with larger samples and more granular racial/ethnic classifications.

These findings support core assumptions of intersectionality theory that health inequities emerge through interacting systems of power rather than through additive effects of individual identities alone (Carbado et al., 2013; Mosley et al., 2025). Traditional approaches examining race, sex, or discrimination independently may therefore underestimate the complexity through which social experiences influence health outcomes.

The racial centrality analyses provided suggestive evidence that identity-related factors may shape the relationship between discrimination and adiposity. Among adolescents with high racial centrality, the estimated association between discrimination and waist adiposity was weaker and consistently below the magnitude observed among adolescents with lower racial centrality. Additionally, the interaction term suggested an approximately 34% reduction in the

effect of discrimination among adolescents with stronger racial centrality, although statistical significance was not achieved.

These findings are consistent with theoretical work proposing that strong racial or ethnic identity may function as a psychosocial resource that buffers the adverse effects of discrimination (Mossakowski et al., 2019; Yip et al., 2008). Adolescents with stronger racial centrality may possess greater social support, stronger cultural connectedness, or more adaptive coping mechanisms that facilitate interpretation and processing of discriminatory experiences. Prior research has similarly reported protective associations between racial identity and mental health outcomes among youth exposed to discrimination. Although evidence in the present study was limited, the direction of findings suggests that identity processes warrant further investigation as potential resilience mechanisms.

The sensitivity analyses demonstrated highly consistent findings across alternative definitions of discrimination exposure. Redefining high discrimination using the 85th percentile threshold produced results nearly identical to those observed in primary analyses. The consistency of findings across thresholds strengthens confidence in the robustness of the overall conclusions and suggests that the observed attenuation after adjustment was unlikely to be an artifact of exposure categorization.

These findings have important implications for adolescent obesity prevention and health equity efforts. Although perceived ethnic discrimination did not independently predict adiposity after adjustment for baseline and contextual factors, the descriptive and intersectional findings suggest that discrimination is embedded within broader social and structural conditions that shape obesity risk. Consequently, obesity prevention strategies should not focus exclusively on individual behaviors such as diet and physical activity but should also consider upstream social

determinants, including discrimination, neighborhood conditions, and socioeconomic inequities. Interventions that promote supportive school environments, reduce discriminatory experiences, and address structural barriers to health may complement traditional obesity prevention approaches and contribute to more equitable health outcomes among adolescents.

Strengths and Limitations

Several limitations should be considered when interpreting these findings. First, discrimination was assessed through self-report measures and may be subject to recall bias or differences in individual perceptions of discriminatory experiences. Second, although the longitudinal design improves temporal ordering, the follow-up interval may not have been sufficient to detect longer-term physiological consequences of discrimination exposure. Third, residual confounding remains possible despite extensive adjustment. Unmeasured factors such as dietary patterns, stress coping strategies, family dynamics, or biological stress markers may contribute to observed relationships. Fourth, some subgroup analyses included relatively small sample sizes, particularly within interaction models, which may have limited statistical power and contributed to unstable estimates. Fifth, although the longitudinal design improves temporal ordering, the approximately one-year follow-up period may have been insufficient to capture adiposity changes resulting from cumulative discrimination-related stress. Because discrimination is theorized to influence obesity through long-term physiological and behavioral pathways, longer follow-up periods may be needed to fully evaluate its impact on adiposity trajectories. Finally, the heterogeneous Asian/Other category likely combined multiple distinct populations with differing social experiences and may obscure important within-group variability.

Despite these limitations, this study has several important strengths. The use of longitudinal data permitted examination of prospective relationships, IPCW methods reduced potential bias associated with attrition, and multiple adiposity measures captured both general and central obesity. Additionally, the incorporation of intersectionality and racial centrality extends prior work by moving beyond traditional main-effects approaches and examining how discrimination may operate within broader social contexts.

CONCLUSION

Overall, the present findings suggest that discrimination is socially patterned and that higher perceived racial and ethnic discrimination was associated with greater adiposity in unadjusted analyses. However, this association was attenuated and no longer statistically significant after adjustment for baseline adiposity and sociodemographic characteristics. Nonetheless, the intersectionality and racial centrality findings indicate that the association between discrimination and obesity may differ across social identities and psychosocial contexts. Future research should investigate the relationship between discrimination and obesity in younger children and further explore the role of racial centrality in the relationship.

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Table 1. Baseline demographic and health characteristics of adolescents stratified by perceived ethnic discrimination status.

	Discrimination	
	None/Low	High
	N= 7958 n(%)	N= 910 n(%)
Child Age (months, mean [SD])	119.12 (7.48)	118.76 (7.45)
Child Sex Female	3834 (48.2)	348 (38.2)
Child Race White	4677 (58.8)	306 (33.6)
Black	884 (11.1)	248 (27.3)
Hispanic	1423 (17.9)	233 (25.6)
Other	974 (12.2)	123 (13.5)
Nativity US Born	7747 (97.4)	872 (95.9)
Child Education Grade School	7956 (100.0)	910 (100.0)
Child Depression Normal	7390 (92.9)	823 (90.4)
Borderline	357 (4.5)	56 (6.2)
Clinical	210 (2.6)	31 (3.4)
Child Obesity Healthy Weight	5287 (66.6)	519 (57.7)
Obesity	1257 (15.8)	217 (24.1)
Overweight	1398 (17.6)	163 (18.1)
Child Physical Activity	3.57 (2.30)	3.21 (2.35)

Note. Values are presented as *n* (%) unless otherwise indicated; continuous variables are presented as mean (SD). Percentages may not total 100% due to rounding. Group differences were evaluated using chi-square tests for categorical variables and independent *t* tests for continuous variables. Child obesity categories were defined using age- and sex-specific CDC body mass index percentile cutoffs (healthy weight: 5th to <85th percentile; overweight: 85th to <95th percentile; obesity: ≥95th percentile). Depression categories were derived from standardized symptom measures.

Table 2. Family and neighborhood characteristics of adolescents stratified by perceived ethnic discrimination status

	Discrimination	
	None / Low	High
	N=7958	N=910
	n(%)	n(%)
Parent Nativity		
US Born	1241 (49.5)	130 (43.2)
Non-US Born <10 yrs	119 (4.7)	21 (7.0)
Non-US Born ≥10 yrs	1146 (45.7)	150 (49.8)
Parent Education		
Under High School	409 (5.1)	88 (9.7)
High School / GED	680 (8.6)	128 (14.1)
Above High School	6859 (86.3)	690 (76.2)
Parent Marital Status		
Never Married	779 (9.8)	182 (20.1)
Married/Living with partner	6098 (77.1)	581 (64.2)
Widowed/Divorced/Separated	1034 (13.1)	142 (15.7)
Parent Income		
<\$35k	1203 (16.3)	299 (36.5)
\$35k–\$74,999	1671 (22.6)	211 (25.7)
≥\$75k	4522 (61.1)	310 (37.8)
Neighborhood		
Safety	3.95 (0.94)	3.66 (1.07)
Disadvantage	0.10 (0.09)	0.15 (0.13)
Healthy Foods	4.00 (6.01)	5.92 (9.58)
Walkability	10.48 (3.72)	10.69 (3.71)
Note. Values are presented as <i>n</i> (%) unless otherwise indicated; continuous variables are presented as mean (SD). Percentages may not total 100% because of rounding. Group differences between adolescents with none/low and high perceived ethnic discrimination were assessed using chi-square tests for categorical variables and independent <i>t</i> tests for continuous variables. Neighborhood measures were derived from standardized composite indices, with higher values indicating greater levels of the corresponding construct.		

Table 3. IPCW-weighted Poisson regression models examining associations between perceived ethnic discrimination and adiposity outcomes

		Model 1	Model 2	Model 3
	Cases, n(%)	RR, 95% CI	RR, 95% CI	RR, 95% CI
Discrimination				
Overweight/Obesity				
None/Low	2655 (33.36)	Ref.	Ref.	Ref.
High	380 (41.75)	1.26 (1.16-1.37)	1.02 (0.88-1.18)	1.03 (0.91-1.18)
Waist Adiposity				
None/Low	1787 (22.45)	Ref.	Ref.	Ref.
High	266 (29.23)	1.27 (1.14-1.42)	0.89 (0.70-1.13)	0.97 (0.800-1.17)

Note. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting; Ref. = reference category. Risk ratios and 95% confidence intervals were estimated using IPCW-weighted modified Poisson regression models with a log link. BMI outcome represents overweight/obesity status (body mass index ≥ 85 th percentile for age and sex). Waist circumference outcome represents waist adiposity (≥ 90 th percentile for age and sex). Model 1 = unadjusted. Model 2 = adjusted for child age, child sex, and baseline BMI. Model 3 = adjusted for child age, child sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI.

Table 4. Sex-stratified IPCW-weighted modified Poisson regression models examining associations between perceived ethnic discrimination and adiposity outcomes

Discrimination	Cases, n(%)	Model 1	Model 2	Model 3
		RR, 95% CI	RR, 95% CI	RR, 95% CI
Male				
Overweight/Obesity				
None/Low	1412 (34.2)	Ref.	Ref.	Ref.
High	220 (39.1)	1.15 (1.02-1.28)	1.01 (0.90-1.13)	1.01 (0.87-1.18)
Waist Adiposity				
None/Low	941 (22.8)	Ref.	Ref.	Ref.
High	152 (27.0)	1.16 (1.00-1.35)	0.99 (0.85-1.17)	1.02 (0.82-1.26)
Female				
Overweight/Obesity				
None/Low	1243 (32.4)	Ref.	Ref.	Ref.
High	160 (46.0)	1.44 (1.27-1.63)	1.06 (0.82-1.36)	1.04 (0.82-1.32)
Waist Adiposity				
None/Low	846 (22.1)	Ref.	Ref.	Ref.
High	114 (32.8)	1.45 (1.23-1.72)	0.84 (0.58-1.20)	0.79 (0.55-1.14)

Note. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting; Ref. = reference category. Risk ratios and 95% confidence intervals were estimated using IPCW-weighted modified Poisson regression models with a log link. BMI outcome represents overweight/obesity status (body mass index ≥ 85 th percentile for age and sex). Waist circumference outcome represents waist adiposity (≥ 90 th percentile for age and sex). Model 1 = unadjusted. Model 2 = adjusted for child age and baseline BMI. Model 3 = adjusted for child age, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI. Analyses were stratified by sex.

Table 5. Multiplicative interaction effects between perceived ethnic discrimination, sex, and race/ethnicity on adiposity outcomes among adolescents

Interaction term	Overweight/Obesity	Waist Adiposity
	RR (95%CI)	RR (95%CI)
Discrimination x Female	1.15 (0.85-1.56)	0.93 (0.61-1.43)
Discrimination x Black	0.83 (0.64-1.06)	0.84 (0.6-1.16)
Discrimination x Hispanic	0.96 (0.75-1.23)	0.92 (0.65-1.31)
Discrimination x Asian/Other	0.74 (0.47-1.18)	0.37 (0.18-0.75)
Female x Black	1.04 (0.89-1.23)	1.08 (0.85-1.36)
Female x Hispanic	1.02 (0.83-1.25)	1.26 (1.04-1.52)
Female x Asian/Other	1.07 (0.9-1.27)	1.15 (0.9-1.46)
Discrimination x Female x Black	0.69 (0.31-1.55)	0.47 (0.13-1.72)
Discrimination x Female x Hispanic	0.91 (0.58-1.43)	0.86 (0.47-1.6)
Discrimination x Female x Asian/Other	1.24 (0.68-2.25)	3.46 (1.47-8.15)

Note. RR = risk ratio; CI = confidence interval. Risk ratios and 95% confidence intervals were estimated from IPCW-weighted modified Poisson regression models with a log link. Models were adjusted for child age, baseline BMI, race/ethnicity, parent nativity, parent education, and parent marital status. Reference categories were male sex, White race/ethnicity, and none/low perceived ethnic discrimination. Interaction terms represent multiplicative effects beyond lower-order effects. Overweight/obesity was defined as body mass index ≥ 85 th percentile for age and sex; waist adiposity was defined as waist circumference ≥ 90 th percentile for age and sex.

Table 6. Sensitivity analysis examining associations between perceived ethnic discrimination and adiposity outcomes using an alternative discrimination threshold (85th percentile): IPCW-weighted modified Poisson regression models

Discrimination	Model 1 RR, 95% CI	Model 2 RR, 95% CI	Model 3 RR, 95% CI
Overweight/Obesity			
None/Low	Ref.	Ref.	Ref.
High	1.25 (1.17-1.35)	1.05 (0.93-1.18)	1.06 (0.94-1.19)
Waist Adiposity			
None/Low	Ref.	Ref.	Ref.
High	1.29 (1.17-1.42)	0.97 (0.81-1.15)	1.06 (0.91-1.25)

Note. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting; Ref. = reference category. Risk ratios and 95% confidence intervals were estimated using IPCW-weighted modified Poisson regression models with a log link. For this sensitivity analysis, high perceived ethnic discrimination was defined using the 85th percentile threshold rather than the primary analysis threshold. Overweight/obesity was defined as body mass index $\geq$ 85th percentile for age and sex, and waist adiposity was defined as waist circumference $\geq$ 90th percentile for age and sex. Model 1 = unadjusted. Model 2 = adjusted for child age, child sex, and baseline BMI. Model 3 = adjusted for child age, child sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI.

Table 7. Effect modification by racial centrality in the association between perceived ethnic discrimination and overweight/obesity among adolescents

Racial Centrality	Model	RR (95% CI)
Low/Moderate	Model 1	1.38 (1.2-1.59)
	Model 2	0.89 (0.64-1.23)
	Model 3	1.13 (0.94-1.35)
High	Model 1	0.97 (0.75-1.26)
	Model 2	0.77 (0.57-1.04)
	Model 3	0.84 (0.52-1.34)

Note. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting. Risk ratios and 95% confidence intervals were estimated using IPCW-weighted modified Poisson regression models with a log link. Analyses were stratified by racial centrality level (low/moderate versus high). Overweight/obesity was defined as body mass index ≥ 85 th percentile for age and sex. Model 1 = unadjusted. Model 2 = adjusted for child age, child sex, and baseline BMI. Model 3 = adjusted for child age, child sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI.

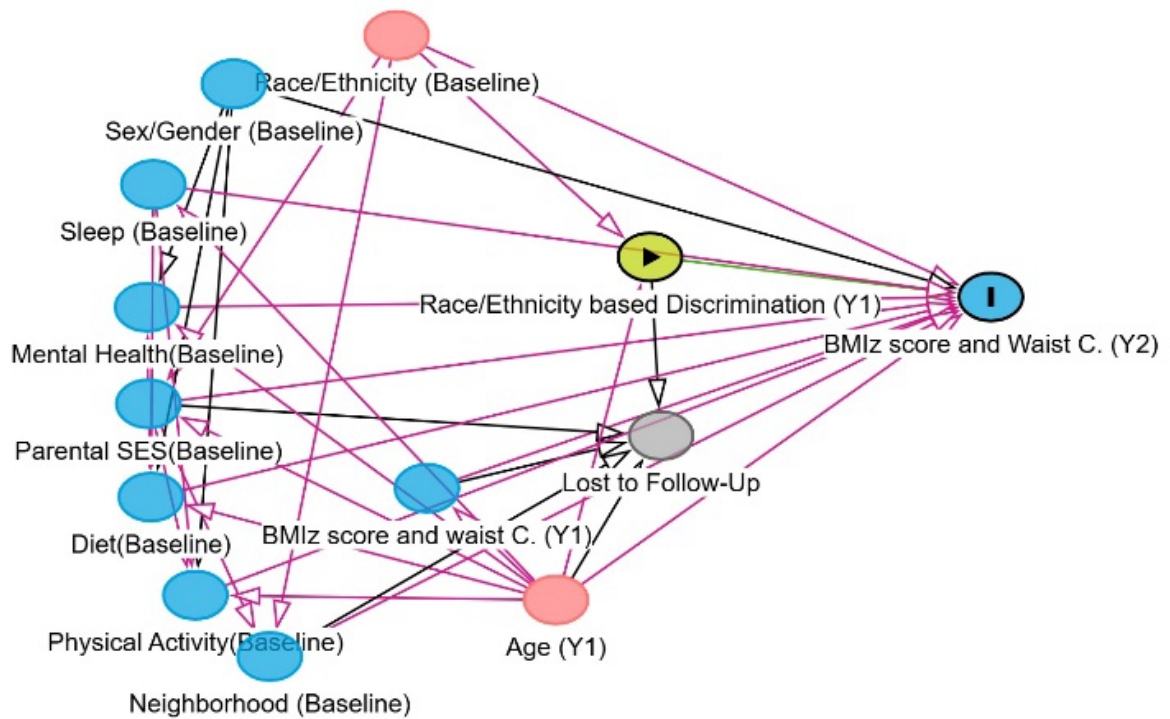


Figure 2. Directed acyclic graph (DAG) illustrating the hypothesized causal relationships among perceived race/ethnicity-based discrimination, adiposity outcomes, potential confounders, and selection processes.

Note. The directed acyclic graph (DAG) represents the hypothesized causal structure underlying the association between perceived race/ethnicity-based discrimination measured at Year 1 (Y1) follow-up and adiposity outcomes (body mass index [BMI] and waist circumference) measured at Year 2 (Y2) follow-up in the ABCD Study. Baseline sociodemographic, behavioral, psychosocial, and neighborhood characteristics were identified as potential confounders based on prior literature and subject-matter knowledge. Baseline BMI and waist circumference were included to account for pre-existing adiposity. The node representing loss to follow-up reflects potential selection bias due to attrition between Y1 and Y2; inverse probability of censoring weighting (IPCW) was used to account for differential loss to follow-up. Arrows indicate hypothesized causal relationships and do not represent observed associations.

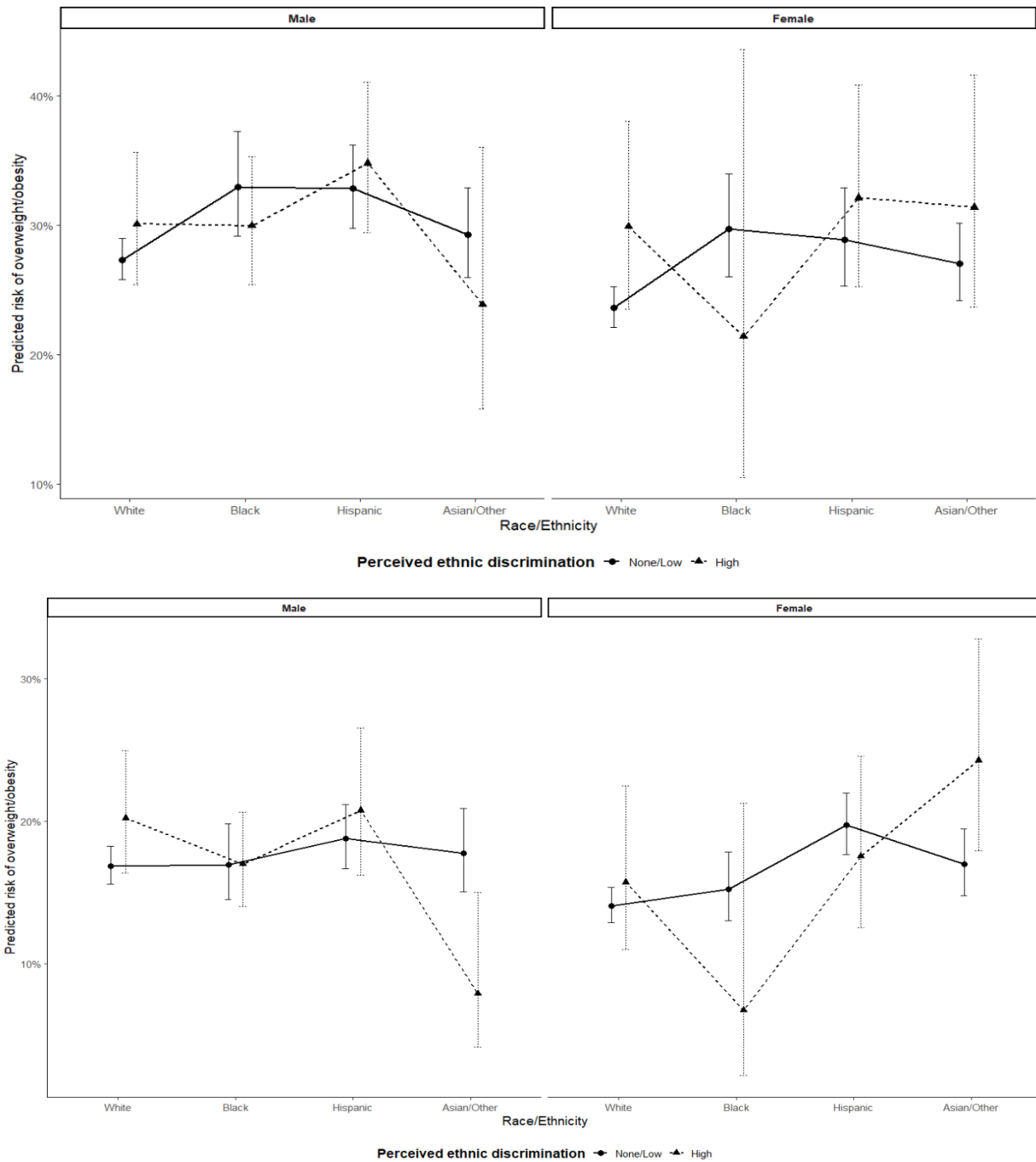


Figure 3. Predicted Risk of Adiposity by Perceived Ethnic Discrimination, Sex, and Race/Ethnicity.

Chapter 3 ASSOCIATION BETWEEN STATE-LEVEL STRUCTURAL STIGMA AND ADIPOSITY AMONG ADOLESCENTS

ABSTRACT

Background: Structural stigma has emerged as an important social determinant of health, yet its relationship with adolescent adiposity (excess body fat) remains poorly understood. This study examined the prospective association between state-level structural stigma and adiposity among U.S. adolescents and explored whether associations differed across intersecting race/ethnicity and sex.

Methods: Data were obtained from participants in the Adolescent Brain Cognitive Development (ABCD) Study. Structural stigma was measured at baseline using a state-level index incorporating racism, sexism, and sexual orientation stigma. Adiposity outcomes assessed two years later included overweight/obesity (≥ 85 th percentile) and waist circumference adiposity (≥ 90 th percentile). Social identities considered in the intersectionality analyses included sex, recorded as male or female, and parent-reported race/ethnicity, categorized as non-Hispanic White, non-Hispanic Black, Hispanic, and Asian/Other. Inverse probability of censoring weighted regression models estimated risk ratios (RRs) and 95% confidence intervals (CIs), adjusting for demographic, socioeconomic, and baseline adiposity characteristics. Sex-stratified analyses were conducted, and multiplicative interaction models including two-way (structural stigma $\times$ sex, structural stigma $\times$ race/ethnicity, and sex $\times$ race/ethnicity) and three-way (structural stigma $\times$ sex $\times$ race/ethnicity) interaction terms were fitted to examine whether associations differed across intersecting social identities. Sensitivity analyses were conducted.

Results: In unadjusted analyses, higher structural racism was associated with greater risk of both overweight/obesity (RR = 1.13, 95% CI: 1.08–1.17) and abdominal adiposity (RR =

1.13, 95% CI: 1.07–1.19). After adjustment for demographic, family, and baseline adiposity characteristics, associations were attenuated, with only a modest association remaining between structural racism and overweight/obesity (RR = 1.07, 95% CI: 1.00–1.15). Structural sexism and sexual orientation stigma were not associated with adiposity outcomes after adjustment. Sex-stratified and intersectionality analyses demonstrated similar patterns across sex and racial/ethnic groups. Sensitivity analyses using continuous outcomes identified a small positive association between sexual orientation stigma and BMI but did not demonstrate consistent associations for the remaining structural stigma domains.

Conclusions: State-level structural stigma was not independently associated with adolescent adiposity after adjustment for individual and family characteristics.

INTRODUCTION

Adolescent obesity remains a major public health challenge in the United States, affecting approximately one in five youth and contributing substantially to long-term morbidity and mortality (CDC, 2026). Overweight/ Obesity during adolescence is associated with increased risk of cardiovascular disease, hypertension, insulin resistance, type 2 diabetes, and adverse psychosocial outcomes, while also increasing the likelihood of obesity persistence into adulthood (CDC, 2026; Kansra et al., 2021). Although traditional obesity research has emphasized individual behaviors such as diet and physical activity, growing evidence suggests that obesity is also shaped by broader social, political, and environmental conditions that influence health across the life course (Adamou et al., 2025b; Hemmingsson et al., 2023; Martino et al., 2025; Rubeis et al., 2025; Yang et al., 2021). Consequently, researchers have increasingly called for

greater attention to upstream social determinants that may contribute to obesity disparities among children and adolescents.

One social determinant that has received increasing attention is stigma. Stigma refers to social processes through which individuals or groups are devalued, marginalized, or excluded because of socially constructed characteristics or identities (Andersen et al., 2022; Liamputtong & Rice, 2022; O'Brien et al., 2023). Historically, stigma research has focused primarily on interpersonal experiences such as discrimination, prejudice, and victimization. Studies have demonstrated that adolescents who experience discrimination report higher levels of psychological distress, depressive symptoms, disordered eating behaviors, and adverse physical health outcomes (A. Benner, 2017; A. D. Benner et al., 2018).

While interpersonal experiences of discrimination are important, contemporary stigma theory emphasizes that stigma operates across multiple levels of society (Rao et al., 2019). *Structural* stigma refers to societal-level conditions, institutional policies, cultural norms, and social practices that systematically disadvantage specific social groups (Gordon et al., 2024; Martino et al., 2025). Unlike individual acts of discrimination, structural stigma is embedded within broader social systems and may influence health regardless of whether individuals directly experience discriminatory encounters (Gordon et al., 2024; Stepanikova et al., 2017). Structural stigma can be reflected in exclusionary policies, unequal access to social and economic resources, discriminatory institutional practices, and widespread societal attitudes that reinforce the marginalization of particular populations (Hatzenbuehler & Link, 2014). For example, a high structural stigma environment may include states with fewer legal protections against discrimination, policies that restrict the rights of marginalized groups, and more negative public attitudes toward racial/ethnic minorities, women, and sexual minority populations. These

structural conditions can shape access to educational, economic, and healthcare opportunities and contribute to chronic psychosocial stress, even among individuals who do not directly experience interpersonal discrimination.

Recent research has demonstrated that structural stigma is associated with a variety of adverse health outcomes (Hatzenbuehler & Link, 2014). Among adolescents, structurally stigmatizing environments have been linked to elevated rates of depression, anxiety, suicidality, substance use, and psychological distress (Martino et al., 2025; Price & Hollinsaid, 2022). Studies examining sexual minority youth, racial and ethnic minority populations, and other marginalized groups suggest that structural stigma may contribute to chronic stress exposure and reduced access to supportive environments, thereby influencing developmental trajectories during adolescence (Martino et al., 2025). However, despite increasing evidence connecting structural stigma to mental health outcomes, considerably less is known about its potential relationship with physical health outcomes, particularly obesity and adiposity.

Several mechanisms suggest that structural stigma may influence obesity risk. Chronic exposure to stigmatizing social environments may activate physiological stress pathways involving the hypothalamic-pituitary-adrenal axis, resulting in prolonged elevations in cortisol and other stress-related hormones that contribute to fat accumulation and metabolic dysregulation (Scott et al., 2012). Structural stigma may also shape neighborhood environments by influencing residential segregation, economic opportunity, educational access, and the availability of health-promoting resources such as recreational facilities, safe spaces for physical activity, and healthy food options (Turner & Greene, 2021). These pathways suggest that structural stigma may contribute to obesity risk not only through individual experiences of

discrimination but also through broader contextual conditions that shape opportunities for healthy development.

Importantly, structural stigma is not experienced uniformly across populations. Intersectionality theory posits that health outcomes are shaped by the simultaneous operation of multiple systems of power and oppression, including racism, sexism, heterosexism, and other forms of social stratification (Alvidrez et al., 2021; Carbado et al., 2013). Rather than functioning independently, these systems interact to create unique experiences of advantage and disadvantage across social groups. Adolescents who occupy multiple marginalized social positions may therefore experience heightened vulnerability to the health consequences of structurally stigmatizing environments (Martino et al., 2025). Despite increasing recognition of intersectionality within public health research, relatively few studies have examined whether associations between structural stigma and obesity differ across intersecting identities such as sex and race/ethnicity.

The present study addresses these gaps by examining whether exposure to state-level structural stigma related to race/ethnicity, gender, and sexual orientation is associated with subsequent adiposity among adolescents participating in the Adolescent Brain Cognitive Development (ABCD) Study. Unlike the other chapters of this dissertation, which examine adolescents' self-reported experiences of discrimination, this chapter focuses on structural stigma as an upstream, state-level social determinant that may influence adolescent adiposity independent of individual experiences of discrimination. Given prior evidence linking stigma-related stress to obesity-related outcomes, we hypothesized that adolescents residing in high structural stigma environments would demonstrate greater risk of overweight/obesity and abdominal adiposity compared with adolescents residing in lower stigma environments. We

further hypothesized that these associations would be more pronounced among adolescents occupying multiple marginalized social positions, particularly among racial and ethnic minority girls.

METHODS

Study Design and Data Source

This study used a prospective longitudinal design to evaluate the association between state-level structural stigma and adiposity among adolescents using data from the Adolescent Brain Cognitive Development Study (v5.1). The ABCD Study is a nationally distributed ongoing longitudinal cohort that follows children to examine trajectories of brain development (Barch et al., 2018). Between 2016 and 2018, participants were enrolled from 21 research sites across the United States using probability-based sampling strategies designed to recruit a cohort that closely reflects the demographic characteristics of U.S. children. . At baseline and annual follow-up visits, the ABCD Study collects information on physical health, psychosocial functioning, environmental exposures, and neurodevelopment through annual follow-up visits.

The present analyses utilized structural stigma measured at Baseline (2016–2017, age 9) as the primary exposure and adiposity outcomes measured at Year 2 follow-up (2018–2020, age 11).

Study Sample

Participants were eligible for inclusion if they had available data on structural stigma at baseline and adiposity outcomes at Year 2. Participants with missing data on primary exposure variables, outcome variables, or key covariates (collected at baseline) were excluded from complete case analyses.

The analytic sample was derived from participants enrolled in the ABCD Study who had available anthropometric and covariate data across study waves. Of the 11,868 participants initially available, 735 were excluded due to missing height or weight measurements at baseline, resulting in a sample of 11,133 participants. An additional 2,261 participants were excluded because height or weight measurements were unavailable at Year 2, yielding a final analytic sample of 8,868 adolescents.

Measures

Structural Stigma

The primary exposure for Aim 2 is state-level structural stigma measured at baseline, which is measured using three composite indices that reflect societal attitudes, institutional policies, and social conditions related to race/ethnicity, gender, and sexual orientation. These indices were constructed from publicly available datasets (Gordon et al., 2024; Martino et al., 2025). This structural stigma score is calculated at the state-level and was linked to the ABCD Study using participants geocoded address. Sources included large-scale surveys such as the General Social Survey and Pew Research Center that assess population-level endorsement of prejudicial attitudes; policy databases that code the inclusiveness or restrictiveness of state laws across domains such as immigration, education, and housing; and contextual indicators that serve as proxies for supportive environments, such as the proportion of high schools with Gay-Straight Alliances (GSAs) (Gordon et al., 2024; Martino et al., 2025).

Each index was independently subjected to exploratory factor analysis, with items required to load at or above 0.40 onto a single latent factor. This approach yielded a unidimensional structural stigma score for each identity domain, supporting construct validity.

These factor scores were computed at the state level and linked to ABCD Study participants according to their study site location (Gordon et al., 2024; Martino et al., 2025).

For this analysis, structural stigma was examined separately across three domains: racism, sexism, and sexual orientation stigma. State-level continuous indices for each structural stigma domain were assigned to participants based on their state of residence. Each index was analyzed as a continuous exposure, with higher values representing greater levels of structural stigma within that domain (Gordon et al., 2024; Martino et al., 2025)

Adiposity Outcomes

Adiposity outcomes included body mass index (BMI)-defined overweight/obesity and waist circumference-defined abdominal adiposity. All anthropometric measurements were obtained by trained study personnel using standardized ABCD Study protocols (Barch et al., 2018).

For BMI measurement, participants' height and weight were measured by trained research staff while wearing light clothing and no shoes. Height was recorded to the nearest 0.1 cm and weight to the nearest 0.1 kg. Body mass index was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Age- and sex-specific BMI percentiles and z-scores were calculated using Centers for Disease Control and Prevention growth chart reference standards. Participants were categorized as underweight (<5th percentile), healthy weight (5th to <85th percentile), overweight (85th to <95th percentile), and obesity ($\geq$ 95th percentile). For the primary analyses, BMI was dichotomized as healthy weight (<85th percentile) versus overweight/obesity ($\geq$ 85th percentile), consistent with established pediatric definitions(CDC, 2024).

Waist circumference was assessed three times at the level of the iliac crest following standardized protocols, and the average of the three measurements was used in all analyses (Barch et al., 2018). Age- and sex-specific waist circumference percentiles were derived using National Health and Nutrition Examination Survey reference values based on the LMS method (A. K. Sharma et al., 2015). Abdominal adiposity was defined as waist circumference at or above the 90th percentile for age and sex.

To account for pre-existing differences in adiposity, baseline BMI and baseline waist circumference were included as covariates in their corresponding longitudinal models.

Covariates

Covariates were selected a priori based and previous literature examining relationships between state-level structural stigma and obesity-related outcomes among adolescents (Arubuolawe et al., n.d.; Hooper et al., 2022; Raney et al., 2023). Demographic variables included age, sex assigned at birth (male and female), race/ethnicity (white, black/African American, Hispanic, Asian/other), and nativity status (us born, foreign born living in the USA for less than 10 years and foreign born living in the USA for 10 years or more (collected at baseline). Socioeconomic and family-level characteristics included parent educational attainment (less than highschool, highschool, more than highschool), parent marital status (never married, married/living with a partner, widowed/divorced/separated), and parent nativity (collected at baseline). Baseline BMI measures were additionally included to account for preexisting differences in weight status (Figure 4).

Statistical Analysis

All analyses were conducted using R statistical software version 4.2.0. Descriptive analyses were performed to summarize participant characteristics overall and according to each

structural domain. Continuous variables are presented as means and standard deviations, whereas categorical variables are summarized using frequencies and percentages.

To address potential selection bias arising from differential loss to follow-up and missing outcome data, inverse probability of censoring weights (IPCW) were incorporated into all multivariable models.. Stabilized IPCW were estimated using baseline demographic and clinical characteristics associated with study retention. (Figure 4) . Stabilized weights were calculated using the marginal probability of remaining under observation at Year 2 follow-up as the numerator and the predicted probability of remaining under observation from a logistic regression model as the denominator. The censoring model included baseline age, neighborhood safety score, body mass index (BMI), and anxiety/depression status. To improve estimator stability and the potential influence of extreme weights, stabilized weights were truncated at the 1st and 99th percentiles. Weight distributions were examined prior to analysis and demonstrated minimal variability, indicating no evidence of substantial extreme weights or violations of the positivity assumption. All weighted analyses were implemented using the survey package in R.

The primary analyses examined the associations between each structural stigma domain and adiposity outcomes were examined using modified Poisson regression models with a log link and robust variance estimation to directly estimate risk ratios (RRs) and 95% confidence intervals (CIs). Separate models were estimated for overweight/obesity and elevated waist circumference. For each adiposity outcome, separate unadjusted and adjusted regression models were estimated for the racism, sexism, and sexual orientation structural stigma indices. Unadjusted models included a single structural stigma index, whereas adjusted models additionally controlled for age, sex, race/ethnicity, parental nativity, parental education, parental marital status, and baseline BMI.

Adjusted sex-stratified analyses were conducted to examine whether associations differed between male and female adolescents. Additional analyses evaluated whether relationships between each structural stigma domain and adiposity varied across combinations of social identities. To the adjusted model, two-way interaction terms were added one at a time, two-way (sex x stigma and race/ethnicity x stigma) whether the association between structural stigma and adiposity were modified by race/ethnicity and sex. In a separate model, a three-way interaction terms was added to the adjusted model (sex x race/ethnicity x stigma) to assess whether the effects of stigma on adiposity outcomes were modified by intersecting social identities. Predicted probabilities were calculated and visualized to facilitate interpretation of significant interaction effects. For three-way interaction models, predicted risks were estimated across levels of each structural stigma index by race/ethnicity and displayed separately for male and female adolescents. Estimates were plotted using ggplot2.

Sensitivity Analyses

Sensitivity analyses were conducted using continuous measures of BMI and waist circumference at Year 2 in place of the dichotomous adiposity outcomes. Survey-weighted linear regression models were estimated separately for the racism, sexism, and sexual orientation structural stigma indices. Unadjusted and adjusted models included the same covariates used in the primary analyses to evaluate the robustness of the observed associations across alternative outcome specifications.

RESULTS

Table 8 presents the baseline demographic and health characteristics of the analytic sample (N = 8,868). The mean age of participants was 9.9 years (SD = 0.62), and 47.2% were

female. Most participants identified as White (56.2%), followed by Hispanic (18.7%), Black (12.8%), and Other race/ethnicity (12.4%). The majority of adolescents were born in the United States (97.3%). Most participants were classified as having normal depressive symptoms (92.6%), while 4.7% were categorized as borderline and 2.7% as clinical. Based on baseline body mass index, 61.9% of adolescents were classified as having a healthy weight, 16.1% as overweight, and 18.3% as obese. The mean physical activity score was 3.53 (SD = 2.30).

Table 9 presents the baseline family and neighborhood characteristics of the analytic sample. Among participants with available parental nativity data, 48.8% had parents who were born in the United States, 46.2% had parents who were born outside the United States and had resided in the country for at least 10 years, and 5.0% had parents who had resided in the United States for fewer than 10 years. Most parents had attained education above the high school level (85.3%), while 9.1% had completed high school or a General Educational Development (GED) credential and 5.6% had less than a high school education. Most parents were married or living with a partner (75.8%), whereas 13.3% were widowed, divorced, or separated and 10.9% had never been married. More than half of households reported an annual income of at least \$75,000 (58.8%), followed by incomes of \$35,000–\$74,999 (22.9%) and less than \$35,000 (18.3%). The mean neighborhood safety score was 3.92 (SD = 0.95), the mean neighborhood disadvantage index was 0.11 (SD = 0.10), the mean healthy food environment score was 4.19 (SD = 6.49), and the mean walkability score was 10.50 (SD = 3.72).

Association of structural stigma on adiposity

Table 10 presents the associations between each continuous structural stigma domain index and adiposity outcomes. The structural sexism, sexual orientation stigma, and racism indices had mean (SD) values of –0.23 (0.92), –0.25 (0.88), and –0.17 (0.74), respectively.

For BMI-defined overweight/obesity, the unadjusted model showed a positive association for the structural racism index (RR = 1.13, 95% CI [1.08, 1.17]), whereas the structural sexism (RR = 1.03, 95% CI [1.00, 1.06]) and structural sexual orientation stigma (RR = 0.99, 95% CI [0.95, 1.02]) indices demonstrated smaller associations. After adjustment for child age, sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI, the estimated risk ratios were 1.04 (95% CI [0.99, 1.10]) for the structural sexism index, 1.04 (95% CI [0.99, 1.09]) for the structural sexual orientation stigma index, and 1.07 (95% CI [1.00, 1.15]) for the structural racism index.

For waist adiposity, unadjusted models yielded risk ratios of 1.05 (95% CI [1.00, 1.09]) for the structural sexism index, 0.98 (95% CI [0.94, 1.03]) for the structural sexual orientation stigma index, and 1.13 (95% CI [1.07, 1.19]) for the structural racism index. In adjusted models, the estimated risk ratios were 1.03 (95% CI [0.96, 1.11]) for the structural sexism index, 1.01 (95% CI [0.94, 1.09]) for the structural sexual orientation stigma index, and 1.06 (95% CI [0.97, 1.17]) for the structural racism index.

Table 11 presents sex-stratified associations between each continuous structural stigma domain index and adiposity outcomes. Among male adolescents, the structural racism index had a mean (SD) of -0.18 (0.74), the structural sexism index had a mean (SD) of -0.23 (0.92), and the structural sexual orientation stigma index had a mean (SD) of -0.25 (0.88). For BMI-defined overweight/obesity, unadjusted risk ratios were 1.09 (95% CI [1.03, 1.15]) for the structural racism index, 1.02 (95% CI [0.98, 1.06]) for the structural sexism index, and 0.97 (95% CI [0.92, 1.01]) for the structural sexual orientation stigma index. After adjustment, the estimated risk ratios were 1.05 (95% CI [0.96, 1.15]), 1.04 (95% CI [0.97, 1.12]), and 1.04 (95% CI [0.97, 1.12]), respectively. For waist adiposity, unadjusted risk ratios were 1.11 (95% CI [1.04, 1.19])

for the structural racism index, 1.03 (95% CI [0.98, 1.09]) for the structural sexism index, and 0.96 (95% CI [0.90, 1.02]) for the structural sexual orientation stigma index. Adjusted risk ratios were 1.04 (95% CI [0.92, 1.17]), 1.03 (95% CI [0.94, 1.13]), and 1.02 (95% CI [0.93, 1.11]), respectively.

Among female adolescents, the structural racism, structural sexism, and structural sexual orientation stigma indices had mean (SD) values of -0.17 (0.75), -0.24 (0.91), and -0.25 (0.87), respectively. For BMI-defined overweight/obesity, unadjusted risk ratios were 1.17 (95% CI [1.10, 1.24]) for the structural racism index, 1.05 (95% CI [1.00, 1.10]) for the structural sexism index, and 1.01 (95% CI [0.96, 1.06]) for the structural sexual orientation stigma index. Corresponding adjusted risk ratios were 1.10 (95% CI [0.99, 1.23]), 1.05 (95% CI [0.97, 1.14]), and 1.04 (95% CI [0.96, 1.13]), respectively. For waist adiposity, unadjusted risk ratios were 1.14 (95% CI [1.06, 1.23]) for the structural racism index, 1.06 (95% CI [1.00, 1.13]) for the structural sexism index, and 1.01 (95% CI [0.95, 1.08]) for the structural sexual orientation stigma index. After adjustment, the estimated risk ratios were 1.10 (95% CI [0.95, 1.28]), 1.03 (95% CI [0.91, 1.16]), and 0.99 (95% CI [0.87, 1.13]), respectively.

Intersectionality

Table 12 presents the multiplicative interaction analyses evaluating whether the associations between the continuous structural stigma domain indices and adiposity outcomes varied across sex, race/ethnicity, and their intersection. For BMI-defined overweight/obesity, the interaction risk ratios for sex ranged from 1.03 (95% CI [0.92, 1.16]) for the structural sexual orientation stigma index to 1.09 (95% CI [0.95, 1.24]) for the structural racism index. Race/ethnicity interaction estimates for the structural racism index ranged from 0.98 (95% CI

[0.77, 1.26]) among Black adolescents to 1.09 (95% CI [0.88, 1.36]) among Asian/Other adolescents. For the structural sexism index, interaction risk ratios ranged from 0.96 (95% CI [0.78, 1.19]) among Black adolescents to 1.14 (95% CI [0.97, 1.34]) among Asian/Other adolescents. Interaction estimates for the structural sexual orientation stigma index ranged from 1.03 (95% CI [0.91, 1.17]) among Hispanic adolescents to 1.20 (95% CI [1.03, 1.41]) among Asian/Other adolescents. Three-way interaction risk ratios involving structural stigma, sex, and race/ethnicity ranged from 0.92 (95% CI [0.66, 1.27]) to 1.52 (95% CI [0.93, 2.48]).

For waist adiposity, sex-by-structural stigma interaction risk ratios ranged from 0.98 (95% CI [0.85, 1.13]) for the structural sexual orientation stigma index to 1.11 (95% CI [0.92, 1.32]) for the structural racism index. Race/ethnicity interaction estimates for the structural racism index ranged from 0.87 (95% CI [0.71, 1.07]) among Hispanic adolescents to 1.11 (95% CI [0.84, 1.48]) among Asian/Other adolescents. For the structural sexism index, interaction risk ratios ranged from 0.80 (95% CI [0.68, 0.95]) among Hispanic adolescents to 1.05 (95% CI [0.85, 1.30]) among Asian/Other adolescents. Interaction estimates for the structural sexual orientation stigma index ranged from 0.80 (95% CI [0.67, 0.96]) among Hispanic adolescents to 1.10 (95% CI [0.89, 1.35]) among Asian/Other adolescents. Three-way interaction risk ratios ranged from 0.83 (95% CI [0.54, 1.28]) to 1.73 (95% CI [0.84, 3.56]).

Adjusted Predicted Probabilities

Figure 5 displays adjusted predicted probabilities of overweight/obesity across the range of each continuous structural stigma domain index, stratified by sex and race/ethnicity. Predicted probabilities are presented separately for the structural racism, structural sexism, and structural sexual orientation stigma indices across White, Black, Hispanic, and Asian/Other adolescents.

Across the structural racism index, predicted probabilities were relatively stable among White adolescents for both sexes. Among Black adolescents, predicted probabilities increased across the structural racism index for females and decreased for males. Hispanic adolescents demonstrated modest increases in predicted probabilities across the index for both sexes, whereas Asian/Other adolescents exhibited gradual increases across the index for both females and males.

For the structural sexism index, predicted probabilities among White adolescents remained relatively constant across the range of the index. Among Black adolescents, predicted probabilities increased across the index for females and decreased for males. Hispanic adolescents demonstrated relatively small changes in predicted probabilities across the index for both sexes. Among Asian/Other adolescents, predicted probabilities increased across the index for both females and males, with a steeper increase observed among males.

Across the structural sexual orientation stigma index, predicted probabilities among White adolescents were relatively stable for males and decreased modestly for females. Among Black adolescents, predicted probabilities increased across the index for females and decreased for males. Hispanic adolescents demonstrated minimal changes in predicted probabilities across the index for both sexes. Among Asian/Other adolescents, predicted probabilities increased across the index for both females and males, with larger increases observed among males. Confidence intervals generally widened at the lower and upper ends of each structural stigma index, reflecting greater uncertainty in predicted probabilities at the extremes of the observed distributions.

Figure 6 presents adjusted predicted probabilities of waist adiposity across the range of each continuous structural stigma domain index, stratified by sex and race/ethnicity. Predicted

probabilities are displayed separately for the structural racism, structural sexism, and structural sexual orientation stigma indices among White, Black, Hispanic, and Asian/Other adolescents.

Across the structural racism index, predicted probabilities increased modestly for both male and female White adolescents. Among Black adolescents, predicted probabilities increased across the index for females and decreased slightly for males. Hispanic adolescents demonstrated relatively stable predicted probabilities across the range of the index, with a slight downward trend among males and minimal change among females. Among Asian/Other adolescents, predicted probabilities increased across the index for both sexes.

For the structural sexism index, predicted probabilities increased modestly across the index for both male and female White adolescents. Among Black adolescents, predicted probabilities increased for females and decreased for males across the range of the index. Hispanic adolescents demonstrated gradual decreases in predicted probabilities for both sexes. Among Asian/Other adolescents, predicted probabilities increased across the index for both sexes, with a steeper increase observed among males.

Across the structural sexual orientation stigma index, predicted probabilities increased modestly for White adolescents of both sexes. Among Black adolescents, predicted probabilities increased across the index for females, whereas predicted probabilities among males remained relatively stable. Hispanic adolescents demonstrated gradual decreases in predicted probabilities across the index for both sexes. Among Asian/Other adolescents, predicted probabilities increased across the index for both sexes, with a greater increase observed among males. Confidence intervals generally widened at the lower and upper ends of each structural stigma index, particularly among Black and Asian/Other adolescents, indicating greater uncertainty in the predicted probabilities at the extremes of the observed distributions.

Sensitivity analysis

Sensitivity analyses were conducted using continuous measures of BMI and waist circumference at Year 2 to examine associations between each structural stigma domain and adiposity outcomes (Table 13). In unadjusted models, the racism structural stigma index was positively associated with both BMI ($\beta = 0.50$, 95% CI [0.37, 0.63]) and waist circumference ($\beta = 0.74$, 95% CI [0.40, 1.08]). The sexism structural stigma index was associated with BMI ($\beta = 0.10$, 95% CI [−0.01, 0.20]) and waist circumference ($\beta = 0.27$, 95% CI [−0.01, 0.54]), whereas the sexual orientation structural stigma index was associated with BMI ($\beta = -0.05$, 95% CI [−0.16, 0.07]) and waist circumference ($\beta = -0.22$, 95% CI [−0.52, 0.07]).

After adjustment for child age, sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI, the association between the sexual orientation structural stigma index and BMI was $\beta = 0.13$ (95% CI [0.03, 0.23]). Adjusted estimates for the sexism and racism structural stigma indices were $\beta = 0.07$ (95% CI [−0.03, 0.17]) and $\beta = 0.06$ (95% CI [−0.06, 0.19]), respectively. For waist circumference, adjusted estimates were $\beta = 0.21$ (95% CI [−0.13, 0.54]) for the sexism index, $\beta = 0.11$ (95% CI [−0.24, 0.45]) for the sexual orientation structural stigma index, and $\beta = -0.03$ (95% CI [−0.45, 0.39]) for the racism structural stigma index.

DISCUSSION

The present study examined whether exposure to state-level structural racism, structural sexism, and structural sexual orientation stigma was associated with subsequent adiposity among U.S. adolescents participating in the ABCD Study. Each structural stigma domain was examined

separately as a continuous state-level index and evaluated in relation to overweight/obesity and abdominal adiposity assessed approximately two years later. Each structural stigma domain was examined separately as a continuous state-level index. Collectively, these findings suggest that structural stigma may be associated with disparities in adolescent adiposity, its influence is likely intertwined with broader socioeconomic, familial, and demographic factors that shape obesity risk.

The attenuation of associations following adjustment is notable. Adolescents living in states with higher levels of structural racism, structural sexism, and structural sexual orientation stigma were exposed to broader social and contextual differences across multiple social determinants of health, including parental education, household income, parental marital status, neighborhood safety, neighborhood disadvantage, and walkability. These findings are consistent with theoretical frameworks suggesting that structural stigma rarely operates in isolation; rather, it co-occurs with broader social and economic conditions that influence health behaviors and access to health-promoting resources (Gordon et al., 2024; Hatzenbuehler, 2016; Martino et al., 2025). Structural stigma may therefore function as part of a larger constellation of contextual factors that collectively shape obesity risk trajectories.

Sex-stratified analyses suggested modest differences in associations across the three structural stigma domains between male and female adolescents; however, adjusted estimates were similar across sexes and confidence intervals overlapped considerably. Although previous studies have suggested that adolescent girls may be more susceptible to stress-related pathways linking social disadvantage to obesity, the present findings provide limited evidence that associations between structural stigma and adiposity differ meaningfully by sex during early adolescence (Morales-Suárez-Varela et al., 2025; Todd et al., 2015).

The intersectionality analyses provide additional insight into potential heterogeneity in the relationship between each structural stigma domain and adiposity. Although interaction estimates were generally characterized by wide confidence intervals, predicted probability plots suggested that associations between structural stigma and adiposity varied across combinations of sex and race/ethnicity, particularly for the structural racism index. Patterns were less consistent for the structural sexism and structural sexual orientation stigma indices. These findings are consistent with intersectionality theory, which posits that health risks emerge through the simultaneous operation of multiple systems of power and oppression rather than through isolated social identities (Alvidrez et al., 2021; Carbado et al., 2013; Mosley et al., 2025).

Importantly, the wide confidence intervals observed in the intersectionality models indicate limited statistical precision and preclude definitive conclusions regarding subgroup differences. The complexity of the interaction models and smaller subgroup sample sizes likely reduced statistical power to detect three-way interactions. Nevertheless, predicted probability analyses suggests that future research should continue to investigate obesity risk through an intersectional lens rather than relying exclusively on average population effects. Such approaches may be particularly important for identifying subgroups that experience disproportionate vulnerability within structurally stigmatizing environments.

Sensitivity analyses using continuous BMI and waist circumference outcomes yielded findings that were generally consistent with the primary analyses. In unadjusted models, the structural racism index demonstrated the largest positive associations with both continuous adiposity measures, whereas associations for the structural sexism and structural sexual orientation stigma indices were comparatively smaller. After covariate adjustment, effect

estimates were attenuated across all three structural stigma domains. The consistency of these findings across dichotomous and continuous adiposity outcomes suggests that the primary conclusions were robust to alternative outcome specifications.

Strengths and limitations

Several limitations should be considered when interpreting these findings. First, structural stigma was measured at the state level and may not adequately capture local contextual variation in social environments. Considerable heterogeneity likely exists within states, and adolescents may experience structural conditions differently depending on neighborhood, school, and community contexts. Second, although the longitudinal design strengthens temporal ordering, residual confounding remains possible despite adjustment for numerous demographic and socioeconomic characteristics. Third, although the use of continuous structural stigma indices preserved exposure variability, the state-level measures may not fully capture individual or community-level experiences of structural stigma. Fourth, interaction analyses involved relatively small subgroup sample sizes, resulting in imprecise estimates for several interaction terms. Finally, adiposity outcomes were assessed during early adolescence, and longer follow-up periods may be necessary to capture the cumulative physiological consequences of chronic exposure to structurally stigmatizing environments.

Despite these limitations, this study has several notable strengths. The analysis utilized a large, geographically diverse longitudinal cohort of U.S. adolescents, incorporated objectively measured anthropometric outcomes, and employed inverse probability of censoring weights to address differential attrition. The study additionally extends the structural stigma literature beyond mental health outcomes by examining obesity-related outcomes and integrating an intersectionality framework to evaluate heterogeneity across social identities.

CONCLUSION

In conclusion, the structural racism index demonstrated the strongest associations with overweight/obesity and waist adiposity in unadjusted analyses, whereas associations for the structural sexism and structural sexual orientation stigma indices were smaller. After adjustment for demographic, socioeconomic, and baseline health characteristics, associations across all three structural stigma domains were attenuated. Future research should examine longer-term developmental trajectories, incorporate more localized measures of structural stigma, and continue to investigate how intersecting systems of social disadvantage shape obesity risk across adolescence and into adulthood.

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Table 8. Baseline demographic and health characteristics of adolescents.

Overall Analytic Sample	
	N=8868
	n(%)
Child Age (months, mean, SD)	119.08 (7.47)
Child Sex	
Female	4182 (47.2)
Child Race	
White	4983 (56.2)
Black	1132 (12.8)
Hispanic	1656 (18.7)
Other	1097 (12.4)
Nativity	
US Born	8619 (97.3)
Child Depression	
Normal	8213 (92.6)
Borderline	413 (4.7)
Clinical	241 (2.7)
Child Obesity	
Healthy Weight	5475 (61.9)
Obesity	1615 (18.3)
Overweight	1420 (16.1)
Child Physical Activity	3.53 (2.30)

Note. Values are presented as *n* (%) unless otherwise indicated; continuous variables are presented as mean (SD). Percentages may not total 100% due to rounding. Child obesity categories were defined using age- and sex-specific CDC body mass index percentile cutoffs (healthy weight: 5th to <85th percentile; overweight: 85th to <95th percentile; obesity: ≥95th percentile). Depression categories were derived from standardized symptom measures.

Table 9. Family and neighborhood characteristics of adolescents.

	Overall Analytic Sample N=8868 n(%)
Parent Nativity	
US Born	1371 (48.8)
Non-US Born <10 yrs	140 (5.0)
Non-US Born ≥10 yrs	1296 (46.2)
Parent Education	
Under High School	497 (5.6)
High School / GED	808 (9.1)
Above High School	7549 (85.3)
Parent Marital Status	
Never Married	961 (10.9)
Married/Living with partner	6679 (75.8)
Widowed/Divorced/Separated	1176 (13.3)
Parent Income	
<\$35k	1502 (18.3)
\$35k–\$74,999	1882 (22.9)
≥\$75k	4832 (58.8)
Neighborhood	
Safety	3.92 (0.95)
Disadvantage	0.11 (0.10)
Healthy Foods	4.19 (6.49)
Walkability	10.50 (3.72)

Note. Values are presented as *n* (%) unless otherwise indicated; continuous variables are presented as mean (SD). Percentages may not total 100% because of rounding. Neighborhood measures were derived from standardized composite indices, with higher values indicating greater levels of the corresponding construct.

Table 10. Associations between the overall structural stigma index and adiposity outcomes differed across the individual structural stigma domains of sexism, sexual orientation stigma, and racism.

Outcome	Structural stigma Domain index Mean (SD)	Unadjusted RR (95% CI)	Adjusted RR (95% CI)
Overweight/Obesity			
Sexism	-0.23 (0.92)	1.03 (1.00-1.06)	1.04 (0.99–1.10)
Sexual orientation	-0.25 (0.88)	0.99 (0.95-1.02)	1.04 (0.99–1.09)
Racism	-0.17 (0.74)	1.13 (1.08-1.17)	1.07 (1.00–1.15)
Waist adiposity			
Sexism	-0.23 (0.92)	1.05 (1.00-1.09)	1.03 (0.96–1.11)
Sexual orientation	-0.25 (0.88)	0.98 (0.94-1.03)	1.01 (0.94–1.09)
Racism	-0.17 (0.74)	1.13 (1.07-1.19)	1.06 (0.97–1.17)

Note. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting. Risk ratios and 95% confidence intervals were estimated using IPCW-weighted modified Poisson regression models with a log link. Overweight/obesity was defined as body mass index $\geq$ 85th percentile for age and sex. Models were adjusted for child age, child sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI.

Table 11. Associations between the overall structural stigma index and adiposity outcomes differed across the individual structural stigma domains of sexism, sexual orientation stigma, and racism stratified by sex.

Outcome	Structural stigma Domain index Mean (SD)	Unadjusted RR (95% CI)	Adjusted RR (95% CI)
Male			
Overweight/Obesity			
Racism	-0.18 (0.74)	1.09 (1.03–1.15)	1.05 (0.96–1.15)
Sexism	-0.23 (0.92)	1.02 (0.98–1.06)	1.04 (0.97–1.12)
Sexual orientation	-0.25 (0.88)	0.97 (0.92–1.01)	1.04 (0.97–1.12)
Waist adiposity			
Racism	-0.18 (0.74)	1.11 (1.04–1.19)	1.04 (0.92–1.17)
Sexism	-0.23 (0.92)	1.03 (0.98–1.09)	1.03 (0.94–1.13)
Sexual orientation	-0.25 (0.88)	0.96 (0.90–1.02)	1.02 (0.93–1.11)
Female			
Overweight/Obesity			
Racism	-0.17 (0.75)	1.17 (1.10–1.24)	1.10 (0.99–1.23)
Sexism	-0.24 (0.91)	1.05 (1.00–1.10)	1.05 (0.97–1.14)
Sexual orientation	-0.25 (0.87)	1.01 (0.96–1.06)	1.04 (0.96–1.13)
Waist adiposity			
Racism	-0.17 (0.75)	1.14 (1.06–1.23)	1.10 (0.95–1.28)
Sexism	-0.24 (0.91)	1.06 (1.00–1.13)	1.03 (0.91–1.16)
Sexual orientation	-0.25 (0.87)	1.01 (0.95–1.08)	0.99 (0.87–1.13)

Note. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting. Risk ratios and 95% confidence intervals were estimated using IPCW-weighted modified Poisson regression models with a log link. Overweight/obesity was defined as body mass index ≥ 85 th percentile for age and sex. Models were adjusted for child age, child sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI.

Table 12. Multiplicative interaction effects between the overall structural stigma index and adiposity outcomes differed across the individual structural stigma domains of sexism, sexual orientation stigma, and racism.

Outcome	Overweight/Obesity RR(95% CI)	Waist adiposity RR(95% CI)
Two-way Interaction Terms		
Racism x Female	1.09 (0.95-1.24)	1.11 (0.92-1.32)
Sexism x Female	1.04 (0.94-1.16)	1.02 (0.88-1.18)
Sexual orientation x Female	1.03 (0.92-1.16)	0.98 (0.85-1.13)
Racism x Black	0.98 (0.77-1.26)	0.98 (0.68-1.42)
Racism x Hispanic	1.02 (0.88-1.19)	0.87 (0.71-1.07)
Racism x Asian/Other	1.09 (0.88-1.36)	1.11 (0.84-1.48)
Sexism x Black	0.96 (0.78-1.19)	0.87 (0.63-1.19)
Sexism x Hispanic	1.02 (0.91-1.15)	0.8 (0.68-0.95)*
Sexism x Asian/Other	1.14 (0.97-1.34)	1.05 (0.85-1.3)
Sexual orientation x Black	1.06 (0.86-1.31)	1.03 (0.75-1.42)
Sexual orientation x Hispanic	1.03 (0.91-1.17)	0.8 (0.67-0.96)*
Sexual orientation x Asian/Other	1.2 (1.03-1.41)*	1.1 (0.89-1.35)
Three-way Interaction Terms		
Racism x Female x Black	1.52 (0.93–2.48)	1.73 (0.84–3.56)
Racism x Female x Hispanic	1.20 (0.88–1.66)	1.17 (0.77–1.77)
Racism x Female x Asian/Other	1.02 (0.64–1.62)	1.08 (0.60–1.94)
Sexism x Female x Black	1.49 (0.97–2.29)	1.42 (0.74–2.70)
Sexism x Female x Hispanic	1.12 (0.87–1.44)	1.00 (0.71–1.40)
Sexism x Female x Asian/Other	0.96 (0.69–1.33)	0.85 (0.55–1.30)
Sexual orientation x Female x Black	1.37 (0.90–2.09)	1.32 (0.69–2.55)
Sexual orientation x Female x Hispanic	1.14 (0.86–1.49)	0.94 (0.66–1.33)
Sexual orientation x Female x Asian/Other	0.92 (0.66–1.27)	0.83 (0.54–1.28)

Note. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting. Risk ratios and 95% confidence intervals were estimated using IPCW-weighted modified Poisson regression models with a log link. Overweight/obesity was defined as body mass index ≥ 85 th percentile for age and sex. Models were adjusted for child age, child sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI.

Table 13. Sensitivity analyses examining associations between individual structural stigma indices (sexism, sexual orientation stigma, and racism) and continuous adiposity outcomes

Outcome	Unadjusted β (95% CI)	Adjusted β (95% CI)
BMI (kg/m²)		
Sexism	0.10 (-0.01, 0.20)	0.07 (-0.03, 0.17)
Sexual orientation	-0.05 (-0.16, 0.07)	0.13 (0.03, 0.23)
Racism	0.50 (0.37, 0.63)	0.06 (-0.06, 0.19)
Waist circumference (cm)		
Sexism	0.27 (-0.01, 0.54)	0.21 (-0.13, 0.54)
Sexual orientation	-0.22 (-0.52, 0.07)	0.11 (-0.24, 0.45)
Racism	0.74 (0.4, 1.08)	-0.03 (-0.45, 0.39)

Note. β = regression coefficient; CI = confidence interval; IPCW = inverse probability of censoring weighting. Estimates and 95% confidence intervals were obtained from survey-weighted linear regression models. Adjusted models included child age, child sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI

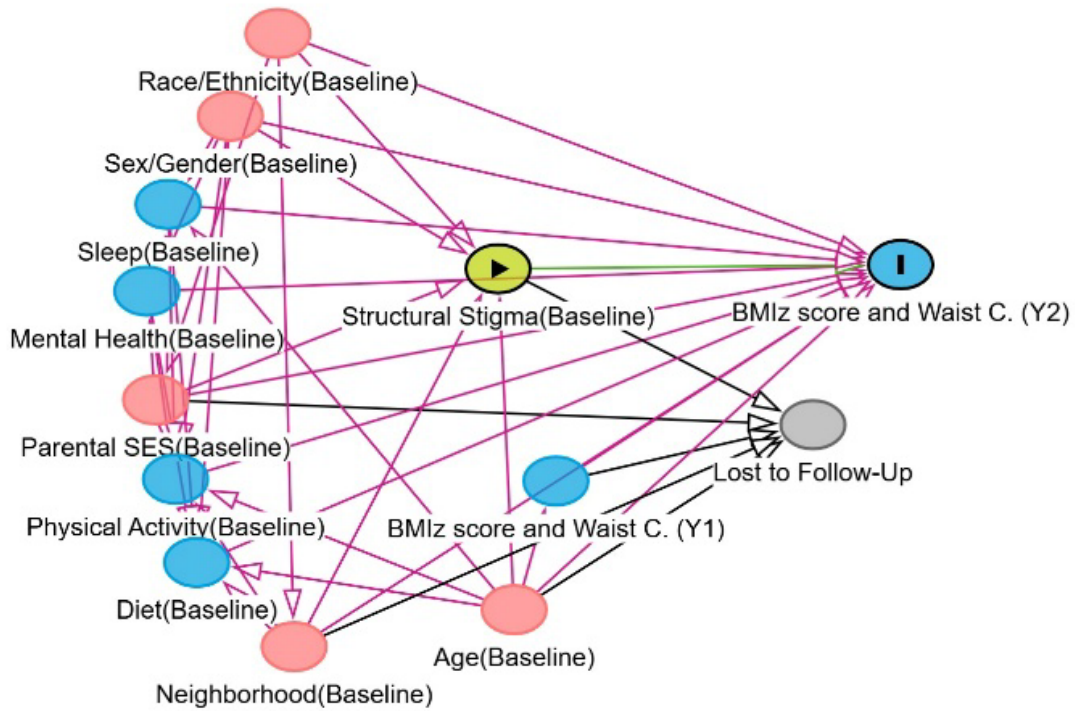


Figure 4. Directed acyclic graph (DAG) illustrating the hypothesized causal relationships among Structural Stigma, adiposity outcomes, potential confounders, and selection processes.

Note. The directed acyclic graph (DAG) represents the hypothesized causal structure underlying the association between Structural Stigma measured at baseline and adiposity outcomes (body mass index [BMI] and waist circumference) measured at Year 2 (Y2) follow-up in the ABCD Study. Baseline sociodemographic, behavioral, psychosocial, and neighborhood characteristics were identified as potential confounders based on prior literature and subject-matter knowledge. Baseline BMI and waist circumference were included to account for pre-existing adiposity. The node representing loss to follow-up reflects potential selection bias due to attrition between Y1 and Y2; inverse probability of censoring weighting (IPCW) was used to account for differential loss to follow-up. Arrows indicate hypothesized causal relationships and do not represent observed associations.

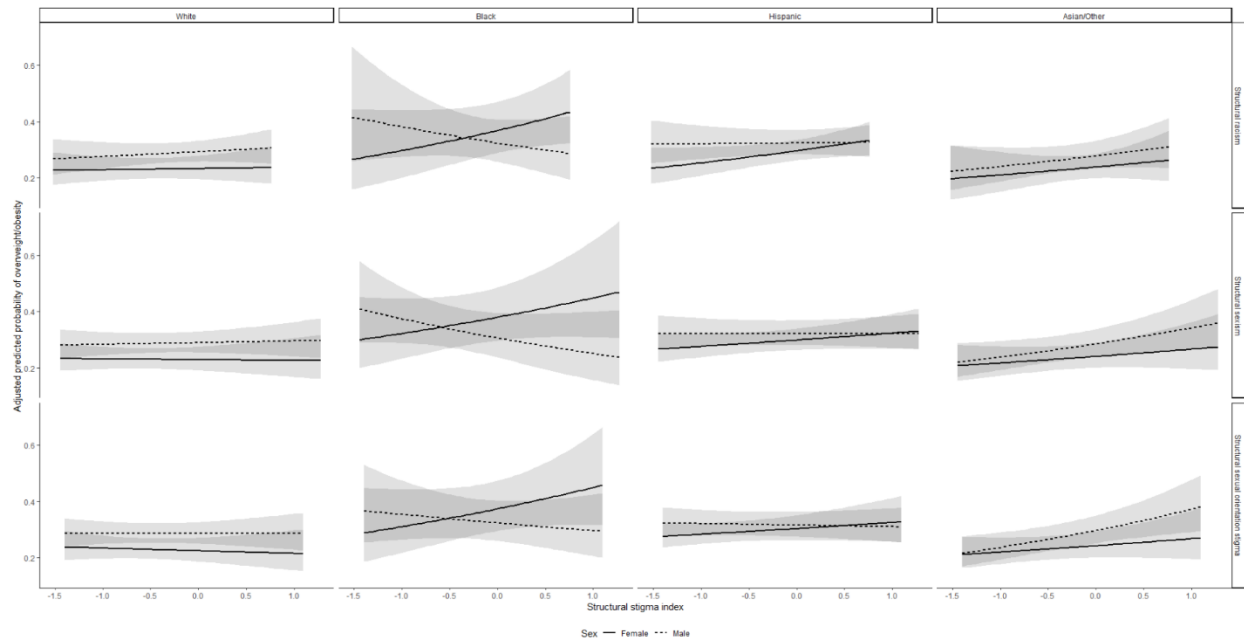


Figure 5. Predicted Risk of Overweight/Obesity by structural stigma domain, sex and race/ethnicity.

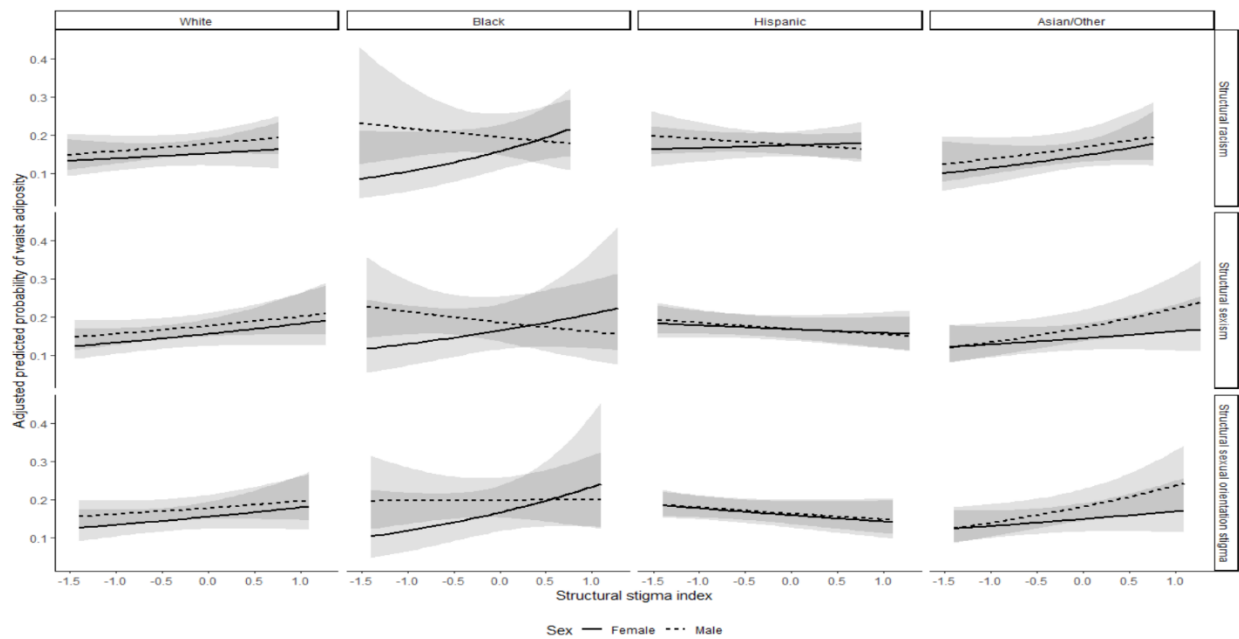


Figure 6. Predicted Risk of waist adiposity by structural stigma domain, sex and race/ethnicity.

Chapter 4 ASSOCIATION BETWEEN DIFFERENT DOMAINS OF PERCEIVED DISCRIMINATION AND ADIPOSITY

ABSTRACT

Background: Discrimination is increasingly recognized as a social determinant of health that may contribute to obesity risk through chronic psychosocial stress pathways. However, longitudinal evidence examining multiple discrimination domains and adolescent adiposity remains limited.

Objective: To examine the prospective association between four domains of perceived discrimination and adiposity outcomes among U.S. adolescents and to evaluate whether these associations differed across intersections of sex and race/ethnicity.

Methods: Data were drawn from 8,822 participants in the Adolescent Brain Cognitive Development (ABCD) Study. Perceived discrimination was assessed at Year 1 (ages 10–11 years) using four domains of discrimination: race/ethnicity, nativity, sexual orientation, and weight. Outcomes included overweight/obesity (body mass index ≥ 85 th percentile) and elevated waist adiposity (waist circumference ≥ 90 th percentile) measured at Year 2. Inverse probability of censoring weighted modified Poisson regression models estimated risk ratios (RRs) and 95% confidence intervals (CIs). Sex-stratified and interaction analyses examined effect modification by sex and race/ethnicity. Sensitivity analyses evaluated continuous body mass index and waist circumference.

Results: All four discrimination domains were associated with increased risks of overweight/obesity and waist adiposity in unadjusted analyses. After adjustment for demographic, family, neighborhood, and baseline body mass index characteristics, most associations were attenuated. Weight discrimination remained associated with elevated waist

adiposity (aRR = 1.20, 95% CI: 1.01–1.43). Among females, after adjustment, nativity discrimination was associated with overweight/obesity (aRR = 1.57, 95% CI [1.17, 2.10]) and waist adiposity (aRR = 2.19, 95% CI [1.60, 3.00]). Interaction analyses identified selected sex- and race/ethnicity-specific differences, whereas three-way interaction models produced unstable estimates because of sparse data. Sensitivity analyses using continuous adiposity outcomes yielded similar findings, with weight discrimination demonstrating the most consistent associations.

Conclusions: Although most associations were attenuated after adjustment, weight discrimination demonstrated the most consistent associations with adolescent adiposity. These findings suggest that weight-based discriminatory experiences may contribute to obesity-related outcomes during adolescence and support continued investigation of discrimination as a psychosocial factor influencing adolescent health.

INTRODUCTION

Adolescent obesity remains a major public health concern in the United States and represents a significant contributor to long-term cardiometabolic morbidity and mortality (CDC, 2026). Obesity disproportionately affects racial/ethnic minority and socially marginalized youth, contributing to persistent health disparities across the life course (CDC, 2026; Smith et al., 2020). Excess adiposity during adolescence is associated with increased risk of hypertension, insulin resistance, type 2 diabetes, cardiovascular disease, and adverse mental health outcomes later in life. Importantly, obesity disparities emerge early in the life course and are strongly influenced by broader social, structural, and environmental determinants of health rather than solely by individual behavioral factors (Kansra et al., 2021; Tomiyama, 2019; Wójcik et al.,

2023). Increasing attention has therefore been directed toward understanding how chronic psychosocial stressors contribute to obesity risk among adolescents.

One psychosocial stressor that has received growing attention in health disparities research is discrimination. Discrimination refers to unfair or negative treatment based on socially stigmatized characteristics or identities and has been increasingly recognized as a social determinant of health (Stangl et al., 2019). Exposure to discrimination during childhood and adolescence is associated with a wide range of adverse mental and physical health outcomes, including depressive symptoms, anxiety, sleep disturbances, substance use, and poor self-rated health (A. D. Benner et al., 2018; Priest et al., 2013). Adolescence may represent a particularly vulnerable developmental period because youth are simultaneously undergoing substantial biological, cognitive, and social changes while also developing identity awareness and social belonging (National Academies of Sciences et al., 2019). Discrimination may also contribute to obesity through activation of physiological stress pathways, including the hypothalamic-pituitary-adrenal axis, as well as behavioral responses such as emotional eating, reduced physical activity, poor sleep, and healthcare disengagement (Tomiya, 2019; CDC, 2026; Lee et al., 2021; Scott et al., 2012).

Discrimination encompasses multiple domains that may shape adolescent health in distinct ways. Racial/ethnic discrimination refers to unfair treatment based on an individual's racialized or ethnic identity and has consistently been associated with adverse psychological and physical health outcomes among youth (Hutchins et al., 2022; Vines et al., 2017). Other forms, including nativity, sexual orientation, and weight discrimination, have also been associated with poorer mental and physical health through chronic stress, social exclusion, and reduced access to

supportive environments (A. D. Benner et al., 2018; DuPont-Reyes & Villatoro, 2019; Goosby et al., 2018; Izraelle I. McKinnon et al., 2024; Stepanikova et al., 2017; Stoll et al., n.d.).

Nativity-related discrimination represents another important but less frequently studied domain among adolescents. Nativity discrimination refers to unfair treatment based on immigration status, country of origin, language, or perceptions of foreignness (Esses, 2021; NYC Comission on Human Rights, 2026; U.S. Department of Labor, 2026). Experiences of nativity-related discrimination have been associated with increased psychological distress, reduced social belonging, and adverse health outcomes among immigrant-origin youth (Alegría et al., 2023; Mamudu et al., 2024; Zarei et al., 2022; Gonçalves et al., 2026).

Sexual orientation discrimination may also represent an important psychosocial stressor during adolescence. Adolescents who identify as lesbian, gay, bisexual, questioning, or sexual minority youth often experience stigma, victimization, bullying, and social exclusion related to sexual orientation (Gower et al., 2018; Martin-Storey & Fish, 2019). Minority stress theory posits that chronic exposure to stigma and discrimination contributes to adverse health outcomes among sexual minority populations through heightened stress burden and reduced access to supportive social environments (Blashill & Calzo, 2019; Cisek & Rogowska, 2023; Nagata et al., 2024).

Weight discrimination constitutes an additional form of stigmatization that may independently contribute to obesity risk. Weight stigma refers to negative attitudes, stereotypes, and discriminatory treatment directed toward individuals perceived as overweight or obese (Edwards-Gayfield, 2026; Hollett & Carter, 2021). Importantly, weight discrimination may paradoxically exacerbate obesity-related outcomes rather than motivate weight loss behaviors. Prior studies suggest that weight stigma is associated with increased cortisol reactivity,

emotional eating, avoidance of physical activity, disordered eating behaviors, and reduced healthcare utilization (Puhl & Heuer, 2010; Tomiyama et al., 2018). Adolescents may be particularly vulnerable to the effects of weight-related discrimination because peer acceptance, body image, and social evaluation become increasingly salient during this developmental period.

While evidence suggests that multiple forms of discrimination may adversely affect adolescent health, several important gaps remain in the literature. Many studies have examined discrimination using single-domain measures focused exclusively on racial/ethnic discrimination, potentially overlooking the multidimensional nature of discriminatory experiences among adolescents (Nagata et al., 2021).

An intersectionality framework may provide important insight into these relationships. Intersectionality theory proposes that systems of oppression and social identities (including race, gender, socioeconomic position, immigration status, and other marginalized identities) interact to shape lived experiences and health outcomes in ways that cannot be understood through single-axis approaches alone (Alvidrez et al., 2021; Bauer et al., 2021; Crenshaw, 1989). Adolescents occupying multiple marginalized identities may therefore experience distinct forms of stress exposure and differential vulnerability to adverse health outcomes.

The present study sought to examine the prospective association between perceived discrimination and adiposity outcomes among adolescents using data from the Adolescent Brain Cognitive Development (ABCD) Study. Specifically, this study evaluated whether adolescents reporting discrimination demonstrated greater risk of overweight/obesity and elevated waist adiposity at follow-up. In addition, the study examined whether these associations differed across intersections of sex and race/ethnicity using an intersectionality-informed analytic framework. Finally, sensitivity analyses evaluated whether specific discrimination domains—including

racial/ethnic discrimination, nativity discrimination, sexual orientation discrimination, and weight discrimination—were differentially associated with adiposity outcomes.

METHODS

Study Design and Data Source

This study used data from the Adolescent Brain Cognitive Development (ABCD) Study, a large, ongoing longitudinal cohort study designed to examine brain development and child health across adolescence in the United States (Barch et al., 2018). The ABCD Study recruited children between the ages of 9 and 10 years from 21 research sites across the United States using probability-based school sampling strategies designed to approximate the sociodemographic diversity of the U.S. population. Baseline data collection began in 2016, with annual follow-up assessments conducted thereafter.

The present analyses utilized perceived discrimination measured at Year 1 follow-up (2017–2019, age mean 10.9, SD 0.64) as the primary exposure and adiposity outcomes measured at Year 2 follow-up (2018–2020, age mean 11.9, SD 0.65).

Study Sample

Participants were eligible for inclusion if they had available data on perceived discrimination at Year 1 and adiposity outcomes at Year 2. Participants with missing data on primary exposure variables, outcome variables, or key covariates (collected at baseline) were excluded from complete case analyses.

The analytic sample was derived from participants enrolled in the ABCD Study who had available anthropometric and covariate data across study waves. Of the 11,868 participants initially available, 735 were excluded due to missing height or weight measurements at Year 1, resulting in a sample of 11,133 participants. An additional 2,261 participants were excluded

because height or weight measurements were unavailable at Year 2, leaving 8,872 participants. Three participants were further excluded due to missing responses on the perceived discrimination questionnaire, resulting in 8,822 participants.

Measures

Perceived Discrimination

Perceived discrimination was assessed at the Year 1 using items from the Perceived Discrimination Scale (PDS) (Xu et al., 2025). Adolescents were asked whether they had experienced unfair treatment or discrimination across four domains during the prior 12 months. Four binary discrimination items were examined, including discrimination related to race/ethnicity, nativity, sexual orientation, and weight. Responses were coded dichotomously (0 = no, 1 = yes). Responses coded as “don’t know” or “refused” were treated as missing.

For the primary analyses, each discrimination domain was examined separately as an independent exposure to evaluate the associations of race/ethnicity-, nativity-, sexual orientation-, and weight-related discrimination with subsequent adiposity outcomes. Separate regression models were estimated for each discrimination domain.

Adiposity Outcomes

Adiposity outcomes were defined using body mass index (BMI)-defined overweight/obesity and waist circumference-defined abdominal adiposity. Anthropometric data were obtained by trained research staff using standardized protocols (Barch et al., 2018).

For BMI, participants’ height was recorded to the nearest 0.1 cm and weight to the nearest 0.1 kg with participants wearing light clothing and no shoes. Body mass index was computed by dividing weight in kilograms by height in meters squared (kg/m^2). Age- and sex-

specific BMI percentiles and z-scores were calculated using the Centers for Disease Control and Prevention growth chart reference standards. Participants were categorized according to established pediatric definitions, including underweight (<5th percentile), healthy weight (5th to <85th percentile), overweight (85th to <95th percentile), and obesity ($\geq$ 95th percentile). The primary analyses classified participants as having healthy weight (<85th percentile) or overweight/obesity ($\geq$ 85th percentile), consistent with established pediatric definitions (CDC, 2024).

Waist circumference was assessed in triplicate at the level of the iliac crest using standardized procedures, and the average of the three measurements was used in all analyses (Barch et al., 2018). Age- and sex-specific waist circumference percentiles were derived using National Health and Nutrition Examination Survey reference values based on the LMS method (A. K. Sharma et al., 2015). Abdominal adiposity was defined as waist circumference at or above the age- and sex-specific 90th percentile.

Covariates

Covariates were selected a priori based on theoretical relevance and prior literature examining discrimination and obesity-related outcomes among adolescents (Arubuolawe et al., n.d.; Hooper et al., 2022; Raney et al., 2023) (Figure 6). Child-level covariates included age, sex, race/ethnicity, nativity status (US born vs Non-US born), depressive symptoms (normal, borderline, clinical depression), and physical activity (days of moderate/vigorous physical activity a week) (collected at baseline). Race/ethnicity was categorized as White, Black, Hispanic, and Asian/Other. Sex was coded as male or female.

Family-level covariates included parent nativity, parent education, parent marital status, and annual household income. Parent nativity was categorized as U.S.-born, non-U.S.-born

living in the United States for less than 10 years, and non-U.S.-born living in the United States for 10 years or more. Parent education was categorized as less than high school, high school/GED, or education above high school. Parent marital status was categorized as married/living with partner, widowed/divorced/separated, or never married. Household income was categorized as <\$35,000, \$35k–\$74,999, and ≥\$75k.

Neighborhood-level covariates included perceived neighborhood safety, neighborhood disadvantage, access to healthy foods, and neighborhood walkability (collected at baseline). Neighborhood characteristics were assessed at baseline using parent-reported measures adapted from validated neighborhood environment scales developed by (Echeverria et al., 2004) and (Mujahid et al., 2007). Four continuous summary measures were included: perceived neighborhood safety, neighborhood disadvantage, access to healthy foods, and neighborhood walkability. Each measure was calculated by averaging responses across multiple Likert-type items assessing parents' perceptions of their neighborhood environment. Higher scores reflected greater perceived neighborhood safety, greater neighborhood disadvantage, better access to healthy foods, and greater neighborhood walkability, respectively.

Statistical Analysis

Descriptive statistics were calculated to characterize the analytic sample overall and stratified by perceived discrimination status. Continuous variables were summarized using means and standard deviations, whereas categorical variables were summarized using frequencies and percentages.

To minimize potential bias resulting from differential loss to follow-up and missing outcome data, inverse probability of censoring weights (IPCW) were applied to all multivariable analyses. Stabilized IPCW were estimated using logistic regression models predicting the

probability of remaining under observation at the Year 2 follow-up based on baseline age, perceived neighborhood safety, baseline body mass index (BMI), and anxiety/depression status. Stabilized weights were calculated by dividing the marginal probability of remaining under observation by each participant's predicted probability of remaining under observation from the logistic regression model. To reduce the potential influence of extreme weights and improve estimator stability, stabilized weights were truncated at the 1st and 99th percentiles. The distribution of the stabilized weights was examined prior to analysis to assess for extreme values, and the final stabilized weights were incorporated into all multivariable models using the survey package in R. The distribution of the final weights was examined before analysis and showed minimal variability, with values ranging from 0.9969 to 1.0346 and a median of 0.9973. Overall, 176 observations (2.0% of non-missing weights) were truncated. Prior to truncation, the maximum stabilized weight was 62.97. Following truncation, the weights ranged from 0.9969 to 1.0346, indicating minimal variability among the final analytic weights.

Associations between each domain of perceived discrimination and adiposity outcomes were estimated using IPCW-weighted Poisson regression models with a log link to obtain risk ratios (RRs) and 95% confidence intervals (CIs). Separate models were estimated for overweight/obesity and elevated waist adiposity. Unadjusted models estimated crude associations between each domain of discrimination and adiposity outcomes, whereas adjusted models controlled for demographic, socioeconomic, family, and baseline adiposity covariates. Models were fit using the survey package in R, which incorporates the inverse probability of censoring weights and estimates standard errors using design-based robust (sandwich) variance estimators based on Taylor series linearization.

To examine whether associations between perceived discrimination and adiposity differed across intersecting social identities, interaction models were estimated including perceived discrimination, sex, and race/ethnicity. Two-way interaction terms were specified for discrimination $\times$ sex, discrimination $\times$ race/ethnicity, and sex $\times$ race/ethnicity. In addition, a three-way interaction term (discrimination $\times$ sex $\times$ race/ethnicity) was included to evaluate whether the association between each discrimination domain and adiposity varied jointly across combinations of sex and race/ethnicity.

Sensitivity analyses evaluated the robustness of the findings using continuous measures of body mass index (BMI) and waist circumference at Year 2 rather than dichotomous adiposity outcomes. The same discrimination domain-specific exposures and covariate adjustment strategy were applied in these analyses.

All analyses were conducted in R statistical software using the survey package to account for IPCW weighting procedures.

RESULTS

Table 14 summarizes the baseline demographic, psychosocial, and health characteristics of the 8,822 adolescents included in the analytic sample. Participants had a mean age of 119.09 months (SD = 7.47; approximately 9.9 years), and 47.3% were female. The sample was predominantly White (56.3%), followed by Hispanic (18.7%), Black (12.7%), and adolescents identifying with other racial groups (12.3%). Overall, 2.7% of participants were born outside the United States.

Most adolescents had depression scores within the normal range (92.6%), whereas 4.7% were classified as borderline and 2.7% met the threshold for clinical depression. Based on body mass index categories at baseline, 61.9% of participants were classified as having a healthy

weight, 16.0% as overweight, 18.3% as having obesity, and 3.7% as underweight. The mean baseline physical activity score was 3.54 (SD = 2.30).

Table 15 presents the baseline family and neighborhood characteristics of the analytic sample. Among participants with available parental nativity data, 48.7% had parents born in the United States, 5.0% had parents born outside the United States who had resided in the country for fewer than 10 years, and 46.3% had parents born outside the United States who had resided in the country for 10 years or longer. Most parents had attained education beyond high school (85.3%), while 9.1% had completed high school or a General Educational Development (GED) credential and 5.6% had less than a high school education.

Approximately three-quarters of adolescents lived in households in which parents were married or living with a partner (75.8%), whereas 13.3% had parents who were widowed, divorced, or separated, and 10.9% had parents who had never married. Most households reported an annual income of at least \$75,000 (58.8%), followed by \$35,000 to \$74,999 (22.9%) and less than \$35,000 (18.2%).

Mean neighborhood scores indicated an average perceived neighborhood safety score of 3.92 (SD = 0.95), a neighborhood disadvantage score of 0.11 (SD = 0.10), a healthy food access score of 4.19 (SD = 6.49), and a walkability score of 10.51 (SD = 3.72).

Association between discrimination and adiposity

Table 16 presents the associations between each perceived discrimination domain assessed at Year 1 and subsequent overweight/obesity and waist adiposity at Year 2. In

unadjusted analyses, all four discrimination domains were associated with an increased risk of overweight/obesity. The largest unadjusted association was observed for weight-based discrimination (RR = 2.15, 95% CI [2.00, 2.30]), followed by race/ethnicity discrimination (RR = 1.41, 95% CI [1.25, 1.58]), nativity discrimination (RR = 1.36, 95% CI [1.13, 1.65]), and sexual orientation discrimination (RR = 1.31, 95% CI [1.16, 1.48]). After adjustment for demographic, family, neighborhood, and baseline BMI characteristics, risk estimates were attenuated. Adjusted risk ratios ranged from 1.04 (95% CI [0.82, 1.32]) for nativity discrimination to 1.19 (95% CI [0.97, 1.46]) for sexual orientation discrimination.

Similar patterns were observed for waist adiposity. In unadjusted analyses, race/ethnicity discrimination (RR = 1.54, 95% CI [1.32, 1.79]), nativity discrimination (RR = 1.52, 95% CI [1.19, 1.93]), sexual orientation discrimination (RR = 1.40, 95% CI [1.19, 1.65]), and weight-based discrimination (RR = 2.84, 95% CI [2.60, 3.10]) were each associated with an increased risk of elevated waist adiposity. Following covariate adjustment, the magnitude of the associations was reduced. Adjusted risk ratios ranged from 0.86 (95% CI [0.64, 1.17]) for race/ethnicity discrimination to 1.20 (95% CI [1.01, 1.43]) for weight-based discrimination.

Table 17 presents the sex-stratified associations between each perceived discrimination domain at Year 1 and subsequent overweight/obesity and waist adiposity at Year 2. Among males, unadjusted models showed elevated risks of overweight/obesity associated with race/ethnicity discrimination (RR = 1.27, 95% CI [1.07, 1.51]), nativity discrimination (RR = 1.29, 95% CI [1.01, 1.65]), and weight-based discrimination (RR = 2.03, 95% CI [1.83, 2.25]). For waist adiposity, race/ethnicity discrimination (RR = 1.38, 95% CI [1.10, 1.72]) and weight-based discrimination (RR = 2.63, 95% CI [2.30, 3.00]) were associated with elevated risk in unadjusted analyses. Following adjustment, weight-based discrimination remained associated

with waist adiposity (RR = 1.27, 95% CI [1.03, 1.56]), whereas adjusted risk ratios for the remaining discrimination domains ranged from 0.81 (95% CI [0.54, 1.21]) to 1.18 (95% CI [0.91, 1.52]) for overweight/obesity and from 0.81 (95% CI [0.54, 1.21]) to 1.12 (95% CI [0.81, 1.55]) for waist adiposity.

Among females, all four discrimination domains were associated with increased risks of overweight/obesity and waist adiposity in unadjusted analyses. The largest unadjusted associations were observed for weight-based discrimination, with risk ratios of 2.28 (95% CI [2.07, 2.50]) for overweight/obesity and 3.06 (95% CI [2.72, 3.45]) for waist adiposity. After adjustment, nativity discrimination was associated with overweight/obesity (RR = 1.57, 95% CI [1.17, 2.10]) and waist adiposity (RR = 2.19, 95% CI [1.60, 3.00]). Adjusted risk ratios for the remaining discrimination domains ranged from 1.08 (95% CI [0.82, 1.42]) to 1.23 (95% CI [0.98, 1.54]) for overweight/obesity and from 0.87 (95% CI [0.56, 1.36]) to 1.17 (95% CI [0.71, 1.90]) for waist adiposity.

Intersectionality

Table 18 presents the multiplicative interaction effects between each perceived discrimination domain and sex and race/ethnicity on overweight/obesity and waist adiposity. For overweight/obesity, the interaction between nativity discrimination and sex was associated with an increased risk (RR = 1.92, 95% CI [1.29, 2.88]), whereas the interactions between race/ethnicity discrimination and sex (RR = 1.08, 95% CI [0.72, 1.61]), sexual orientation discrimination and sex (RR = 0.97, 95% CI [0.62, 1.52]), and weight-based discrimination and sex (RR = 1.10, 95% CI [0.86, 1.42]) were not. Among the race/ethnicity interaction terms, the interaction between sexual orientation discrimination and Black race (RR = 1.88, 95% CI [1.01,

3.51]) was associated with increased risk, whereas the interaction between weight-based discrimination and Black race (RR = 0.54, 95% CI [0.32, 0.91]) and weight-based discrimination and Hispanic ethnicity (RR = 0.61, 95% CI [0.47, 0.79]) were associated with lower risk. The remaining interaction terms had confidence intervals that included 1.00.

For waist adiposity, the interaction between nativity discrimination and sex was associated with an increased risk (RR = 2.63, 95% CI [1.55, 4.45]). The interaction between weight-based discrimination and Black race (RR = 0.33, 95% CI [0.15, 0.72]) and weight-based discrimination and Hispanic ethnicity (RR = 0.50, 95% CI [0.36, 0.69]) were associated with lower risk. No other interaction terms demonstrated confidence intervals that excluded 1.00.

Three-way interaction models evaluating the joint effects of discrimination, sex, and race/ethnicity were estimated. However, several discrimination domains had sparse observations within sex- and race/ethnicity-specific strata, resulting in unstable parameter estimates and extremely wide confidence intervals. Consequently, three-way interaction results were considered unreliable and were not interpreted.

Sensitivity Analysis

Sensitivity analyses using continuous adiposity outcomes are presented in Table 19. Survey-weighted linear regression models were estimated to examine the associations between each discrimination domain and continuous measures of body mass index (BMI) and waist circumference at Year 2 after adjustment for child age, sex, race/ethnicity, parent nativity, parent education, parent marital status, baseline BMI, and inverse probability of censoring weights.

For continuous BMI, the estimated regression coefficients were $\beta = 0.45$ (95% CI: $-0.07, 0.97$) for race/ethnicity discrimination, $\beta = 0.27$ (95% CI: $-0.19, 0.74$) for nativity discrimination, $\beta = 0.34$ (95% CI: $-0.12, 0.80$) for sexual orientation discrimination, and $\beta =$

0.55 (95% CI: 0.10, 1.00) for weight discrimination. For continuous waist circumference, the estimated regression coefficients were $\beta = -0.02$ (95% CI: $-1.49, 1.44$) for race/ethnicity discrimination, $\beta = -0.21$ (95% CI: $-1.75, 1.32$) for nativity discrimination, $\beta = 0.45$ (95% CI: $-1.19, 2.09$) for sexual orientation discrimination, and $\beta = 2.11$ (95% CI: $0.53, 3.69$) for weight discrimination.

DISCUSSION

The present study examined the prospective associations between four domains of perceived discrimination (race/ethnicity, nativity, sexual orientation, and weight discrimination) and subsequent adiposity outcomes among adolescents participating in the ABCD Study. All four discrimination domains were associated with increased risks of overweight/obesity and waist adiposity in unadjusted analyses; however, adjustment for demographic, family, neighborhood, and baseline BMI characteristics attenuated most associations. Weight discrimination remained associated with elevated waist adiposity, whereas nativity discrimination remained associated with overweight/obesity and waist adiposity among female adolescents in the sex-stratified analyses. Interaction analyses further suggested that the associations between discrimination and adiposity varied across selected sex and race/ethnicity groups. However, three-way interaction models produced unstable estimates because of sparse observations within several sex- and race/ethnicity-specific strata, limiting interpretation of higher-order interaction effects.

Although associations between the discrimination domains and adiposity were generally attenuated after adjustment, the observed pattern is consistent with prior research suggesting that discrimination represents an important psychosocial stressor that may contribute to obesity-related outcomes among adolescents. The attenuation of the associations after adjustment indicates that demographic, family, neighborhood, and baseline adiposity characteristics account

for a substantial proportion of the observed differences in adiposity risk. These findings underscore the importance of considering discrimination within the broader social and environmental contexts that shape adolescent health.

Consistent with the study hypothesis, each discrimination domain was associated with increased risks of overweight/obesity and waist adiposity in unadjusted analyses. However, after adjustment for demographic, family, neighborhood, and baseline BMI characteristics, most associations were substantially attenuated. Weight discrimination demonstrated the most consistent associations across adiposity outcomes, remaining associated with elevated waist adiposity in the overall sample, whereas nativity discrimination remained associated with both overweight/obesity and waist adiposity among female adolescents. These findings align with prior literature linking discrimination-related stress to obesity-related outcomes among both adolescents and adults (Himmelstein et al., 2015; Lofton et al., 2023). Chronic exposure to discrimination may contribute to dysregulation of stress-response systems, including hypothalamic-pituitary-adrenal (HPA) axis activation, elevated cortisol secretion, inflammatory processes, and maladaptive coping behaviors that collectively promote adiposity accumulation (Tomiya, 2019).

The observed association between weight discrimination and waist adiposity is particularly noteworthy because central adiposity is more strongly associated with cardiometabolic risk than overall BMI and may represent a more sensitive indicator of stress-related physiological dysregulation (National Academies of Sciences et al., 2019). Previous research has suggested that chronic psychosocial stressors, including weight-based stigma, may contribute to visceral fat accumulation through repeated activation of neuroendocrine pathways involved in stress regulation, including dysregulation of the hypothalamic-pituitary-adrenal axis

and cortisol secretion (Lofton et al., 2023; Puhl & Heuer, 2010). The consistency of the findings for weight discrimination across both the primary and sensitivity analyses suggests that weight-based discriminatory experiences may have particular relevance for adolescent adiposity and warrants further investigation into the biological and behavioral mechanisms underlying this relationship.

The interaction analyses demonstrated that the associations between perceived discrimination and adiposity varied across selected sex and race/ethnicity groups. In particular, nativity discrimination demonstrated evidence of interaction with sex for both overweight/obesity and waist adiposity, indicating that the association differed between male and female adolescents. These findings are consistent with prior research indicating that adolescent girls may experience greater psychological and physiological vulnerability to interpersonal stressors and social evaluation processes (Slopen et al., 2016). Greater exposure to gendered socialization processes, body image pressures, and differences in stress-related coping behaviors may contribute to variation in the health effects of discriminatory experiences among female adolescents.

Evidence of interaction was also observed for selected race/ethnicity-specific comparisons. Specifically, the associations between sexual orientation discrimination and overweight/obesity differed among Black adolescents, whereas interactions between weight discrimination and both Black and Hispanic race/ethnicity suggested variation in adiposity risk across racial/ethnic groups. Similar patterns were observed for waist adiposity, where interactions involving nativity discrimination and sex, as well as weight discrimination with Black and Hispanic race/ethnicity, were identified. However, several interaction estimates were imprecise, and three-way interaction models produced unstable estimates because of sparse

observations within sex- and race/ethnicity-specific strata. Consequently, the interaction findings should be interpreted cautiously and viewed as exploratory.

From an intersectionality perspective, the findings suggest that the health consequences of discrimination may not be uniform across population subgroups but instead may be shaped by multiple, intersecting social identities and systems of marginalization. Intersectionality theory posits that social identities such as race, gender, and socioeconomic position interact within broader structures of power to shape lived experiences and health outcomes (Alvidrez et al., 2021; Crenshaw, 1989). Although the observed interaction effects should be interpreted with caution, they are consistent with the conceptual framework of intersectionality, which emphasizes that the effects of social exposures may differ depending on the combination of multiple social identities rather than any single characteristic in isolation. Future studies with larger samples of adolescents reporting discrimination across multiple marginalized identities are needed to better characterize these complex relationships.

Sensitivity analyses using continuous BMI and waist circumference yielded findings that were generally consistent with the primary analyses. Weight discrimination remained positively associated with both continuous BMI and waist circumference after adjustment, whereas the associations for race/ethnicity, nativity, and sexual orientation discrimination were attenuated and their confidence intervals included the null. The consistency of the findings for weight discrimination across both categorical and continuous adiposity outcomes strengthens the overall interpretation that weight-based discriminatory experiences may have particular relevance for adolescent adiposity. These findings are consistent with growing literature positing that weight stigma may paradoxically contribute to obesity-related outcomes through stress-mediated

physiological pathways, avoidance of physical activity, emotional eating behaviors, and healthcare disengagement (Puhl & Heuer, 2010; Tomiyama et al., 2018).

The stronger and more consistent association observed between weight discrimination and waist adiposity compared with overall overweight/obesity suggests that weight-based discriminatory experiences may be particularly relevant for central adiposity and stress-related fat distribution. Because waist adiposity is more closely associated with stress physiology and visceral fat accumulation, these findings may reflect biologically mediated stress responses associated with weight-based discriminatory experiences. Alternatively, adolescents experiencing weight discrimination may engage in maladaptive coping strategies that disproportionately contribute to central adiposity accumulation. Additional longitudinal research is needed to clarify the biological and behavioral pathways through which weight discrimination may influence adiposity during adolescence.

Strengths and Limitations

Several limitations should be considered when interpreting the findings of this study. First, discrimination was assessed using self-reported measures, which may be subject to recall bias or differential interpretation of discriminatory experiences. However, perceived discrimination itself represents an important psychosocial exposure regardless of objective verification. Second, although the study used a prospective design and adjusted for baseline BMI, causal inference remains limited due to the observational nature of the data. Residual confounding from unmeasured factors, including dietary intake, chronic stress exposures, or family-level psychosocial characteristics, may persist. Third, each discrimination domain was assessed using a single self-reported item, which may not fully capture the frequency, severity, chronicity, or cumulative burden of discriminatory experiences. More comprehensive

multidimensional measures of discrimination may provide a better understanding of how different aspects of discriminatory experiences influence adiposity over time.

Additionally, several interaction estimates demonstrated wide confidence intervals, suggesting reduced statistical precision for some subgroup analyses. Higher-order interaction models often require substantial sample sizes to detect intersectional effects reliably, and some demographic subgroup combinations may have included relatively small numbers of participants. Consequently, findings from the intersectionality analyses should be interpreted cautiously and considered exploratory. Future studies using larger samples or alternative intersectionality analytic approaches may help further clarify these relationships.

Lastly, the study was not adequately powered to estimate complex three-way interactions because some discrimination domains were infrequently reported within specific race/ethnicity-by-sex subgroups. Future studies with larger samples of adolescents reporting discrimination across multiple marginalized identities are needed to evaluate intersectional differences more reliably.

Despite these limitations, the present study has several important strengths. The study utilized a large, geographically diverse longitudinal cohort with standardized anthropometric assessments and prospective follow-up. The inclusion of both overweight/obesity and waist adiposity allowed for examination of both general and central adiposity outcomes. The use of IPCW methods strengthened internal validity by addressing potential bias resulting from differential attrition. Additionally, the examination of four distinct discrimination domains, sex-stratified analyses, interaction models, and sensitivity analyses using continuous adiposity outcomes provided a more comprehensive evaluation of the relationship between perceived discrimination and adolescent adiposity.

The findings of this study have important implications for adolescent health equity and obesity prevention efforts. Traditional obesity prevention strategies often focus primarily on individual behaviors such as diet and physical activity while overlooking the broader psychosocial and structural conditions that shape health outcomes. The present findings suggest that certain forms of perceived discrimination, particularly weight discrimination, may contribute to differences in adolescent adiposity through psychosocial and stress-related pathways. Although most associations were attenuated after adjustment, the observed patterns underscore the importance of considering discrimination within broader social and environmental contexts that influence adolescent health. Interventions aimed at reducing adolescent obesity may therefore benefit from incorporating trauma-informed, anti-discrimination, and equity-focused approaches that address psychosocial stressors alongside behavioral risk factors.

At the structural level, efforts to reduce discrimination within schools, healthcare systems, and community environments may represent important avenues for promoting adolescent health equity. Policies and interventions designed to foster inclusive environments, reduce stigma, and strengthen social support systems may help mitigate the adverse health effects of discrimination during adolescence. Future research should continue to examine the biological, behavioral, and social mechanisms linking different forms of perceived discrimination to adiposity and investigate how these relationships evolve across developmental stages and intersecting social identities.

CONCLUSION

In conclusion, all four domains of perceived discrimination were associated with overweight/obesity and waist adiposity in unadjusted analyses; however, most associations were

attenuated after adjustment for demographic, family, neighborhood, and baseline BMI characteristic. Weight discrimination demonstrated the most consistent associations across adiposity outcomes, while interaction analyses suggested that the relationship between perceived discrimination and adiposity may vary across selected sex and race/ethnicity groups, although these findings should be interpreted cautiously because of limited precision. Collectively, these findings highlight the importance of considering perceived discrimination as a psychosocial factor that may contribute to adolescent adiposity and support continued investigation into the biological, behavioral, and social mechanisms linking discriminatory experiences to obesity-related outcomes.

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Table 14. Baseline Demographic, Psychosocial, and Health Characteristics of Adolescents at baseline (N = 8,822).

	Overall Analytic Sample N=8822
Child Age (months)	119.09 (7.47)
Child Sex	
Female	4171 (47.3)
Child Race	
White	4964 (56.3)
Black	1123 (12.7)
Hispanic	1652 (18.7)
Other	1083 (12.3)
Nativity	
Non-US Born	239 (2.7)
Child Depression	
Normal	8167 (92.6)
Borderline	413 (4.7)
Clinical	241 (2.7)
Child Obesity	
Underweight	327 (3.7)
Healthy Weight	5448 (61.9)
Overweight	1409 (16.0)
Obesity	1611 (18.3)
Child Physical Activity	3.54 (2.30)

Note. Values are presented as *n* (%) for categorical variables and mean (SD) for continuous variables. Percentages may not sum to 100% because of rounding and missing data.

Table 15. Baseline Parent and Neighborhood Characteristics of Adolescents at baseline (N = 8,822).

Overall Analytic Sample N=8822	
Parent Nativity	
US Born	1360 (48.7)
Non-US Born <10 yrs	140 (5.0)
Non-US Born ≥10 yrs	1291 (46.3)
Parent Education	
Under High School	494 (5.6)
High School / GED	803 (9.1)
Above High School	7511 (85.3)
Parent Marital Status	
Never Married	957 (10.9)
Married/Living with partner	6649 (75.8)
Widowed/Divorced/Separated	1164 (13.3)
Parent Income	
<\$35k	1491 (18.2)
\$35k–\$74,999	1874 (22.9)
≥\$75k	4808 (58.8)
Neighborhood	
Safety	3.92 (0.95)
Disadvantage	0.11 (0.10)
Healthy Foods	4.19 (6.49)
Walkability	10.51 (3.72)

Note. Values are presented as *n* (%) for categorical variables and mean (SD) for continuous variables. Parent nativity was categorized as U.S.-born, non-U.S.-born residing in the United States for less than 10 years, and non-U.S.-born residing in the United States for 10 years or longer. Neighborhood characteristics reflect higher scores indicating greater perceived neighborhood safety, neighborhood disadvantage, no access to healthy foods, and walkability. Percentages may not sum to 100% because of rounding and missing data.

Table 16. Association Between Reported Discrimination Exposure and Adiposity Outcomes Among Adolescents: IPCW-Weighted Modified Poisson Regression Models (N = 8,822)

Discrimination Domain	Cases n(%)	Unadjusted RR (95%CI)	Adjusted RR (95%CI)
Overweight/obesity			
Race/Ethnicity	351(4.3)	1.41 (1.25–1.58)	1.05 (0.86-1.28)
Nativity	128(1.5)	1.36 (1.13–1.65)	1.04 (0.82-1.32)
Sexual orientation	333(4.0)	1.31 (1.16–1.48)	1.19 (0.97-1.46)
Weight	493(5.8)	2.15 (2.00–2.30)	1.16 (0.99-1.35)
Waist Adiposity			
Race/Ethnicity	351(4.3)	1.54 (1.32–1.79)	0.86 (0.64-1.17)
Nativity	128(1.5)	1.52 (1.19–1.93)	1.1 (0.78-1.56)
Sexual orientation	333(4.0)	1.40 (1.19–1.65)	1.12 (0.85-1.48)
Weight	493(5.8)	2.84 (2.60–3.10)	1.2 (1.01-1.43)

Footnote. Values are presented as adjusted risk ratios (RRs) and 95% confidence intervals (CIs) derived from separate IPCW-weighted modified Poisson regression models for each discrimination domain. Discrimination domains included race/ethnicity, nativity, sexual orientation, and weight-based discrimination. Overweight/obesity was defined as body mass index (BMI) ≥ 85 th percentile for age and sex, and elevated waist adiposity was defined as waist circumference ≥ 90 th percentile for age and sex. Models were adjusted for child age, sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI. IPCW weights were applied to account for differential loss to follow-up. Statistically significant associations were identified when 95% confidence intervals excluded 1.00. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting.

Table 17. Sex-stratified associations between perceived discrimination domains at Year 1 and overweight/obesity and waist adiposity at Year 2 among adolescents in the ABCD Study

Discrimination Domain	Unadjusted RR (95%CI)	Adjusted RR (95%CI)
Male		
Overweight/obesity		
Race/Ethnicity	1.27 (1.07–1.51)	1.00 (0.75–1.33)
Nativity	1.29 (1.01–1.65)	0.83 (0.61–1.14)
Sexual orientation	1.12 (0.93–1.35)	1.18 (0.91–1.52)
Weight	2.03 (1.83–2.25)	1.08 (0.92–1.27)
Waist Adiposity		
Race/Ethnicity	1.38 (1.10–1.72)	0.84 (0.57–1.22)
Nativity	1.34 (0.97–1.87)	0.81 (0.54–1.21)
Sexual orientation	1.18 (0.92–1.50)	1.12 (0.81–1.55)
Weight	2.63 (2.30–3.00)	1.27 (1.03–1.56)
Female		
Overweight/obesity		
Race/Ethnicity	1.57 (1.34–1.83)	1.08 (0.82–1.42)
Nativity	1.48 (1.10–1.98)	1.57 (1.17–2.10)
Sexual orientation	1.56 (1.32–1.84)	1.17 (0.79–1.73)
Weight	2.28 (2.07–2.50)	1.23 (0.98–1.54)
Waist Adiposity		
Race/Ethnicity	1.72 (1.40–2.11)	0.87 (0.56–1.36)
Nativity	1.81 (1.27–2.58)	2.19 (1.60–3.00)
Sexual orientation	1.70 (1.36–2.12)	1.17 (0.71–1.90)
Weight	3.06 (2.72–3.45)	1.16 (0.90–1.49)

Footnote. Values are presented as adjusted risk ratios (RRs) and 95% confidence intervals (CIs) derived from separate IPCW-weighted modified Poisson regression models for each discrimination domain. Discrimination domains included race/ethnicity, nativity, sexual orientation, and weight-based discrimination. Overweight/obesity was defined as body mass index (BMI) ≥ 85 th percentile for age and sex, and elevated waist adiposity was defined as waist circumference ≥ 90 th percentile for age and sex. Models were adjusted for child age, sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI. IPCW weights were applied to account for differential loss to follow-up. Statistically significant associations were identified when 95% confidence intervals excluded 1.00. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting.

Table 18. Multiplicative interaction effects between each discrimination domain and adiposity outcomes.

Outcome	Overweight/Obesity	Waist adiposity
Two-way Interaction Terms		
Race/Ethnicity x Sex	1.08 (0.72-1.61)	1.01 (0.55-1.86)
Nativity x Sex	1.92 (1.29-2.88)	2.63 (1.55-4.45)
Sexual orientation x Sex	0.97 (0.62-1.52)	0.96 (0.53-1.74)
Weight x Sex	1.1 (0.86-1.42)	0.92 (0.67-1.26)
Race/Ethnicity x Black	1.65 (0.51-5.3)	1.51 (0.3-7.72)
Race/Ethnicity x Hispanic	2.03 (0.68-6.06)	2.26 (0.52-9.79)
Race/Ethnicity x Asian/Other	2.09 (0.66-6.58)	2.07 (0.44-9.8)
Nativity x Black	1.87 (0.35-9.9)	0.89 (0.17-4.76)
Nativity x Hispanic	2.66 (0.51-13.73)	1.73 (0.36-8.19)
Nativity x Asian/Other	2.51 (0.4-15.66)	0.82 (0.1-7.01)
Sexual orientation x Black	1.88 (1.01-3.51)	1.56 (0.63-3.83)
Sexual orientation x Hispanic	1.52 (0.85-2.69)	1.28 (0.64-2.55)
Sexual orientation x Asian/Other	1.87 (0.95-3.71)	0.99 (0.29-3.32)
Weight x Black	0.54 (0.32-0.91)	0.33 (0.15-0.72)
Weight x Hispanic	0.61 (0.47-0.79)	0.5 (0.36-0.69)
Weight x Asian/Other	0.87 (0.59-1.29)	0.69 (0.44-1.09)

Note. RR = risk ratio; CI = confidence interval; IPCW = inverse probability of censoring weighting. Risk ratios and 95% confidence intervals were estimated using IPCW-weighted modified Poisson regression models with a log link. Overweight/obesity was defined as body mass index ≥ 85 th percentile for age and sex. Models were adjusted for child age, child sex, race/ethnicity, parent nativity, parent education, parent marital status, and baseline BMI.

Table 19 Sensitivity analysis: Associations between perceived discrimination domains at Year 1 and continuous body mass index and waist circumference at Year 2 among adolescents in the ABCD Study

Discrimination Domain	Adjusted β (95%CI)	p-value
Overweight/obesity		
Race/Ethnicity	0.45 (-0.07–0.97)	0.092
Nativity	0.27 (-0.19–0.74)	0.252
Sexual orientation	0.34 (-0.12–0.80)	0.147
Weight	0.55 (0.10–1.00)	0.016
Waist Adiposity		
Race/Ethnicity	-0.02 (-1.49–1.44)	0.975
Nativity	-0.21 (-1.75–1.32)	0.783
Sexual orientation	0.45 (-1.19–2.09)	0.591
Weight	2.11 (0.53–3.69)	0.009

Note. Values are presented as adjusted regression coefficients (β) and 95% confidence intervals (CIs) derived from separate survey-weighted linear regression models for each discrimination domain. Discrimination domains included race/ethnicity, nativity, sexual orientation, and weight-based discrimination. Continuous body mass index (BMI; kg/m²) and waist circumference (cm) measured at Year 2 were examined as outcomes. Models were adjusted for child age, sex, race/ethnicity, parent nativity, parent education, parent marital status, baseline BMI (or baseline waist circumference for waist circumference models), and inverse probability of censoring weights (IPCW). β = regression coefficient; CI = confidence interval; IPCW = inverse probability of censoring weighting.

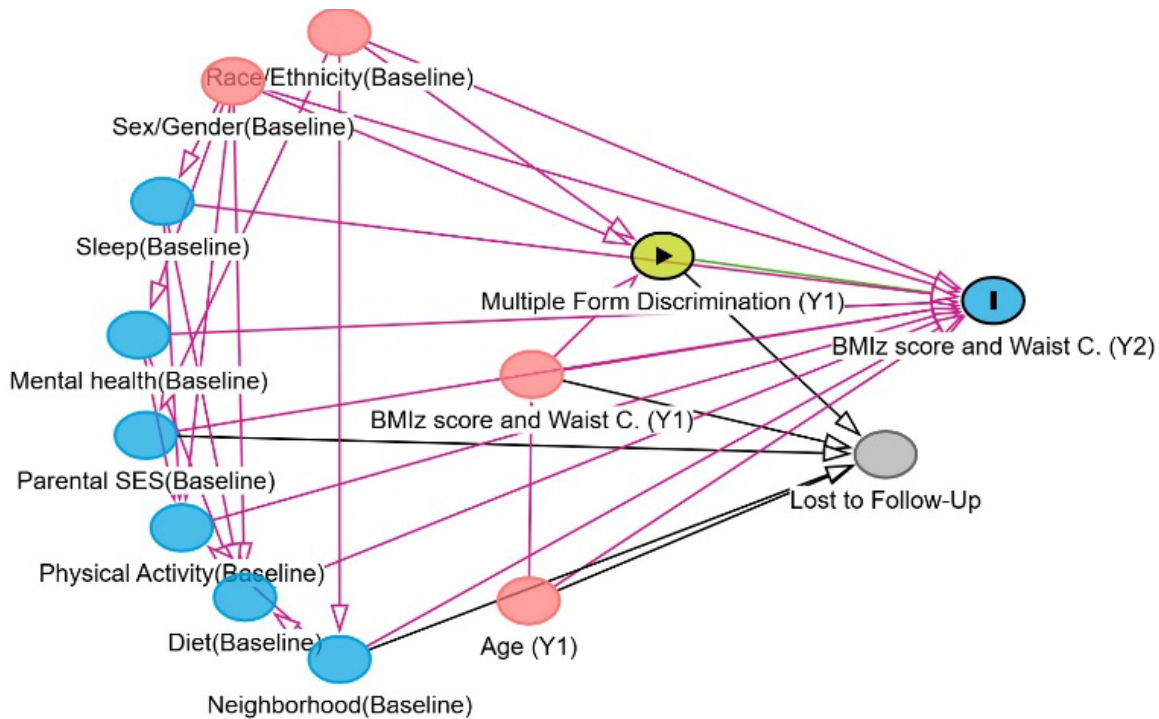


Figure 7. Directed acyclic graph (DAG) illustrating the hypothesized causal relationships among domains of perceived discrimination, adiposity outcomes, potential confounders, and selection processes.

Note. The directed acyclic graph (DAG) represents the hypothesized causal structure underlying the association between perceived discrimination measured at Year 1 (Y1) follow-up and adiposity outcomes (body mass index [BMI] and waist circumference) measured at Year 2 (Y2) follow-up in the ABCD Study. Baseline sociodemographic, behavioral, psychosocial, and neighborhood characteristics were identified as potential confounders based on prior literature and subject-matter knowledge. Baseline BMI and waist circumference were included to account for pre-existing adiposity. The node representing loss to follow-up reflects potential selection bias due to attrition between Y1 and Y2; inverse probability of censoring weighting (IPCW) was used to account for differential loss to follow-up. Arrows indicate hypothesized causal relationships and do not represent observed associations.

Chapter 5 DISSERTATION DISCUSSION

This dissertation examined stigma as a multilevel social determinant of adolescent adiposity by evaluating both interpersonal experiences of discrimination and structural stigma using longitudinal data from the Adolescent Brain Cognitive Development (ABCD) Study. Across three complementary studies, the findings provide new evidence regarding the extent to which stigma contributes to obesity risk during early adolescence. Although unadjusted analyses consistently demonstrated that adolescents exposed to interpersonal discrimination or structural stigma experienced a greater burden of overweight/obesity and abdominal adiposity, these associations were substantially attenuated after accounting for demographic, socioeconomic, family, neighborhood, and baseline adiposity characteristics. Collectively, these findings suggest that stigma does not operate independently but rather functions within broader social and environmental contexts that shape adolescent obesity risk.

One of the most consistent findings across all three studies was the attenuation of associations following covariate adjustment. Adolescents exposed to discrimination or residing in environments characterized by higher levels of structural stigma also differed from their peers across numerous social determinants of health, including parental education, household income, family structure, neighborhood disadvantage, neighborhood safety, and baseline adiposity. These factors may therefore have confounded the crude associations observed between stigma-related exposures and adiposity. After accounting for these characteristics, there was limited evidence that stigma or discrimination independently predicted subsequent adiposity over the study period. Although stigma may plausibly operate along pathways linking broader social and socioeconomic conditions to health, the present studies did not formally evaluate mediation and therefore cannot determine whether stigma serves as an intermediate mechanism through which

social disadvantage influences adolescent adiposity. Future research using longitudinal mediation or other causal approaches may help clarify these relationships.

The findings also support the conceptual framework proposed in this dissertation, which views stigma as operating across multiple levels. Interpersonal discrimination represents direct experiences of unfair treatment, whereas structural stigma reflects broader societal conditions embedded within policies, institutions, and social norms. Although these forms of stigma differ conceptually, both demonstrated similar patterns within this dissertation. Initial associations with adiposity were evident in unadjusted analyses but were substantially reduced after accounting for characteristics that capture broader social and contextual inequalities. This consistency across interpersonal and structural measures suggests that stigma should be understood as one component of the larger system of social determinants influencing adolescent obesity rather than as an isolated causal mechanism.

Despite the overall attenuation of associations, weight discrimination emerged as the most consistent interpersonal predictor of adiposity. Among the discrimination domains examined, weight discrimination demonstrated persistent associations with waist adiposity and with continuous measures of both body mass index and waist circumference. These findings are consistent with growing evidence that weight stigma may contribute to obesity through physiological and behavioral pathways. Chronic exposure to weight-based stigma has been associated with activation of the hypothalamic-pituitary-adrenal axis, elevated cortisol production, systemic inflammation, emotional distress, unhealthy eating behaviors, reduced physical activity, and avoidance of healthcare, all of which may contribute to excess adiposity over time (Himmelstein et al., 2015; Puhl & Heuer, 2009; Tomiyama, 2019). Unlike other forms

of discrimination, weight discrimination may also create a self-reinforcing cycle in which adolescents with higher adiposity experience greater stigma, leading to additional psychological stress and behaviors that further promote weight gain. The consistency of these findings across several analytic approaches suggests that weight discrimination may represent a particularly important target for future obesity prevention efforts.

This dissertation also contributes to the growing literature examining intersectionality in adolescent health. Across the three studies, several interaction analyses suggested that associations between stigma and adiposity differed across combinations of sex and race/ethnicity, although many higher-order interaction estimates were characterized by wide confidence intervals and limited statistical precision. Similarly, racial centrality appeared to attenuate the relationship between perceived racial/ethnic discrimination and waist adiposity, although statistical evidence for effect modification was limited. Together, these findings are consistent with intersectionality theory, which argues that systems of oppression operate simultaneously and that health risks cannot always be understood through single social identities alone (Alvidrez et al., 2021; Bauer et al., 2021; Crenshaw, 1989). Although definitive conclusions regarding subgroup differences cannot be drawn from the present analyses, the observed patterns suggest that future research should continue examining how multiple social identities interact to influence obesity risk rather than relying exclusively on average population effects.

The findings additionally highlight the importance of considering developmental timing when examining stigma and obesity. Adolescence represents a critical developmental period characterized by rapid biological, psychological, and social change. Exposure to discrimination

during this period may influence stress physiology, emotional regulation, health behaviors, and social relationships in ways that accumulate over the life course (Gee & Ford, 2011; Slopen et al., 2016). Although most associations observed in this dissertation were attenuated after adjustment, it remains possible that the health consequences of stigma require longer periods of exposure before manifesting as measurable differences in adiposity. The relatively short follow-up period available within the current analyses may therefore underestimate the cumulative influence of chronic discrimination and structural stigma across adolescence and early adulthood.

From a public health perspective, these findings highlight the importance of considering the broader social and socioeconomic context in research on adolescent obesity. Although discrimination and structural stigma were associated with adiposity in several unadjusted analyses, these associations were substantially attenuated after accounting for sociodemographic characteristics and baseline adiposity. Thus, the findings do not provide strong evidence that stigma independently contributes to adolescent adiposity over the study period. Instead, they demonstrate the importance of accounting for the social and socioeconomic conditions that may confound observed associations between stigma-related exposures and obesity. Future research should examine the temporal and potentially mediating relationships among socioeconomic conditions, stigma, discrimination, and adiposity to better understand whether and how these factors contribute to obesity disparities.

STRENGTHS AND LIMITATIONS

This dissertation possesses several important strengths. First, the longitudinal design establishes temporal ordering between stigma exposure and subsequent adiposity outcomes, strengthening inference compared with cross-sectional studies. Second, the use of data from the

nationally diverse ABCD Study enhances the generalizability of findings to U.S. adolescents. Third, this dissertation simultaneously examined multiple levels of stigma (including interpersonal discrimination and structural stigma) within a unified conceptual framework, providing a more comprehensive assessment of stigma than most previous studies. Fourth, the incorporation of inverse probability of censoring weights reduced the potential for bias associated with differential attrition, while multiple sensitivity analyses demonstrated that the primary findings were generally robust across alternative analytic approaches and outcome specifications.

Several limitations should also be considered. First, as an observational study, causal relationships cannot be established, and residual confounding from unmeasured factors remains possible. Second, discrimination was assessed using self-reported measures and may therefore be subject to recall and reporting error. Adolescents may differ in their ability to recall discriminatory experiences, their interpretation of whether an event constitutes discrimination, or their willingness to report such experiences. Because discrimination was assessed before the subsequent adiposity outcomes, this measurement error would generally be expected to be nondifferential with respect to Year 2 adiposity; that is, errors in reporting discrimination would not be expected to systematically differ according to the subsequent outcome. For the binary discrimination measures, nondifferential exposure misclassification would generally be expected to attenuate associations toward the null, although the direction of bias cannot be assumed under all conditions. Consequently, measurement error in self-reported discrimination may have contributed to underestimation of associations between discrimination and subsequent adiposity. Differential reporting remains possible if factors related to adiposity or other participant characteristics influenced adolescents' perception or reporting of discrimination, in which case

the direction of bias would be less predictable. Third, discrimination and structural stigma were measured at a single point in time and may not fully capture cumulative or changing exposures throughout adolescence. Fourth, although interaction analyses provided valuable insights into potential heterogeneity across intersecting social identities, several subgroup analyses were limited by sparse observations and wide confidence intervals, reducing statistical precision. Finally, because the follow-up period was relatively short, longer-term effects of chronic exposure to stigma on obesity trajectories may not have been fully captured.

Future research should extend these findings by examining repeated measures of discrimination and structural stigma across adolescence, allowing investigators to evaluate cumulative exposure and changes over time. Studies incorporating biological markers of chronic stress, inflammation, and neuroendocrine functioning may further clarify the mechanisms linking stigma to adiposity. Additional research should also evaluate protective factors, including resilience, family support, positive racial or ethnic identity, school climate, and community resources, that may buffer the health consequences of stigma. Finally, larger longitudinal studies will be needed to more rigorously evaluate intersectionality and identify subgroups of adolescents who may be disproportionately affected by multiple forms of social marginalization.

CONCLUSION

In conclusion, this dissertation contributes to the growing literature recognizing stigma as a social determinant of health. Across all three studies, a consistent pattern emerged in which associations observed in unadjusted analyses were substantially attenuated after accounting for demographic, socioeconomic, family, neighborhood, and baseline health characteristics. At the same time, the consistent associations observed for weight discrimination and the evidence

suggesting heterogeneity across intersecting social identities indicate that stigma remains an important consideration in understanding obesity disparities. Collectively, this dissertation supports a more comprehensive public health approach to adolescent obesity that addresses not only individual behaviors but also the social and structural conditions that influence health across the life course.

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