Weight stigma: Cross-sectional and longitudinal associations with disordered eating and weight-related health behaviors in an ethnically/racially and socioeconomically diverse sample of adolescents and young adults

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE
UNIVERSITY OF MINNESOTA
BY

Laura Hooper

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

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July 2022

Acknowledgements

I want to acknowledge the many funding sources that supported my time and made this dissertation possible (see below). I especially appreciate the training I received in translational science through the Translational Research and Career Training (TRACT TL1) Predoctoral Fellowship, in the Clinical and Translational Science Institute, and also for the training I received in adolescent health through the Leadership Education in Adolescent Health (LEAH) Predoctoral Fellowship, in the Division of General Pediatrics and Adolescent Health, including all that I learned from the faculty and my co-fellows in these programs.

I am so grateful to my dissertation committee members: Dr. Marla Reicks, Dr. Scott Crow, Dr. Marla Eisenberg, Dr. Rebecca Puhl, and Dr. Dianne Neumark-Sztainer. Each of you is a giant in your respective field of study. You have each played a distinct role in representing your discipline which has allowed this complex topic to be examined in the way that it deserves. It has been such an honor to be taught and mentored by each of you. I appreciate the interdisciplinary collaboration that you have modeled and all that you have taught me about science communication. Dr. Reicks, thank you for offering your expertise in public health nutrition and adolescent obesity. Thank you for the critical lens you bring to making sure I am clearly explaining my research methods and rationale for my decisions. Thank you for helping me use the health equity lens I seek to reflect in my writing. Dr. Crow, thank you for bringing your expertise and wisdom from the field of eating disorders research, including thoughtful considerations and insights for future research. Thank you for representing the clinical perspective, a perspective that is near and dear to my heart, and for bringing the important lens of the disciplines of psychology and psychiatry. Dr. Eisenberg, thank you for bringing your expertise in adolescent health, stigma and bullying, health equity, research methods, and statistical analysis to this work. Thank you for always making yourself available to answer my questions, big and small, related to statistical analysis and data interpretation. Dr. Puhl, your expertise and leadership in the field of weight stigma has been essential throughout this process. Thank you for all that you taught me about scientific writing, for keeping me on my toes when it comes to understanding the weight stigma literature from so many different angles, and for the extra time and effort you made to be a full participant on this committee as a distance mentor. Dr. Neumark-Sztainer, you are an expert and leader in public health research focused on the intersection of disordered eating and weight-related health in young people. Thank you for reading every version of every manuscript so thoroughly and for your prompt and constructive feedback. Thank you for answering all my questions and for encouraging me to ask them. Thank you for guiding me for the past five years, helping me learn and grow, and helping me gain independence as a researcher.

I want to thank the Project EAT research team members, past and present, as well as the study participants. This work is complex and requires collaboration from an interdisciplinary team of researchers like the Project EAT team. This dissertation would not be possible without that team.

Thank you to my peers and my near-peer mentors who encouraged me and helped me feel confident that my approach to this research was important and that I was on the right track. Thank you for teaching me about social science and health equity scholarship, for letting me bounce my ideas off of you, for being my writing companions, for watching me practice my presentations, for sharing positive, open source photographs of youth diverse in body size, ethnicity, and race, for reminding me that my adolescent patients are the reason I do this work, for encouraging me to be brave, and for giving tremendously insightful feedback and advice.

Finally, I want to thank my incredible family and friends for loving me and being there to support me in all imaginable ways. Thank you for helping to ground me and remind me of what's important. Thank you for your encouragement, friendship, kindness, laughter, and generosity. I love you, and I would not have completed this dissertation without you.

Funding Sources:

Translational Research and Career Training (TRACT TL1) Predoctoral Fellowship, National Institutes of Health – National Center for Advancing Translational Sciences, Clinical and Translational Science Institute, University of Minnesota (2020-2022)

Leadership Education in Adolescent Health (LEAH) Predoctoral Fellowship, Health Resources and Services Administration – Maternal and Child Health Bureau, Division of General Pediatrics and Adolescent Health, University of Minnesota (2019-2020)

Leadership, Education and Training Program in Maternal and Child Nutrition ,Health Resources and Services Administration – Maternal and Child Health Bureau, Division of Epidemiology and Community Health, University of Minnesota (2018-2019)

Department of Food Science and Nutrition Graduate Fellowship, Department of Food Science and Nutrition, University of Minnesota (2017-2018)

Graduate Student Recruitment Fellowship, College of Food, Agricultural and Natural Resource Sciences, University of Minnesota (2017-2018)

The Project EAT 2010-2018 study was supported by grant numbers R01HL127077 and R35HL139853 from the National Heart, Lung, and Blood Institute (PI: Dianne Neumark-Sztainer). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Heart, Lung, and Blood Institute.

Dedication

For my family.

Abstract

This dissertation used a health equity lens to examine whether experiencing weight teasing is associated with disordered eating behaviors (DEBs), health behaviors, and weight status in an ethnically/racially and socioeconomically diverse sample of youth. It also investigated whether positive family/parenting factors are protective for DEBs in youth who experience weight stigma.

1,534 Project EAT 2010-2018 participants were surveyed as adolescents (M_{age}=14.4 years) and eight years later. Participants were asked about weight-stigmatizing experiences (e.g., weight teasing). Outcomes included DEBs (e.g., unhealthy weight control behaviors, chronic dieting, binge eating), health behaviors (e.g., physical activity, sleep duration, nutrition habits), and weight status. Regression models were adjusted for sociodemographic characteristics and weight status. Interaction terms and stratified models assessed whether family/parenting factors buffered DEB risk in adolescents who experienced weight stigma.

Experiencing weight teasing was significantly associated with higher prevalence of DEBs and high weight status, cross-sectionally during both adolescence and young adulthood, and longitudinally. Effects of weight teasing were similar across ethnic/racial and socioeconomic subgroups. Black Indigenous, and People of Color (BIPOC) and youth from low socioeconomic backgrounds had higher prevalence of weight teasing, DEBs, and high weight, when compared to their respective counterparts. There was evidence that positive family/parenting factors operate as effect modifiers in cross-

sectional relationships between weight stigma and DEBs, although these factors were primarily protective for adolescents who did not experience weight stigma.

Findings provide evidence that weight teasing is a risk factor for DEBs and high weight status, and that BIPOC youth and youth from low socioeconomic backgrounds are disproportionately affected by weight teasing, DEBs, and high weight status, suggesting weight-stigmatizing experiences may create barriers to health, especially for youth who are already underserved. Positive family/parenting factors did not entirely offset the effects of weight stigma on DEBs, which may reflect the strength of weight stigma as a risk factor for DEBs. Published guidelines provide recommendations for how to decrease weight stigma experienced by youth. Future research should build upon these guidelines and include qualitative, solutions-oriented methods aimed at understanding how families, healthcare providers, and policymakers can decrease weight stigma and its effects on diverse populations of youth.

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List of Abbreviations

BMI: body mass index

COBWEBS: Cyclic Obesity/Weight-Based Stigma

DSM-5: Diagnostic and Statistical Manual of Mental Disorders

SES: socioeconomic status

BIPOC: Black, Indigenous, and other People of Color

UWCB: unhealthy weight control behaviors

MVPA: moderate-to-vigorous physical activity

SSB: sugar-sweetened beverage

U.S.: United States

FFQ: Food Frequency Questionnaire

YAQ: Young Adult Food Frequency Questionnaire

DEB: disordered eating behavior

EWCB: extreme weight control behaviors

IPW: inverse probability weighting

CBPR: community-based participatory research

YPAR: youth-led participatory action research

Chapter 1

Introduction

1.A. Literature Review

Weight Stigma in Adolescents and Young Adults

Weight stigma is based on social devaluation of people due to their high weight status or large body size, including stereotypes that these individuals lack willpower or discipline, are lazy, or are unmotivated [1]. During adolescence and young adulthood, weight stigma most often occurs in the forms of teasing, bullying, and victimization [2], and is a common experience, with United States studies estimating prevalence in young people at 23-32% [3,4]. The transition from adolescence to young adulthood is a critical period of development during which prevention and intervention efforts may decrease health threats and alter health trajectories for the adult population [5]. Forming social relationships is an important part of healthy psychosocial development during this transition [5,6]. Thus, peer rejection and exposure to weight stigma may pose an unique threat to health and well-being during this developmental stage [5,6].

Weight Stigma as a Health Equity Issue

A health equity framework recognizes that research investigators and study participants often overrepresent privileged groups (e.g., white, middle- to upper-class) [7]. Thus, this framework acknowledges that research conclusions and corresponding interventions might miss key factors important in meeting the health needs of underserved populations [7]. Further, research that uses a health equity framework attempts to correct this shortcoming of prior research and instead seeks to identify and decrease health disparities that affect marginalized populations with the long term goal of improving the health of the population as a whole [7].

Health equity frameworks have typically been used to attempt to decrease health inequities based on ethnicity, race, and socioeconomic status [7]. However, the concept of health equity has recently expanded to include other factors representing social stratification such as sexual orientation, gender, gender identity, ability/disability status, place of residence, religion, immigration status, age, and intersectional identities [8,9]. People are marginalized based on each of these factors, and therefore structures and experiences can create barriers to health and well-being for individuals with these identities [8,9]. Another important focus for health equity work is to address discrimination, mistreatment, and marginalization based on body size, namely weight stigma. Both structurally and interpersonally mediated, weight stigma often goes unrecognized and unaddressed, and it is conveyed in nearly every facet of society [10]. Sources of weight stigma include education and workplace settings, the media, friends, family members, healthcare providers, and healthcare settings [10]. Moreover, in the United States, legal protections for people who experience weight-based discrimination are limited to the state of Michigan and a small number of cities (e.g., San Francisco, CA; Binghamton, NY) [10,11]. In fact, globally, few places have such legislative protections [10]. In addition, it is well-established that, due to inequities, BIPOC populations and populations from low SES backgrounds are disproportionately affected by nutrition-, fitness-, and weight-related health problems [7,12,13]. Therefore, it is reasonable to expect that a health equity framework may be useful to research focused on the health effects of weight stigma [10]. Consequently, I attempt to use a health equity framework to investigate the research questions asked in this dissertation.

Weight Stigma and Health Outcomes

Exposure to weight stigma is associated with adverse outcomes for psychosocial health [14,15,24–28,16–23] and, although data are more limited, physical health [22,29–35]. Regarding associations between weight stigma and psychological health, a meta-analysis quantifying effect sizes found an overall significant association between weight-stigmatizing experiences and worse mental health outcomes [28]. When examined in aggregate, this meta-analysis (105 studies in adults and children, n=59,172, mean age=30.5 years), found that body mass index (BMI) modified the relationship between weight stigma and mental health outcomes – the association between weight stigma and these mental health outcomes was stronger in participants with a higher BMI. Age, gender, ethnicity, and coping strategies did not modify the relationship between weight stigma and mental health outcomes as the authors had hypothesized. The overall effect size of the association between weight stigma and mental health outcomes remained statistically significant and comparable in size when the covariates of education, BMI, publication year, and the BMI interaction term were included in the model.

This meta-analysis also examined the relationship between experienced weight stigma and individual mental health outcomes. Weight stigma was associated with body dissatisfaction, low quality of life, depressive symptoms, disordered eating, anxiety symptoms, psychological distress, decreased self-esteem, and decreased well-being (ranked from strongest to weakest effect size). The effect sizes of these outcomes were not statistically different from each other. Although this meta-analysis included participants across the lifespan and was thoughtfully designed, the authors noted that the most available data on this topic were cross-sectional, and thus they were unable to include intervention or prospective cohort studies [28].

Studies focused specifically on adolescents and young adults have examined the relationship between weight stigma and psychosocial health outcomes, showing that weight stigma is linked to increased vulnerability to depression [15–17], substance use [18], body dissatisfaction [15,19], self-harm [15], lower self-esteem [15,17,26,27], social isolation [24], school avoidance [25], and a self-reported decrease in grades [25].

Research examining the weight stigma-physical health outcome relationship has primarily focused on two areas – future weight gain and the physiologic stress response. Findings largely indicate that weight stigma is associated with both an elevated physiologic stress response [34–36] and, regardless of baseline weight status, future increases in weight [22,29,30]. One longitudinal study in a community-based sample of adolescents in Minnesota (Project EAT I-IV, n = 1774, baseline mean age = 14.9 years) found that weight-based teasing predicted elevated weight status 15 years later, after accounting for sociodemographic characteristics and baseline weight status [22]. A national study in adults in the United States (n=6157, baseline mean age=66.5 years) found that weight discrimination predicted high weight status (BMI $\geq$ 30 kg/m^2) four years later when adjusting for sociodemographic characteristics and baseline weight status [32]. When analyses were stratified by baseline weight status (group 1: BMI < 30 kg/m^2, group 2: BMI $\geq$ 30 kg/m^2), the findings did not vary by baseline weight status. A national British study (n=2944, baseline mean age=63.1 years) found that weight discrimination predicted increases in measured weight and measured waist circumference four years later after adjusting for sociodemographic characteristics and baseline weight status [30].

Studies examining the physiologic stress response have shown that weight stigma is associated with higher levels of physiologic stress biomarkers such as c-reactive protein [34], cortisol [35,36], and F2-isoprostanes [36]. Because these biomarkers are also involved in inflammatory pathways which promote the development of weight-related chronic diseases such as type 2 diabetes [37], these findings, together with the weight stigma-elevated weight status relationship, suggest that weight stigma may independently predict additional physical health outcomes. However, few studies have examined this hypothesis. One cross-sectional study in 938 adults (mean age=56.9 years) investigated whether there is a relationship between weight stigma and risk for type 2 diabetes [38]. It found that participants who experienced more weight discrimination had higher hemoglobin A1c, but this relationship was not statistically significant. Additionally, the investigators assessed whether weight discrimination exacerbated the effects of BMI, waist to hip ratio, and waist circumference on hemoglobin A1c and found that it did, but only for participants with a higher waist to hip ratio.

In recent years, increased attention has focused on weight stigma as a potential risk factor for adverse nutrition-, fitness-, body image-, and weight-related health outcomes [39,40]. Evidence indicates that experiencing weight stigma is a risk factor for future weight gain [22,29–32], however, understanding the factors facilitating this process require more comprehensive investigation. In the Cyclic Obesity/Weight-Based Stigma (COBWEBS) model, Tomiyama suggests that there is a “positive feedback loop” between weight-stigmatizing experiences and weight gain [39]. Specifically, Tomiyama proposes that weight-stigmatizing experiences lead to increased stress, which leads to an increase in the physiologic stress response and eating/activity behaviors that promote weight gain, which together lead to elevated weight status, which leads to further weight-stigmatizing experiences [39].

This explanation is compelling given that studies examining the physiologic stress response have shown that weight stigma is associated with higher levels of physiologic stress biomarkers such as c-reactive protein [34], cortisol [35,36], and F2-isoprostanes [36]. Moreover, chronically elevated cortisol levels are known to decrease the basal metabolic rate and promote visceral adipose tissue accumulation [41]. Research has also found that elevated levels of cortisol drive subsequent increases in food consumption and energy-dense food consumption [39,42]. While there is evidence that weight-stigmatizing experiences are linked to elevated levels of physiologic stress biomarkers and that elevated physiologic stress is linked to increases in energy intake, fewer studies have focused on understanding whether a comprehensive set of behaviors is responsible for the observed relationship between weight-stigmatizing experiences and future weight gain. For example, several behaviors influence energy metabolism and body weight regulation, including 1) those that promote low energy expenditure such as excessive screen time and inadequate physical activity, 2) those that promote high energy intake such as excessive intake of sugar-sweetened beverages and fast-food, and 3) disordered eating behaviors such as binge eating and unhealthy weight control behaviors which are established risk factors for subsequent weight gain [43–45]. To the best of my knowledge, studies have not investigated weight stigma as a risk factor for a comprehensive set of behaviors from all three of these categories. Thus, questions remain about the relationship between weight-stigmatizing experiences and behaviors that promote weight gain.

Weight Stigma and Weight-Related Health Behaviors in Adolescents and Young Adults

For adolescents and young adults, the health behaviors typically targeted in both public health campaigns and clinical interventions to promote weight-related health and prevent related chronic diseases include inconsistent breakfast intake, inadequate fruit and vegetable intake, excessive sugar-sweetened beverage intake, excessive fast-food intake, low physical activity, excessive screen time, and inadequate sleep duration [46–49]. These behaviors are tied not only to risk for elevated weight status, but also to risk for weight-related chronic disease. For example, meta-analyses of randomized controlled trials have found that higher intake of dietary sugar increases risk factors for cardiovascular disease, including high triglycerides and high total cholesterol [50,51]. Excessive sugar-sweetened beverage intake increases risk for type 2 diabetes [52], hypertension [53], and coronary heart disease [54]. Additionally, high-sodium foods like fast-food contribute to sodium intake among adolescents which is generally above the recommended amount in the United States [55]; high sodium intake in adolescents and young adults increases their risk for hypertension [55]. Young people who develop hypertension are predisposed to health problems in adulthood, including hypertension and other cardiovascular diseases [55]. Finally, there is strong evidence that physical inactivity is one of the primary risk factors for metabolic syndrome. A prospective cohort study in 4192 black and white adults with a 15-year follow-up period found that an inactive lifestyle independently predicted higher risk for metabolic syndrome [56]. The reverse relationship has been demonstrated, that is regular participation in physical activity predicts lower risk for metabolic syndrome [56–58].

Few studies have examined the relationship between weight-stigmatizing experiences and weight-related health behaviors (frequency of breakfast intake, fruit and vegetable intake, sugar-sweetened beverage intake, fast-food intake, physical inactivity, screen time, and sleep patterns) in adolescents and young adults [17,19,59,60]. The majority of these studies have focused on physical activity. Studies that have investigated the relationship between weight stigma and physical activity levels have found null associations [17,19,59], and one has found mixed results [60]. The first study was conducted in public school students in Brazil (n=95, mean age=13.2 years) [59]. It used the Perception of Weight Teasing Scale to assess weight stigma and 7-day accelerometer measurement to assess physical activity levels [59]. The second study was conducted in female undergraduates in the United States (n=100, mean age=20.1 years) [19]. It used the Stigmatizing Situations Inventory (SSI) to assess weight stigma, and physical activity was assessed with self-reported duration and frequency of mild, moderate, and strenuous activities [19]. The third study was conducted in middle school students in the United States (n=1419, mean age=12.4 years) [17]. Physical activity was assessed by asking participants to report the frequency and duration of aerobic activity, strengthening activity, and activity to improve flexibility [17]. Weight teasing was assessed by asking participants if they had ever been teased for “weighing too much” [17]. These first three studies found no association between weight-stigmatizing experiences and physical activity levels [17,19,59]. The fourth study had mixed results. It was conducted as a part of the LGBTQ Teen Study, a national sample of adolescents identifying as sexual and gender minority in the United States (n=9679, mean age=15.6 years) [60]. It used the Godin Leisure Time Exercise Questionnaire to assess physical activity levels and found that the associations between weight-based victimization and physical activity levels depended on the source [60]. Weight teasing from family was associated with lower physical activity levels; the association was null for weight teasing from peers; and frequency of weight-based victimization at school was associated with higher levels of physical activity [60].

Despite these findings, it has been demonstrated that weight stigma in adolescents and young adults is associated with lower physical activity self-efficacy and motivation [16,17,19], physical activity avoidance [18,25], and lower levels of physical fitness [17]. One study found that adolescents' emotional distress in response to weight teasing predicted avoidance of physical education class [25]. The reason for these somewhat paradoxical findings is unclear. Adult studies have found patterns similar to the adolescent and young adult data. For example, one study in adults with BMI ≥ 25 kg/m^2 found that weight stigma was associated with high motivation to avoid exercise, but not associated with physical activity levels [61]. Another study found that, in women with BMI ≥ 25 kg/m^2, weight bias internalization was associated with lower levels of exercise, but weight-stigmatizing experiences were associated with higher levels of exercise [62].

A review of the literature on weight stigma and sleep in adolescents and young adults produced only one study. This study found that, among adolescents who identify as sexual and gender minorities, the frequency of weight-based victimization at school and weight teasing from family members were both associated with self-reported difficulty falling asleep, but weight teasing from peers was not [60]. My review of the literature identified no studies in adolescents and young adults that examined the relationship between weight stigma and the following relevant weight-related health behaviors: screen time, and intake of breakfast, fruit, vegetables, sugar-sweetened beverages, and fast-food.

In summary, few studies in adolescents and young adults have examined the relationship between weight-stigmatizing experiences and health behaviors that increase risk for weight-related chronic disease [17,19,59,60]. Opportunities remain to understand the relationship between weight-stigmatizing experiences and these health behaviors in adolescents and young adults, especially given that a relationship between weight stigma and future weight gain has been established, but highly relevant behaviors, potentially contributing to that relationship, are largely understudied.

Weight Stigma and Disordered Eating in Adolescents and Young Adults

Disordered eating behaviors are an important health outcome for the adolescent and young adult population for several reasons. First, they are very prevalent in this population, with one study estimating prevalence at 58.8% in adolescent females, 31.7% in adolescent males, 54.8% in young adult females, and 32.6% in young adult males [63]. Second, they represent risk factors for clinical eating disorders, poor dietary intake, and additional adverse health outcomes [64–66]. Third, disordered eating behaviors are established risk factors for subsequent weight gain [43–45] and thus may offer one plausible explanation for the connection between weight-stigmatizing experiences and future weight gain.

Disordered eating refers to binge eating, restrictive eating, or bingeing and purging without meeting the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders) criteria for binge eating disorder, anorexia nervosa, or bulimia nervosa. For example, a person could be restricting their energy intake relative to requirements and have an intense fear of gaining weight, but not have a significantly low body weight in the context of age, gender, developmental trajectory, and physical health. Thus, they would not meet DSM-5 criteria for anorexia nervosa [67]. Or, a person may have recurrent episodes of binge eating with accompanying inappropriate compensatory behavior, such as self-induced vomiting, with the goal to prevent weight gain. However, if they do not engage in such behaviors as often as once per week for at least three months, they do not meet DSM-5 criteria for bulimia nervosa [67].

Several cross-sectional studies have investigated the weight stigma-disordered eating behavior relationship in adolescents and young adults [14,23,68–74]. These studies have largely found that weight stigma independently predicts disordered eating behaviors. However, white, female, and middle- to high-socioeconomic status (SES) populations are overrepresented in these studies. Two cross-sectional studies used samples that overrepresent youth who are Black, Indigenous, and other People of Color (BIPOC) and youth from low socioeconomic backgrounds [14,23], and they are described here.

The first study used data from EAT 2010, which serves as baseline data for the cohort used in this dissertation (EAT 2010-2018) [14]. This study examined cross-sectional associations between family-based weight teasing and disordered eating behaviors in 1557 adolescents from four different ethnic groups: Latinx, Hmong, Somali, and White (mean age=14.5 years). It found independent associations between weight teasing and both unhealthy weight control behaviors (UWCB) and body dissatisfaction among adolescents from all four ethnic groups in analyses adjusted for weight status. Weight teasing occurred across all ethnic groups and genders, and the relationship between weight teasing and disordered eating did not vary by gender, ethnic group, or acculturation. This study was well-designed in its examination of the relationship of weight teasing and disordered eating behaviors in an ethnically/racially diverse sample and in its assessment of whether the weight stigma-disordered eating behavior relationship varied across gender and ethnic group. However, it was limited by its cross-sectional design and did not assess whether the relationship between weight teasing and disordered eating varied by SES.

The second study investigated the cross-sectional relationship between weight stigma and disordered eating in 105 adolescents living in a low-income neighborhood in the United States (mean household income = $17,018) [23]. Mean age was 16.3 years, and the ethnic/racial make-up of the sample was 46% African American, 47% Hispanic, and 7% other. In this study, weight-stigmatizing experiences were assessed using the SSI adapted for adolescents (SSI-A). One-way ANOVA analyses found that the eating disorder group experienced significantly more weight stigma when compared to the no diagnosis group and to the nonclinical binge eating group. Strengths of this study include its oversampling of participants from low SES households and of African American and Hispanic participants, given these populations tend to be underrepresented in studies examining the weight stigma-disordered eating behavior relationship. Limitations include the cross-sectional design and lack of adjustment for weight status or other potential confounders.

While most studies that have examined the relationship between weight stigma and disordered eating behaviors in adolescents and young adults have had cross-sectional designs [14,23,68–74], to date, three published studies have examined these relationships longitudinally, lending insight into the temporal nature of the relationship. In the study by Hunger and colleagues, 2036 female participants were 14 years old at baseline, 52.8% African American and 47.2% white [21]. Weight stigma at baseline was assessed by asking participants if they had "ever been told they were too fat by the following individuals: father, mother, brother, sister, a best girlfriend, the boy you like best, any other girl, any other boy, any teacher." Disordered eating was assessed 5 years later with the Eating Disorder Inventory (EDI). UWCB over the past 30 days were also self-reported. Linear regression with adjustment for demographics, baseline BMI, and baseline disordered eating found that weight stigma predicted greater odds for UWCB, bulimic tendencies, and drive for thinness. Weight stigma from "family members only" predicted greater odds for body dissatisfaction and overall EDI score. Results did not vary by race. Exploratory analyses revealed that weight stigma from family members was a stronger predictor of disordered eating behaviors and cognitions than weight stigma from non-family members. A strength of this study is its prospective cohort design, establishing the temporal nature of the relationship between weight stigma and disordered eating, adjustment for confounding variables, and large representation of African Americans, a population often underrepresented in research investigating disordered eating and weight stigma [28]. Finally, the sample size was large, and the investigators assessed race as an effect modifier [21]. However, they did not examine whether the effect between weight stigma and disordered eating varied by SES.

The second longitudinal study was conducted using the Project EAT I-IV cohort [20]. It examined whether weight-based teasing during adolescence predicted initiation of disordered eating behaviors at 5-year follow up. At baseline, 2516 participants (mean age=14.9 years) were surveyed in the St. Paul and Minneapolis public schools (EAT-I) and by mail at 5-year follow-up (EAT-II). This study found that weight teasing from any source during adolescence predicted initiation of disordered eating behaviors 5 years later and also found differences by gender in the weight teasing-disordered eating relationship. Among adolescents who were teased about their weight, boys were more likely to initiate future binge eating with loss of control and UWCB, while girls were more likely to initiate future frequent dieting. Analyses adjusted for sociodemographic characteristics and baseline BMI.

The third longitudinal study was also conducted in the Project EAT I-IV cohort, and it examined whether weight teasing during adolescence (EAT-I) predicted disordered eating outcomes at 15-year follow-up (EAT-IV) [22]. At baseline, 1774 participants were 14.9 years of age (mean), 56.6% female, and 69% white. Weight stigma during adolescence was assessed by asking participants "Have you ever been teased or made fun of by other kids because of your weight?" and "Have you ever been teased or made fun of by family members because of your weight?" Binge eating, UWCB, and eating as a coping strategy were self-reported at follow-up. Weight teasing by peers and family during adolescence (versus no teasing) was found to predict binge eating, UWCB, and eating as a coping strategy 15 years later for females but not for males.

Due to their prospective cohort designs and adjustment for confounding variables [20,22], the past two studies' strengths are the same as those described for the Hunger and colleagues study [21]. The large sample size in the Project EAT I-IV cohort allowed the investigators to stratify by gender and determine differential results between males and females in the weight stigma-disordered eating behavior relationship. However, neither study assessed whether this relationship varied by ethnicity/race or by SES.

Overall, cross-sectional and longitudinal studies in adolescents and young adults have found that exposure to weight stigma is associated with disordered eating behaviors [20,21,74,22,23,68–73]. In these studies, female, white, and middle- to high-SES populations are overrepresented. This literature gap is important because some data suggest that disordered eating behaviors are more prevalent among BIPOC youth when compared to white youth [75], and among low SES youth when compared to high SES youth [76]. While disordered eating is more prevalent in female youth than male youth, it remains a highly prevalent problem for male youth [63]. Thus, it is important both to study the weight stigma-disordered eating relationship in samples that represent male, BIPOC, and low SES youth and in samples where gender, ethnicity/race, and SES can be examined as potential effect modifiers in this relationship. Regarding gender, one longitudinal study in this review found associations between weight stigma and disordered eating behaviors in female young people but not male young people [22], while another found that the type of disordered eating behavior varied by the gender of the participant [20]. However, the study in the baseline sample for this dissertation (EAT 2010-2018) found that the relationship between weight stigma and disordered eating behaviors did not vary by gender [14]. Given the health risks associated with disordered eating behaviors, it is important to comprehensively understand the longitudinal relationship between weight stigma and disordered eating behaviors in young people across gender, socioeconomic, and ethnic/racial demographic groups.

Weight Stigma and Disordered Eating within the Family Context

Because of the crucial role of family and parenting in adolescent psychosocial development, it is important to understand the relationship between weight-stigmatizing experiences and disordered eating behaviors within the family context. Positive family and parenting factors provide a key form of social support for adolescents, but also represent a broader role in the home environment [77]. In addition to offering social support, family and parenting factors play a vital role in adolescent identity formation and psychosocial development, as well as having influence on adolescents' overall health and well-being [78–80]. Family functioning includes communication within the family, problem solving, affective responsiveness, structural and organizational properties of the family unit, and unconditional acceptance of family members [77–79]. It is measured with the self-report instrument, the Family Assessment Device, General Functioning Scale [81,82]. Previous research has shown high internal consistency (Cronbach's α=0.92) and test-retest reliability (r=0.71) for this scale with ethnically and socioeconomically diverse populations. [77,81,82]. In recent decades, the field of family social science has shifted its focus from parent styles, which were often interpreted as non-modifiable traits, to parenting practices across three domains, one of which is support for psychological autonomy (e.g. not controlling) [77–79]. Examining both family functioning and parental support for psychological autonomy provides a comprehensive understanding of the family environment and its role in adolescent health outcomes.

Studies have demonstrated that positive family and parenting factors [77,83–85] are associated with lower prevalence of adolescent disordered eating behaviors. One of these studies used baseline data from the cohort examined in this dissertation (EAT 2010-2018), and it demonstrated that higher family functioning and parental support for psychological autonomy were cross-sectionally associated with lower odds of adolescent UWCB [77]. In addition, cross-sectional and longitudinal studies have largely found that weight stigma predicts disordered eating in adolescents and young adults. A review of the literature identified no studies in youth which examined the role of social support in the relationship between weight stigma and disordered eating behaviors.

In addition to research that has shown cross-sectional associations between stronger family and parenting factors and lower prevalence of disordered eating, Project EAT I-IV and EAT 2010 research has shown that parental encouragement to diet [86], weight-focused conversations [87], pressure to eat enough food [88], restriction of palatable foods [88], and discordance between parents within the home environment [89] are each associated with higher prevalence of disordered eating behaviors in adolescents and young adults. However, none of these studies specifically examined the role these family and parenting factors play in the weight stigma-disordered eating behavior relationship. Examining this relationship is important because it could elucidate factors that might mitigate the harmful effects of weight stigma, namely disordered eating behaviors. It may be that positive family and parenting factors are sources of support for adolescents who are the targets of weight stigma [90]. On the other hand, parents and other family members are a common source of weight stigma for young people [14,21,90,91]. So it may be that this type of weight stigma can co-occur with weaker family and parenting factors and place young people at even greater risk for disordered eating behaviors. No studies, to the best of my knowledge have specifically examined the role of family and parenting factors as potential buffers in the weight stigma-disordered eating relationship in adolescents and young adults.

1.B. Summary of Literature Review and Contribution of this Dissertation

Weight stigma is a prevalent problem during adolescence and young adulthood with salience for healthy psychosocial development. Health equity frameworks may have relevance for research focused on weight stigma as they seek to identify and decrease barriers to health based on inequities related to social stratification. Because of the data linking weight-stigmatizing experiences with lower quality of life and other psychosocial health outcomes, it is reasonable to conclude that weight stigma creates a form of social stratification that disadvantages people with high weight status. Further, BIPOC populations and populations from low SES backgrounds face inequities in nutrition-, fitness-, and weight-related health [7,12,13]. Thus, I attempt to use a health equity framework in my approach to this dissertation research.

Exposure to weight stigma is associated with adverse outcomes for psychosocial health and, although data are more limited, physical health. Recently, increased attention has focused on weight stigma as a potential risk factor for adverse nutrition-, fitness-, body image-, and weight-related health outcomes [39,40]. However, much remains to be understood about weight-stigmatizing experiences as risk factors for behaviors that interfere with positive nutrition-, fitness-, body image-, and weight-related health outcomes in young people. In addition, parents and other family members are a source of weight stigma for young people. However, positive family and parenting factors are protective for disordered eating behaviors in young people.

Specific Aim 1: Associations of Weight Teasing with Weight-related Health Behaviors and Weight Status

Due to the health risks associated with high weight status, it is important to understand the link between weight stigma and subsequent weight gain. This connection may involve disordered eating behaviors, given that they are associated with future weight gain in adolescents. It may also involve adverse health behaviors which, on their own, are important for preventing weight-related chronic disease, such as infrequent breakfast intake, low fruit and vegetable intake, high sugar-sweetened beverage and fast-food intake, inadequate physical activity, excessive screen time, and inadequate sleep. Of these health behaviors, only physical activity and sleep have been examined as potentially linked with weight-stigmatizing experiences in young people, and this research is limited to cross-sectional designs. The relationship between exposure to weight stigma and health behaviors remains understudied in adolescents and young adults. Thus, one aim of this dissertation is to assess cross-sectional and longitudinal relationships of weight teasing with both health behaviors and weight status in an ethnically/racially and socioeconomically diverse sample of adolescents during the transition to young adulthood (Specific Aim 1a). Consistent with the health equity framework, health disparities will also be investigated. Specifically, this dissertation will investigate whether health behaviors and weight status are higher or lower based on ethnicity/race and SES (Specific Aim 1b) and whether ethnicity/race and SES operate as effect modifiers in the relationship of weight teasing with health behaviors and weight status (Specific Aim 1c).

Specific Aim 2: Associations between Weight Teasing and Disordered Eating Behaviors

Overall, cross-sectional and longitudinal studies in adolescents and young adults have found that weight-stigmatizing experiences are associated with higher prevalence of disordered eating behaviors. In these studies, female, white, and middle- to high-SES populations are overrepresented. This literature gap is noteworthy because some studies have found that disordered eating behaviors are more prevalent among BIPOC youth when compared to white youth and among low SES youth when compared to high SES youth, suggesting that there may be important health inequities that the literature has yet to fully describe. The participant sample examined in this dissertation is ethnically/racially and socioeconomically diverse, it includes both male and female participants, and it has both cross-sectional and longitudinal data. Thus, it provides a unique opportunity to investigate cross-sectional and longitudinal relationships between weight teasing and disordered eating behaviors in a diverse sample of adolescents and young adults (Specific Aim 2a). Because participants who identify as male, BIPOC, and/or from low SES background are underrepresented in studies investigating the weight stigma-disordered eating relationship, but evidence suggests disordered eating is very prevalent in these groups, a second analysis will investigate whether the weight stigma-disordered eating behavior relationship differs by gender, ethnicity/race, or SES (Specific Aim 2b). A third analysis will investigate whether the prevalence of weight stigma and disordered eating behaviors is higher or lower based on gender, ethnicity/race, and SES (Specific Aim 2c).

Specific Aim 3: The Role of Family and Parenting Factors in the Relationship Between Weight Stigma and Disordered Eating Behaviors

It is important to acknowledge the vital role parents, family members, and the home environment play in identity formation, psychosocial development, health behaviors, and health outcomes for adolescents and young adults. Previous cross-sectional studies have demonstrated that positive family and parenting factors are associated with lower prevalence of disordered eating behaviors in adolescents. Also, weight stigma is associated with higher prevalence of disordered eating behaviors. However, no studies to the best of my knowledge have examined the weight stigma-disordered eating relationship while also examining the role of family functioning or parental support for psychological autonomy. When it comes to weight stigmatization of adolescents, family members may be the source of the stigma. However, they can also be a source of support when an adolescent is the target of weight stigma. Additionally, weight stigma may co-occur with lower family functioning and support for psychological autonomy, potentially exacerbating risk or disordered eating behaviors. This dissertation will examine the relationship between four types of weight-stigmatizing experiences – general weight teasing (from any source), peer weight teasing, family weight teasing, hurtful weight-related comments from family – and four disordered eating behaviors – unhealthy weight control behaviors, extreme weight control behaviors, overeating, and binge eating, cross-sectionally during adolescence and longitudinally over an eight-year follow-up (Specific Aim 3a). It will also examine whether family functioning and parental support for psychological autonomy operate as effect modifiers in these relationships (Specific Aim 3b).

1.C. Research Aims and Hypotheses

The objectives of this dissertation were pursued through the three following specific aims.

Specific Aim 1: Assess cross-sectional and longitudinal associations of weight teasing with health behaviors and weight status, in an ethnically/racially and socioeconomically diverse sample of young people.

- **Specific Aim 1a:** Examine cross-sectional and longitudinal relationships of weight teasing with health behaviors and weight status in an ethnically/racially and socioeconomically diverse sample of adolescents during the transition to young adulthood.
    - **Hypothesis 1:** Exposure to weight teasing will predict elevated weight status in cross-sectional and longitudinal analyses.
    - Given the mixed or limited literature on the main effects associations between weight stigmatizing experiences (e.g., weight teasing) and health

behaviors (screen time; physical activity; sleep duration; intake of breakfast, fruit, vegetables, sugar-sweetened beverages, and fast-food), these analyses will be exploratory with no *a priori* hypotheses.

- **<u>Specific Aim 1b:</u>** Assess whether health behaviors and weight status are higher or lower based on ethnicity/race and socioeconomic status.
  - **Hypothesis 2:** Participants who are Black, Indigenous, and other People of Color and of lower socioeconomic status will have outcomes considered to be less supportive of health when compared to their white and higher socioeconomic status counterparts.
- **<u>Specific Aim 1c:</u>** Assess whether ethnicity/race and socioeconomic status operate as effect modifiers in the relationships of weight teasing with health behaviors and weight status.
  - This specific aim has no *a priori* hypothesis and is considered exploratory due to the paucity of literature examining whether ethnicity/race and socioeconomic status operate as effect modifiers in the relationship between weight-stigmatizing experiences (e.g., weight teasing) with health behaviors and weight status.

Specific Aim 2: Examine cross-sectional and longitudinal associations between weight teasing and disordered eating behaviors in an ethnically/racially and socioeconomically diverse sample of young people.

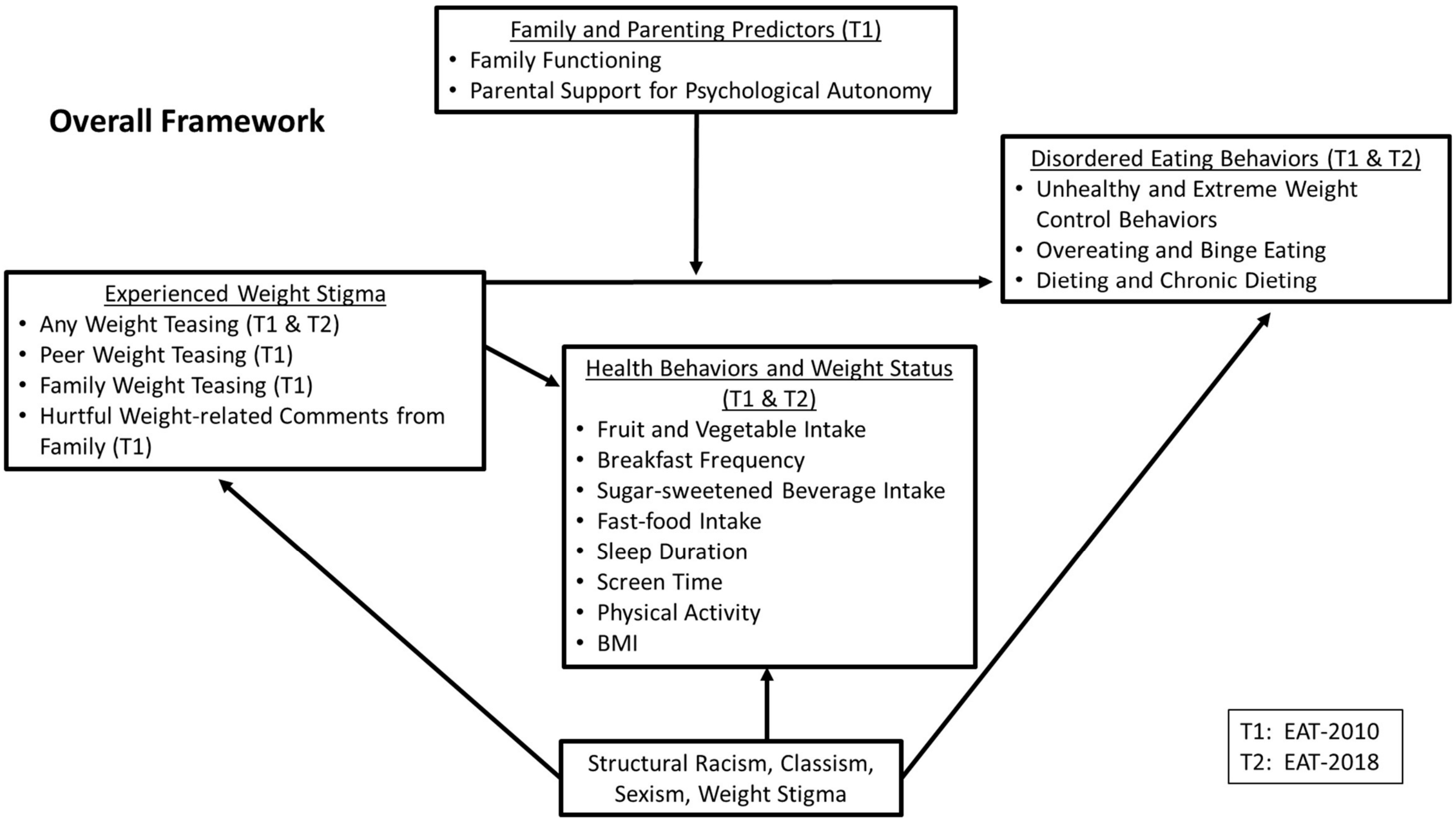
- **<u>Specific Aim 2a:</u>** Assess cross-sectional and longitudinal relationships between experienced weight teasing and disordered eating behaviors in an ethnically/racially and socioeconomically diverse sample of young people.
    - **Hypothesis 3:** Exposure to weight teasing will be associated with disordered eating behaviors, cross-sectionally during adolescence, cross-sectionally during young adulthood, and longitudinally.
- **<u>Specific Aim 2b:</u>** Assess whether the relationship between weight teasing and disordered eating behaviors varies by ethnicity/race, socioeconomic status, or gender.
    - This research question is exploratory with no *a priori* hypothesis, given the mixed literature on this topic.
- **<u>Specific Aim 2c:</u>** Examine whether the prevalence of weight teasing and disordered eating behaviors is higher or lower based on gender, ethnicity/race, and SES.
    - **Hypothesis 4:** The prevalence of both weight teasing and disordered eating behaviors will be higher in Black, Indigenous, and other People of Color, young people from low socioeconomic backgrounds, and female participants, when compared to their respective counterparts.

Specific Aim 3: Investigating the role of positive family and parenting factors in the cross-sectional and longitudinal relationships between weight-stigmatizing experiences and disordered eating behaviors in a sample of young people.

- **<u>Specific Aim 3a:</u>** Examine the relationship between four types of weight-stigmatizing experiences (any weight teasing, peer weight teasing, family weight teasing, hurtful weight-related comments from family) and four disordered eating behaviors (unhealthy weight control behaviors, extreme weight control behaviors, overeating, and binge eating) both cross-sectionally and longitudinally.
    - **Hypothesis 5:** Four types of weight-stigmatizing experiences will be cross-sectionally and longitudinally associated with higher prevalence of four disordered eating behaviors.
- **<u>Specific Aim 3b:</u>** Investigate whether family functioning and parental support for psychological autonomy buffer the relationships between weight-stigmatizing experiences and disordered eating behaviors, both cross-sectionally and longitudinally.
    - **Hypothesis 6:** High family functioning and high parental support for psychological autonomy will have a protective effect on disordered eating behaviors in adolescents who experience weight stigma

1.D. Theoretical Model for Study

Figure 1-1.



Measures of ethnicity/race, socioeconomic status, gender, and body mass index are used as covariates in statistical models as imperfect proxies for exposure to the structural forms of racism, classism, sexism, and weight stigma, respectively.

Figure 1-1. Continued.

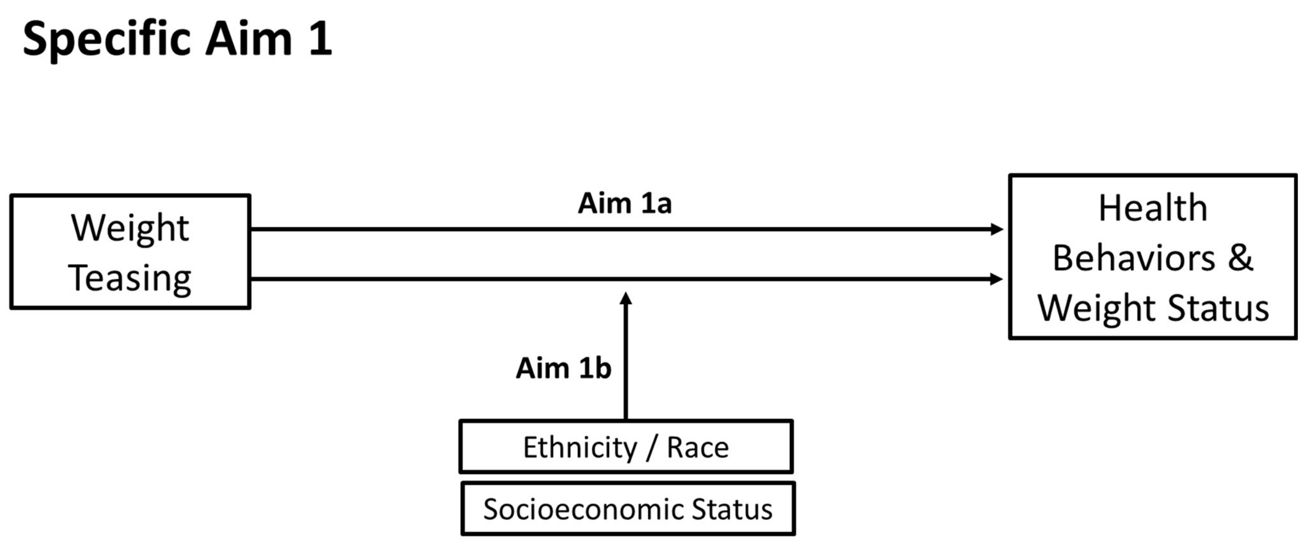


Figure 1-1. Continued.

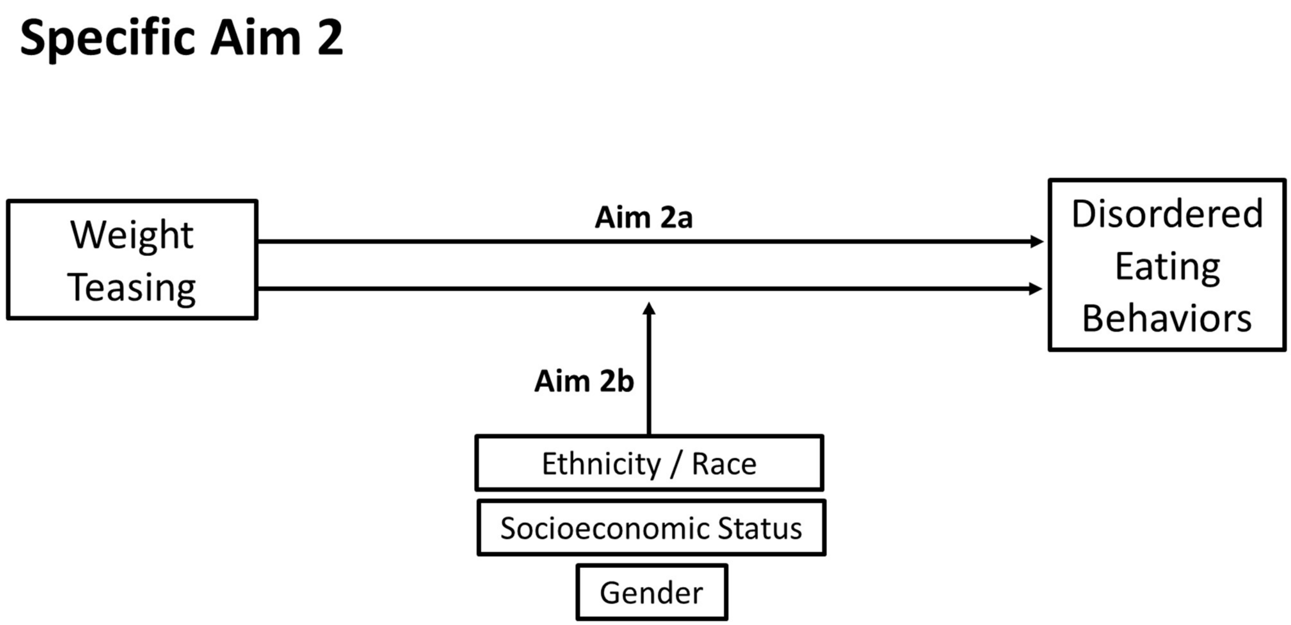
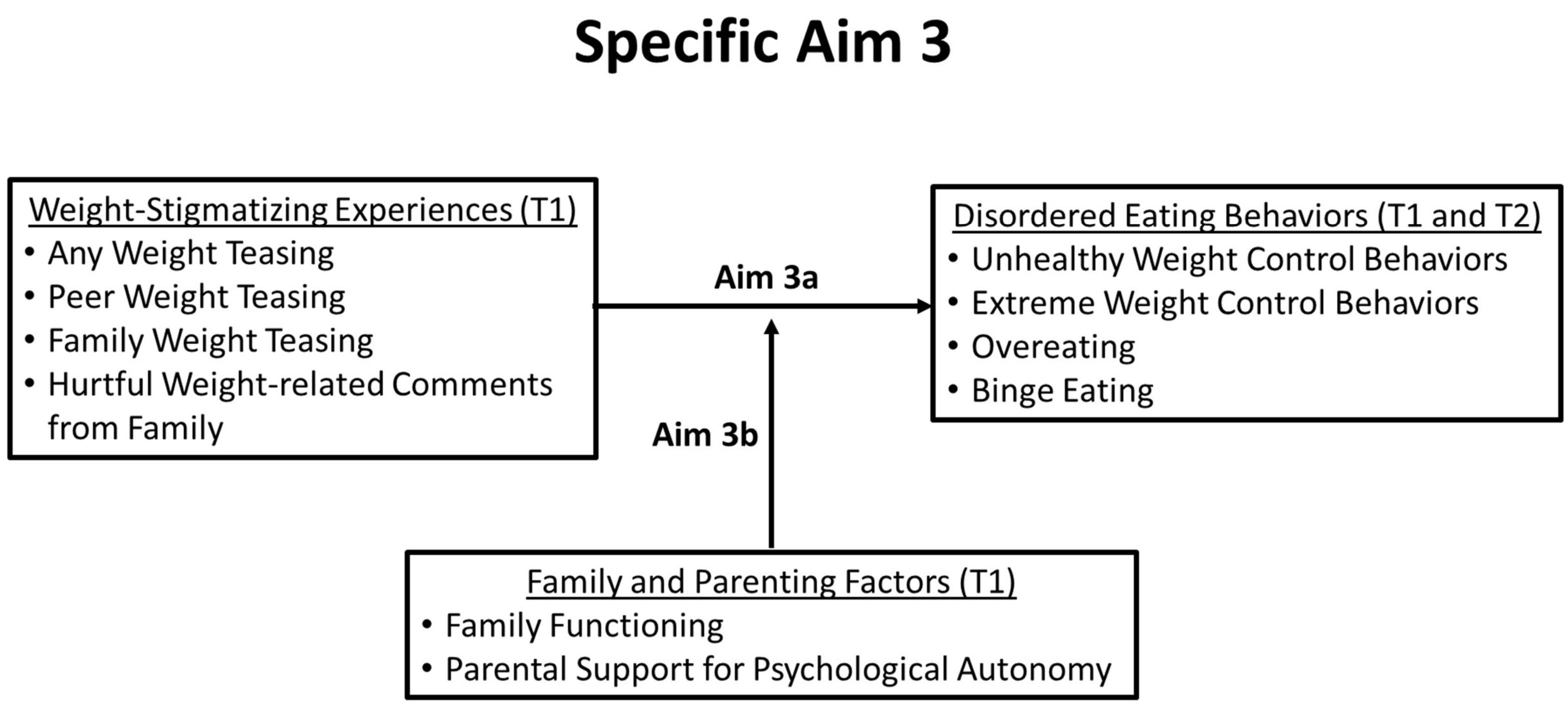


Figure 1-1. Continued.



Chapter 2

How is weight teasing cross-sectionally and longitudinally associated with health behaviors and weight status among ethnically/racially and socioeconomically diverse young people?*

***Published version available: Int J Behav Nutr Phys Act 19, 71 (2022).**

Background: Weight stigma is prevalent among young people and harmful to health. The current study used a health equity lens to examine cross-sectional and longitudinal associations between experiencing weight teasing (a form of weight stigma) with a range of weight-related health behaviors and weight status in an ethnically/racially and socioeconomically diverse sample of young people. We also assessed whether ethnicity/race and adolescent socioeconomic status (SES) operated as effect modifiers in these relationships.

Methods: Adolescents (n=1568) were enrolled in EAT 2010-2018 (Eating and Activity over Time) and followed into young adulthood. Weight teasing; screen time; moderate-to-vigorous physical activity (MVPA); sleep duration; breakfast frequency; fruit, vegetable, sugar-sweetened beverage (SSB), and fast-food intake; and body mass index (BMI) were assessed at baseline (mean age=14.4 years) and eight-year follow-up (mean age=22.2 years). Multivariate linear regression estimated marginal means and 95% confidence intervals. All analyses adjusted for BMI and sociodemographic characteristics.

Results: Weight teasing was cross-sectionally associated with longer screen time, shorter sleep duration, and higher BMI during adolescence; and cross-sectionally associated with shorter sleep duration, lower breakfast frequency, higher fast-food intake, higher SSB intake, and higher BMI during young adulthood. In the longitudinal analyses, weight teasing was not associated with health behaviors but did predict higher BMI (teased: 28.2 kg/m^2, not teased: 26.4 kg/m^2, $p<0.001$). White and higher adolescent SES subgroups had higher MVPA, more frequent breakfast intake, lower fast-food intake, and lower BMI than their respective counterparts. The relationships between weight teasing and health behaviors and weight status were largely consistent across ethnic/racial and adolescent SES subgroups.

Conclusions: Findings add to growing evidence that weight-based mistreatment poses a threat to weight-related health and that young people across ethnic/racial and SES subgroups are vulnerable to the negative effects of weight teasing. Limitations include attrition at follow-up and the self-reported nature of many measures. Results suggest a

need for increased attention to existing recommendations to reduce weight stigma in young people from diverse ethnic/racial and socioeconomic backgrounds including training for healthcare providers to better equip them to address the harms of weight teasing and foster more compassionate care to promote health-supporting behaviors in young people.

2.A. Introduction

Obesity is prevalent among adolescents and adults worldwide and is a risk factor for a number of chronic diseases such as cardiovascular disease, stroke, and type 2 diabetes [92–94]. In the United States (U.S.), obesity disproportionately affects Black, Indigenous, and other People of Color (BIPOC) and people from low socioeconomic backgrounds, thus efforts to address this vital public health issue benefit from use of a health equity lens [7,95,96]. With the goal of improving health for the population as a whole, a health equity lens aims to identify and decrease health disparities in marginalized populations by acknowledging and attempting to correct the fact that research investigators and study participants often overrepresent privileged groups (e.g., white, middle- to upper-class) thus the conclusions and corresponding interventions might miss key factors important in meeting the health needs of underserved populations [7].

An important aspect of addressing weight-related health through a health equity lens is to focus on the negative social aspects of high body weight, namely societal weight stigma [97]. Weight stigma is based on social devaluation of people due to their high weight status or large body size, including stereotypes that these individuals lack willpower or discipline, are lazy, or are unmotivated [1]. This stigma manifests as prejudice and discrimination and can affect people across the weight spectrum. During adolescence and young adulthood, weight stigma most often occurs in the forms of teasing, bullying, and victimization [2], and is a common experience, with U.S. studies estimating prevalence in young people at 23-32% [3,4]. Given the potential for intersectional impacts to young people who identify as BIPOC and those from low socioeconomic status (SES) households [98,99], it is important to understand if the prevalence of weight-stigmatizing experiences differs by ethnicity/race or SES [28,100] and how associations between weight stigma and weight-related health differ by these characteristics. Some studies have demonstrated no differences by ethnicity/race in the prevalence of weight stigma [99,101], while other studies, including our prior work with this sample, have found a higher prevalence among BIPOC young people when compared to their white counterparts [14,100]. Less work has focused on prevalence differences by SES [28], but our recent study found that weight teasing was more prevalent among young people from low SES backgrounds when compared to their higher SES counterparts [100]. Findings from this study were based on unadjusted analyses, given that the research goal was to describe sociodemographic differences in the prevalence of weight teasing.

To date, several studies in young people have demonstrated that experiencing weight stigma is a risk factor for poor psychosocial and behavioral health outcomes, such as higher prevalence of depressive symptoms [15–17], substance use [18], body dissatisfaction [15,19], disordered eating behaviors [14,20–23,100], self-harm [15], social isolation [24], school avoidance [25], and low self-esteem [15,17,26,27]. In addition, studies have found that weight stigma, above and beyond any effects of baseline weight status, is a risk factor for future weight gain [22,29,31,102,103].

Despite evidence of associations between experiencing weight stigma and these adverse health outcomes, what remains more elusive is whether weight-stigmatizing experiences are a risk factor for weight-related health behaviors promoted by public health campaigns and monitored by healthcare providers, such as screen time; physical activity; sleep duration; and intake of breakfast, fruit, vegetables, sugar-sweetened beverages (SSB), and fast-food [104]. Few studies in young people have examined these relationships; in those that have, the focus has been on links between weight stigma and physical activity, yielding mixed results [40]. While some studies have reported associations between weight stigma and lower physical activity self-efficacy and motivation [16,17,19], physical activity avoidance [18,25] and lower levels of physical fitness [17], other studies have reported null associations between weight stigma and physical activity levels [17,19,59] or mixed results [60]. One study in young people examined the relationship between weight stigma and sleep outcomes and found that the frequency of weight-based victimization at school and weight teasing from family members were both associated with self-reported difficulty falling asleep, although there were no associations with weight teasing from peers [60]. To our knowledge, no studies in adolescents and young adults have examined the relationship between weight stigma and screen time, breakfast intake, fruit intake, vegetable intake, SSB intake, or fast-food intake, although in adults, weight-stigmatizing experiences have been linked with higher energy intake [105] and higher intake of convenience foods such as fast-food and SSBs [106].

Furthermore, given structural inequities in the U.S., both BIPOC young people and young people from low SES backgrounds are disproportionately at risk for worse nutrition-, fitness-, and weight-related health outcomes [12,13]. Socio-environmental contributions to these disparities include inequitable access to: 1) healthcare [95,96], 2) opportunities to safely walk and play in one's own neighborhood [107,108], 3) developmentally-appropriate organized physical activities (i.e., dance, sports) [108], and 4) nutritious food [12,95,109]. Factors that play a role in inequitable access to nutritious food include high prevalence of fast-food and convenience stores in low-income, primarily BIPOC neighborhoods [95,110], discriminatory farm subsidies [111,112], targeted marketing of nutrient poor, energy dense foods to BIPOC communities [95,110], and food policies that make these foods the accessible and affordable option [95,109]. Because young people who have been marginalized by these environments may be vulnerable to intersectional forms of stigma (e.g. racism intersecting with weight stigma), it is important to elucidate the relationship between weight-based mistreatment and weight-related health to improve understanding of key factors involved in meeting the needs of these young people.

The present study begins to address these important gaps by examining associations between weight teasing and weight status and health behaviors in an ethnically/racially and socioeconomically diverse cohort of young people. We investigated whether weight teasing is associated with the outcomes of screen time, physical activity, sleep duration, and intake of breakfast, fruit, vegetables, SSBs, fast-food, and body mass index (BMI), cross-sectionally during both adolescence and young adulthood, and longitudinally over an eight-year follow-up. Additionally, we investigated whether health disparities are present in this sample, specifically whether our study's outcomes are higher or lower based on ethnicity/race and adolescent SES and whether ethnicity/race and adolescent SES operate as effect modifiers in these relationships. We hypothesized that exposure to weight teasing would be associated with higher weight status in all three main effects analyses. We also hypothesized that participants who were BIPOC and from lower socioeconomic backgrounds would have outcomes considered to be less supportive of health when compared to their white and high SES counterparts. The other research questions had no a priori hypotheses and were considered exploratory given the mixed or limited literature on the main effects associations between weight-stigmatizing experiences and these health behaviors and given the paucity of literature examining whether ethnicity/race and SES operate as effect modifiers in these relationships. Investigating these underexamined questions can help improve understanding of the weight stigma-health behavior relationship among young people from diverse backgrounds, help clarify how weight stigma contributes to adverse health outcomes, and point to specific areas of focus for future research.

2.B. Methods

Study Design and Participants

Data were collected as part of EAT 2010-2018 (Eating and Activity over Time), a population-based, longitudinal study designed to examine dietary intake, physical activity, weight control behaviors, weight status, and factors associated with these outcomes in young people [113]. For EAT 2010, the study population included adolescents from 20 public middle and high schools in the urban area of Minneapolis/St. Paul, in the State of Minnesota, in the U.S. Adolescents completed classroom surveys and anthropometric measures at school [114]. The follow-up EAT 2018 assessment was designed to examine changes in weight-related outcomes as participants progressed through adolescence and into young adulthood. Participants completed the baseline EAT 2010 study as adolescents during the 2009-2010 academic year and completed the follow-up EAT 2018 survey as young adults in 2017-2018.

Of the original 2793 participants, 410 (14.7%) were lost to follow-up for various reasons, primarily missing contact information at EAT 2010 or no address found at follow-up (n=397). Invitations to participate in the online EAT 2018 survey were mailed to the remaining 2383 young people. To encourage participation, non-responders were mailed up to eight reminders. Additional attempts were made to contact young people using email, phone calls, text messages, messaging through social media, and home visits. The University of Minnesota's Institutional Review Board Human Subjects Committee approved all study protocols.

Survey Development

For the EAT 2010 survey, a 235-item self-report instrument, test-retest reliability of measures and internal consistency of survey items were assessed in a separate sample of 129 middle and high school students over a one-week period [114]. To allow for longitudinal comparisons, key items from the EAT 2010 survey were retained on the follow-up EAT 2018 survey [113]. For EAT 2018, test-retest reliability of measures was assessed in a subgroup of 112 young adult participants over a three-week period. A semi-quantitative Food Frequency Questionnaire (FFQ) was administered with the EAT 2018 survey to assess usual past year intake of fruit, vegetables, SSBs, and other food groups. Previous studies have examined and reported on the reliability and validity of intake estimates [115–117]. At baseline (EAT 2010), the 152-item youth version of the FFQ, the Young Adult Food Frequency Questionnaire (YAQ), was used to assess dietary intake; it has undergone extensive testing for validity and reproducibility in adolescents [118,119]. For both the FFQ and the YAQ, participant responses were excluded if they reported a biologically implausible level of total energy intake (<500 kcal/day or >5000 kcal/day) or left 20 or more items blank (4.4% at baseline, 11.1% at follow-up).

Primary Measures

Weight Teasing: Weight teasing was assessed at baseline and follow-up using the identical question, "How often do any of the following things happen? ..... You are teased about your weight." Responses included "never, less than once a year, a few times a year, a few times a month, and at least once a week" [120]. This variable was dichotomized with "never" coded as "no" and all other response options coded as "yes" (test-retest r=0.73). Dichotomous coding was used because previous studies in young people have shown that reports of ever experiencing weight teasing (versus never) are predictive of adverse health outcomes [14,15,22]. At baseline, 2.7% were missing this variable; 2.8% were missing it at follow-up.

Screen time: To assess screen time at baseline, participants were asked "In your free time on an average weekday….how many hours do you spend doing the following activities?" Activities included "watching TV/DVDs/videos; using a computer (not for homework); Xbox/Play-station/other electronic games that you play while sitting." Due to secular changes in device use among the population of young people, screen time at follow-up was assessed with the following question, "On an average weekday…how many hours of recreational screen time (for example, television, computer, social media, video games, smartphone or tablet) do you have a day? Do not include activities you do for work or school." At both timepoints, the same question was additionally asked for an average weekend day; seven response options ranged from 0 to 5+ hours for each question; and weekly screen time hours were calculated from a weighted mean [121]. Test-retest reliability was r=0.86 (baseline) and r=0.76 (follow-up). At baseline, 0.1% were missing this variable; 1.2% were missing it at follow-up.

Physical activity: The modified Godin-Shephard Leisure-Time Exercise Questionnaire recall was used to assess hours of past-week exercise at both baseline and follow-up [122,123]. Each item included relevant exercise examples for strenuous exercise (aerobics, basketball), moderate exercise (skiing, dancing), and mild exercise (bowling, golf) with six response options ranging from "none" to "6+ hours a week." The midpoint of each response was used to calculate the sum of moderate-to-vigorous physical activity (MVPA) hours per week [124]. Test–retest reliability was r=0.85. At baseline, 0.2% were missing this variable; 0.5% were missing it at follow-up.

Sleep duration: Sleep duration was assessed by asking, "On an average weekday (Monday-Friday), what time do you go to bed (to go to sleep)? What time do you get out of bed (to start your day)?" These questions were repeated for the weekend, and the same method was used to assess sleep duration at baseline and follow-up. Hours per night were averaged across weekday and weekend days (range: 4-16) [125]. Test-retest reliability was r=0.56. At baseline, 6.9% were missing this variable; 9.7% were missing it at follow-up.

Breakfast intake: Frequency of breakfast intake was assessed at both baseline and follow-up by asking, "During the past week, how many days did you eat breakfast?" Response options were "never, 1-2 days, 3-4 days, 5-6 days, and every day" [126]. They were recoded as number of days per week (range: 0-7, test-retest r=0.76). At baseline, 0.2% were missing this variable; 0.6% were missing it at follow-up.

Fruit and vegetable intake: Fruit and vegetable intake were assessed using the YAQ at baseline and the FFQ at follow-up. A daily serving was defined as the equivalent of one-half cup for fruit and vegetables, and vegetables excluded potatoes. Daily servings of fruit and vegetables were summed separately ($range_{fruit}$: 0-10, $range_{vegetables}$: 0-8). For fruit intake, 1.5% were missing this variable at baseline and 5.2% at follow-up. For vegetable intake, 1.5% were missing this variable at baseline and 8.5% at follow-up.

Sugar-sweetened beverage intake: As a part of the YAQ at baseline and the FFQ at follow-up, participants were asked to report their intake over the past year of regular (i.e., non-diet) soda. Responses ranged from "never / < 1 glass per month" to "≥ 3 glasses per day." On the EAT 2010 and 2018 surveys, participants were asked, "In the past year, how many times did you usually drink….an energy drink (such as Red Bull, Full Throttle, Rockstar, etc)….a sports drink (such as Gatorade, Powerade, etc)?" Response options ranged from "never or less than once per month" to "2 or more per day." A serving was defined as the equivalent of one glass, bottle, or can. Regular soda, sports drinks, and energy drinks were aggregated to create the SSB variable (range 0-28 servings per week) [127]. At baseline, 0.5% were missing this variable; 6.4% were missing it at follow-up.

Fast-food intake: At both baseline and follow-up, participants reported fast-food intake by answering the following question, "In the past month, how often did you eat something from the following types of restaurants... (1) traditional 'burger-and-fries' fast-food restaurant…(2) Mexican fast-food restaurant…(3) fried chicken…(4) sandwich or sub shop…(5) pizza place." Response options included "never/rarely, 1–3 times per month, 1–2 times per week, 3–4 times per week, 5–6 times per week, and ≥ 1 times per day." Data were aggregated to create one continuous variable for fast-food intake (range: 0-94 times per month; test-retest r=0.73). At baseline, 0.3% were missing this variable, and 0.3% were excluded for reporting implausible values. At follow-up, 0.6% were missing this variable, and 0.6% were excluded for reporting implausible values.

Weight status: At baseline, adolescent weight and height were measured by trained staff in a private area, using standardized procedures [128]. Weight status at follow-up was based on self-reported weight and height, which highly correlate with objectively measured weight and height in young people (r=0.88 for males and 0.85 for females) [129]. BMI-for-age (percentile) at baseline and BMI (kg/m^2) at follow-up were derived from weight and height using the Centers for Disease Control and Prevention guidelines [130]. At baseline, 1.7% were missing this variable; 2.7% were missing it at follow-up.

Sociodemographic Measures

Adolescent socioeconomic status: Five categories of adolescent SES were generated using classification tree methodology [75,131]. Highest parent/guardian education level primarily determined SES in adolescence. Family eligibility for free/reduced price lunch, family receipt of public assistance, and parent/guardian employment status were subsidiary variables in estimating adolescent SES. SES assessed during adolescence was used for all analyses because evidence suggests that regardless of adult experiences, low SES and other adversities during childhood and adolescence are good predictors of poor health outcomes during adulthood [132–135].

Gender/sex: Gender/sex was assessed at follow-up with the following question, “Are you….? Male, Female, Different identity (please specify): ____.” For simplicity, gender/sex is referred to as gender throughout the remainder of this article.

Other Sociodemographic Characteristics: Age and ethnicity/race were self-reported by young people. Ethnicity/race was assessed at baseline with the following question: “Do you think of yourself as…? White, Black or African American, Hispanic or Latino, Asian American, Native Hawaiian or Pacific Islander, American Indian or Native American, or Other: ____.” Due to small numbers, Native Hawaiian or Pacific Islander, American Indian or Native American, and Other were coded together as “Mixed or Other Race” [75,114]. Test-retest agreement was 98-100%.

Statistical Analysis

Descriptive statistics including frequencies and percentages of ethnicity/race, adolescent SES, and gender, and mean and standard deviation of age, BMI, and weight teasing status were summarized. Multivariate linear regression, adjusted for ethnicity/race, adolescent SES, gender, and BMI, examined the relationship between weight teasing and outcomes (screen time; MVPA; sleep duration; intake of breakfast, fruit, vegetables, SSB, fast-food; and BMI) to estimate marginal means and 95% confidence intervals, cross-sectionally at baseline (EAT 2010), cross-sectionally at follow-up (EAT 2018), and longitudinally (EAT 2010-2018). Longitudinal models were additionally adjusted for the outcome assessed at baseline. We regard the potential confounders of ethnicity/race, adolescent SES, gender, and BMI as proxies for exposure to structural racism, classism, sexism, and weight stigma respectively [95,100,136]. These proxies are considered imperfect because of the heterogeneity of experiences within oppressed groups and the innate limitations that come with the categorization of these demographic characteristics [100,137,138]. There were no observed associations between age and the exposure variable, weight teasing. Therefore, it was determined that age was not a potential confounder, and correspondingly it was not included as a covariate in the statistical models. A sensitivity rank regression analysis was conducted for all variables that were not normally distributed (screen time and intake of fruit, vegetable, SSB, and fast-food).

ANOVA tests examined differences in the means of the health behaviors and BMI by ethnicity/race and adolescent SES. To investigate whether ethnicity/race and adolescent SES operate as effect modifiers in the relationship between weight teasing and the outcomes (health behaviors and weight status), interaction terms between ethnicity/race and weight teasing and between adolescent SES and weight teasing were added to each cross-sectional and longitudinal regression model (separate models). Stratified models were additionally run when an interaction term was statistically significant ($p<0.1$). For ANOVA tests and assessment of effect modification, to assist with interpretability of findings, a 3-category adolescent SES variable was created – low, middle (low middle combined with middle), and high (upper middle combined with high). For all analyses, Cohen's d statistic was used to calculate effect sizes to aid in practical interpretation of results with the following interpretation: small ($d=0.2$), medium ($d=0.5$), large ($d=0.8$) [139].

The sample of young adults who completed surveys at both timepoints included 65.8% of the original participants for whom contact information was available at EAT 2018. In addition, the analytic sample was more likely than the baseline sample to have parents/guardians with low educational attainment, identify as BIPOC, and report being born outside the U.S. when compared to responders. Therefore, inverse probability weighting was used for all analyses [140,141]. Inverse probability weighting minimizes potential response bias due to missing data and allows for extrapolation back to the original school-based EAT 2010 sample. Inverse probability weights were derived as the inverse of the estimated probability that an individual responded at both timepoints based on several characteristics reported in 2010, including parental educational attainment, ethnicity/race, nativity, past year frequency of dieting, and weight status. To be included in the analytic sample, participants needed to have completed both EAT 2010 and EAT 2018 surveys (n=1568) and needed data for the weight teasing exposure, the outcome (health behavior or weight status), and the covariates; thus the analytic sample varied slightly for each analysis. All analyses were conducted using SAS 9.4 (Cary, NC, copyright 2015).

2.C. Results

Participant Characteristics

Weight teasing was prevalent in this sample with 34.1% of participants reporting being teased about their weight during adolescence and 41.5% during young adulthood. The ethnic/racial distribution of the sample included 28.6% African American/Black, 20.0% Asian American, 19.1% white, 17.2% Latinx/Hispanic, and 15.2% mixed/other (Table 2-1). Most of the Asian American participants reported Southeast Asian heritage; approximately 80.6% of this group were Hmong. For adolescent SES, the distribution of the sample was 39.5% low, 22.2% low middle, 17.6% middle, 13.2% upper-middle, and 7.5% high. Distribution by gender/sex was 53.6% female, 45.8% male, and 0.6% different identity (e.g., transgender, non-binary). Mean age was 14.4± 2.0 years at baseline and 22.2 ± 2.0 years at follow-up. Mean BMI-for-age was 69.2 percentile during adolescence (EAT 2010) and 27.2 kg/m^2 during young adulthood (EAT 2018). There were no significant differences in parental education, nativity status, and ethnicity/race between the weighted analytic sample and the full EAT 2010 sample ($p>0.9$); all reported findings reflect weighted analyses.

Table 2-1. Sociodemographic characteristics, weight status, and exposure to weight teasing among young people (N=1568) in Minneapolis-St Paul, Minnesota at baseline (EAT 2010) and at eight-year follow up (EAT 2018)

Characteristics	Mean ± SD or % (n)
Ethnicity / Race (%)[†]	
Asian American	20.0 (306)
Black/African American	28.6 (437)
Latinx/Hispanic	17.2 (263)
Mixed/Other Race	15.2 (232)
White	19.1 (292)
Socioeconomic Status (%)[†]	
Low	39.5 (588)
Low Middle	22.2 (331)
Middle	17.6 (262)
Upper Middle	13.2 (196)
High	7.5 (112)
Gender (%)[††]	
Female	53.6 (813)
Male	45.8 (696)
Different identity	0.6 (9)
Age (mean years)	14.4 ± 2.0[†]
	22.2 ± 2.0[††]
BMI-for-age (percentile)	69.2 ± 27.8[†]
BMI (kg/m^2)	27.2 ± 7.0[††]
Weight Teasing (any)	34.1 (523)[†]
	41.5 (618)[††]

[†] Assessed at baseline (EAT 2010)

[††] Assessed at follow up (EAT 2018)

Associations between Weight Teasing and Health Behaviors: Main Effects

At baseline, after accounting for ethnicity/race, adolescent SES, gender, and weight status, weight teasing was associated with higher screen time, shorter sleep duration, and higher vegetable intake (Table 2-2). For example, among adolescents teased about their weight, mean screen time was 42.6 hours per week, compared to 38.9 hours per week among those not teased (d=0.13, p=0.011). At follow-up, weight teasing was cross-sectionally associated with shorter sleep duration, less frequent breakfast intake, higher SSB intake, and higher fast-food intake, in adjusted models (Table 2-2). For example, among young adults teased about their weight, mean fast-food intake was 16.7 times per month, compared to 13.2 times per month among those not teased (d=0.24, p<0.001). In longitudinal analyses, all health behaviors were unrelated to baseline weight teasing (Table 2-3). The sensitivity rank regression analysis showed similar results to the linear regression analysis for all results.

Associations between Weight Teasing and Weight Status: Main Effects

Weight teasing was associated with higher BMI-for-age in the cross-sectional analysis during adolescence (not teased: 66.1 percentile, teased: 75.0 percentile, d=0.31, p<0.001), the cross-sectional analysis during young adulthood (not teased: 25.8 kg/m^2, teased: 29.0 kg/m^2, d=0.47, p<0.001), and the longitudinal analysis (not teased: 26.4 kg/m^2, teased: 28.2 kg/m^2, d=0.31, p<0.001), after accounting for sociodemographic characteristics and, in the longitudinal analysis, baseline weight status (Tables 2-2 and 2-3). These results did not represent a difference in weight status categories, as both the teased and not teased groups had a mean BMI-for-age that fell into the same category

(5th percentile to less than the 85th percentile) for cross-sectional analysis during adolescence, and a mean BMI in the same category (25.0 to 29.9 kg/m^2) for cross-sectional analysis during young adulthood and longitudinal analysis.

Table 2-2. Cross-sectional relationships of health behaviors and weight status by weight teasing status in young people, effect sizes and marginal means, main effects models

	Adolescence (EAT 2010)			
Outcome	Cohen's d Statistic	Marginal Mean (95% CI)		p-value
		Not Teased	Teased	
Screen Time (hours/week)	0.13	38.9 (37.3, 40.5)	42.6 (40.3, 44.8)	**0.011**
MVPA (hours/week)	0.06	5.9 (5.6, 6.2)	5.6 (5.2, 6.0)	0.220
Sleep duration (hours/night)	0.12	8.6 (8.5, 8.6)	8.4 (8.3, 8.5)	**0.026**
Breakfast intake (days/week)	0.10	4.4 (4.2, 4.5)	4.1 (3.9, 4.3)	0.067
Fruit intake (servings/day)	0.07	2.1 (2.0, 2.2)	2.2 (2.1, 2.4)	0.160
Vegetable intake (servings/day)	0.19	1.2 (1.2, 1.3)	1.5 (1.4, 1.6)	**<0.001**
SSB intake (servings/week)	0.03	5.3 (4.9, 5.7)	5.5 (5.0, 6.0)	0.576
Fast-Food intake (times/month)	0.07	12.5 (11.6, 13.4)	13.6 (12.3, 14.9)	0.172
BMI-for-age (percentile)	0.31	66.1 (64.4, 67.8)	75.0 (72.6, 77.4)	**<0.001**

Table 2-2. Continued.

Outcome	Young Adulthood (EAT 2018) Cohen's d Statistic	Marginal Mean (95% CI) Not Teased	Teased	p-value
Screen Time (hours/week)	0.10	24.8 (24.0, 25.6)	26.0 (25.0, 26.9)	0.068
MVPA (hours/week)	0.07	4.6 (4.3, 4.8)	4.3 (4.0, 4.6)	0.205
Sleep duration (hours/night)	0.24	8.6 (8.5, 8.7)	8.3 (8.1, 8.4)	**<0.001**
Breakfast intake (days/week)	0.13	3.9 (3.7, 4.0)	3.5 (3.3, 3.7)	**0.011**
Fruit intake (servings/day)	0.03	2.0 (1.9, 2.1)	1.9 (1.8, 2.1)	0.634
Vegetable intake (servings/day)	0.07	2.2 (2.1, 2.3)	2.1 (1.9, 2.2)	0.206
SSB intake (servings/week)	0.12	3.4 (3.1, 3.8)	4.1 (3.6, 4.5)	**0.031**
Fast-Food intake (times/month)	0.24	13.2 (12.2, 14.1)	16.7 (15.5, 17.8)	**<0.001**
BMI (kg/m^2)	0.47	25.8 (25.4, 26.3)	29.0 (28.5, 29.6)	**<0.001**

BMI-for-age and BMI models adjusted for ethnicity/race, socioeconomic status, and gender. All other models adjusted for ethnicity/race, socioeconomic status, gender, and weight status. Gender assessed at follow-up; other covariates assessed at baseline. Sample size range: 1190-1479; Weighted analyses. Bold values indicate statistical significance at p <0.05. MVPA: moderate-to-vigorous physical activity; SSB: sugar-sweetened beverage; BMI: body mass index

Table 2-3. Longitudinal relationships of health behaviors and weight status at 8-year follow-up by weight teasing status at baseline, effect sizes and marginal means (EAT 2010-2018, from adolescence to young adulthood), main effects models

Outcome	Cohen's d Statistic	Marginal Mean (95% CI)		p-value
		Not Teased	Teased	
Screen Time (hours/week)	0.00	25.2 (24.5, 26.0)	25.1 (24.0, 26.2)	0.838
MVPA (hours/week)	0.03	4.4 (4.2, 4.7)	4.5 (4.2, 4.9)	0.582
Sleep duration (hours/night)	0.08	8.5 (8.4, 8.6)	8.4 (8.2, 8.5)	0.127
Breakfast intake (days/week)	0.04	3.7 (3.5, 3.8)	3.8 (3.6, 4.0)	0.453
Fruit intake (servings/day)	0.04	2.0 (1.8, 2.1)	2.0 (1.8, 2.2)	0.508
Vegetable intake (servings/day)	0.02	2.2 (2.0, 2.3)	2.2 (2.0, 2.4)	0.791
SSB intake (servings/week)	0.03	3.6 (3.2, 3.9)	3.8 (3.3, 4.2)	0.552
Fast-Food intake (times/month)	0.03	14.4 (13.6, 15.3)	14.9 (13.7, 16.2)	0.535
BMI (kg/m^2)	0.31	26.4 (26.1, 26.8)	28.2 (27.8, 28.7)	**<0.001**

Models adjusted for ethnicity/race, socioeconomic status, gender, outcome assessed at baseline, and weight status

Gender assessed at follow-up; other covariates assessed at baseline

Sample size range: 1130-1475; Weighted analyses

Bold values indicate statistical significance at $p < 0.05$

MVPA: moderate-to-vigorous physical activity; SSB: sugar-sweetened beverage; BMI: body mass index

Health Behaviors and Weight Status by Ethnicity/Race and Socioeconomic Status

Comparison of health behaviors and BMI revealed that they significantly differed by ethnicity/race. White participants had lower screen time, higher MVPA, more frequent breakfast intake, lower SSB intake, less frequent fast-food intake, and lower BMI than several BIPOC groups during adolescence and young adulthood (Table 2-4). Higher adolescent SES background was associated with higher MVPA, higher breakfast intake, lower fast-food intake and lower BMI in both adolescence and young adulthood. Higher adolescent SES was additionally associated with longer sleep duration and lower SSB intake during adolescence (Table 2-5).

Adding interaction terms to fully adjusted regression models provided evidence that ethnicity/race and adolescent SES operated as effect modifiers in the relationship between weight teasing and health behaviors, but only for a few behaviors (approximately 17% of interaction tests). For those behaviors (interaction term with $p<0.1$), stratified models were examined, and results are displayed in Table 2-6. For example, in Black/African American adolescents, experiencing weight teasing was cross-sectionally associated with 1.4 fewer hours per week of MVPA ($d=0.30$, $p=0.012$) and 0.7 fewer hours per night of sleep ($d=0.42$, $p=0.003$) versus no significant differences for white adolescents. For young adults from middle SES backgrounds, weight teasing was associated with 0.9 fewer hours per week of MVPA ($d=0.22$, $p=0.009$) and less frequent breakfast intake (teased: 3.2 times per week, compared to not teased: 4.0 times per week, $d=0.31$, $p<0.001$) versus no difference in both measures for young adults from high SES backgrounds.

Table 2-4. Health behaviors and weight status (means) by ethnicity/race, among adolescents (EAT 2010) and young adults (EAT 2018)

			Adolescence (EAT 2010)				
Outcome	Cohen's d Statistic	Asian American	Black/African American	Latinx/ Hispanic	Mixed/ Other	White	p-value
Screen Time (hours/week)	0.23	38.1 ± 23.0[a]	42.4 ± 31.1[b]	34.9 ± 22.5[a]	43.8 ± 29.9[b]	38.8 ± 23.9[a]	**<0.001**
MVPA (hours/week)	0.32	5.3 ± 4.1[ab]	5.5 ± 5.5[ac]	4.8 ± 3.9[b]	6.2 ± 5.1[cd]	7.0 ± 4.1[d]	**<0.001**
Sleep duration (hours/night)	0.09	8.5 ± 1.1[a]	8.5 ± 1.5[a]	8.4 ± 1.2[a]	8.6 ± 1.2[a]	8.6 ± 1.5[a]	0.511
Breakfast intake (days/week)	0.22	4.0 ± 2.3[a]	4.3 ± 3.0[a]	4.0 ± 2.6[a]	4.3 ± 2.7[a]	4.8 ± 2.3[b]	**<0.001**
Fruit intake (servings/day)	0.25	1.9 ± 1.6[a]	2.3 ± 2.1[b]	2.3 ± 1.8[b]	2.4 ± 2.0[b]	1.9 ± 1.3[a]	**<0.001**
Vegetable intake (servings/day)	0.13	1.2 ± 1.0[a]	1.3 ± 1.6[ab]	1.4 ± 1.4[b]	1.4 ± 1.3[ab]	1.3 ± 1.0[ab]	0.192
SSB intake (servings/week)	0.43	3.5 ± 4.2[a]	6.9 ± 7.7[b]	5.2 ± 5.5[cd]	6.0 ± 6.8[bc]	4.7 ± 4.9[d]	**<0.001**
Fast-Food intake (times/month)	0.46	9.4 ± 11.8[a]	17.4 ± 20.9[b]	11.9 ± 13.0[c]	14.7 ± 15.5[d]	9.6 ± 8.2[ac]	**<0.001**
BMI-for-age (percentile)	0.20	69.7 ± 25.9[a]	69.3 ± 32.5[a]	72.7 ± 26.1[a]	71.0 ± 28.4[a]	64.0 ± 25.3[b]	**0.004**

Table 2-4. Continued.

	Young Adulthood (EAT 2018)						
Outcome	Cohen's d Statistic	Asian American	Black/African American	Latinx/ Hispanic	Mixed/ Other	White	p-value
Screen Time (hours/week)	0.20	27.4 ± 11.7[a]	24.1 ± 13.9[b]	24.3 ± 11.5[b]	25.2 ± 13.0[b]	25.1 ± 10.3[b]	**0.005**
MVPA (hours/week)	0.26	3.7 ± 3.5[a]	4.2 ± 4.5[ab]	4.4 ± 3.9[bc]	4.8 ± 4.9[cd]	5.2 ± 3.8[d]	**<0.001**
Sleep duration (hours/night)	0.14	8.5 ± 1.4[ab]	8.6 ± 2.0[ac]	8.4 ± 1.5[abc]	8.6 ± 1.5[ac]	8.3 ± 1.1[b]	0.128
Breakfast intake (days/week)	0.20	3.3 ± 2.3[a]	3.7 ± 2.6[ab]	4.0 ± 2.4[bc]	3.5 ± 2.3[ac]	4.0 ± 2.3[b]	**0.004**
Fruit intake (servings/day)	0.29	1.7 ± 1.6[a]	1.9 ± 2.0[ab]	2.1 ± 1.8[bc]	2.4 ± 2.3[c]	1.7 ± 1.3[a]	**<0.001**
Vegetable intake (servings/day)	0.15	2.1 ± 1.6[ab]	2.0 ± 2.0[b]	2.4 ± 1.8[a]	2.1 ± 1.7[ab]	2.2 ± 1.5[ab]	0.163
SSB intake (servings/week)	0.18	3.0 ± 3.7[a]	3.9 ± 5.9[b]	3.9 ± 4.8[b]	3.9 ± 5.2[b]	4.0 ± 4.8[b]	**0.044**
Fast-Food intake (times/month)	0.44	11.2 ± 12.2[a]	19.1 ± 19.2[b]	14.0 ± 12.3[cd]	15.5 ± 15.0[d]	11.7 ± 10.2[ac]	**<0.001**
BMI (kg/m^2)	0.23	27.4 ± 6.0[abc]	27.1 ± 8.3[b]	28.3 ± 6.8[ac]	27.5 ± 7.9[abc]	25.8 ± 5.8[d]	**<0.001**

ANOVA tests used to examine differences in unadjusted means by ethnicity/race

[abcd] Within each outcome, cells that share a superscript do not significantly differ at p <0.05

Bold values indicate statistical significance at p <0.05

MVPA: moderate-to-vigorous physical activity; SSB: sugar-sweetened beverage; BMI: body mass index

Table 2-5. Health behaviors and weight status (means) by socioeconomic status among adolescents (EAT 2010) and young adults (EAT 2018)

		Adolescence (EAT 2010)			
Outcome	Cohen's d Statistic	Low SES	Middle SES	High SES	p-value
Screen Time (hours/week)	0.05	39.3 ± 26.3[a]	40.9 ± 27.0[a]	40.0 ± 24.7[a]	0.594
MVPA (hours/week)	0.24	5.2 ± 4.7[a]	5.8 ± 4.6[b]	6.7 ± 4.2[c]	**<0.001**
Sleep duration (hours/night)	0.20	8.4 ± 1.3[a]	8.6 ± 1.3[b]	8.6 ± 0.97[b]	**<0.001**
Breakfast intake (days/week)	0.29	3.9 ± 2.6[a]	4.2 ± 2.6[a]	4.9±2.3[b]	**<0.001**
Fruit intake (servings/day)	0.06	2.1 ± 1.8[a]	2.2 ± 1.8[a]	2.1 ± 1.4[a]	0.500
Vegetable intake (servings/day)	0.11	1.3 ± 1.3[a]	1.4 ± 1.4[a]	1.4 ± 1.1[a]	0.133
SSB intake (servings/week)	0.25	6.0 ± 6.5[a]	5.5 ± 6.2[a]	4.0 ± 4.5[b]	**<0.001**
Fast-Food intake (times/month)	0.16	13.6 ± 16.6[a]	13.5 ± 15.3[a]	10.6 ± 9.5[b]	**0.008**
BMI-for-age (percentile)	0.31	72.3 ± 28.1[a]	70.6 ± 26.5[a]	60.9 ± 27.6[b]	**<0.001**

Table 2-5. Continued.

	Young Adulthood (EAT 2018)				
Outcome	Cohen's d Statistic	Low SES	Middle SES	High SES	p-value
Screen Time (hours/week)	0.09	25.5 ± 13.0^a	25.6 ± 12.1^a	24.3 ± 10.3^a	0.249
MVPA (hours/week)	0.20	4.0 ± 4.1^a	4.5 ± 4.2^a	5.1 ± 3.9^b	**<0.001**
Sleep duration (hours/night)	0.11	8.5 ± 1.6^a	8.5 ± 1.6^a	8.3 ± 1.2^a	0.132
Breakfast intake (days/week)	0.17	3.6 ± 2.4^a	3.7 ± 2.4^a	4.1 ± 2.2^b	**0.004**
Fruit intake (servings/day)	0.09	2.0 ± 1.9^a	2.0 ± 1.8^a	1.8 ± 1.6^a	0.276
Vegetable intake (servings/day)	0.12	2.0 ± 1.7^a	2.2 ± 1.8^a	2.2 ± 1.6^a	0.115
SSB intake (servings/week)	0.06	3.9 ± 5.1^a	3.7 ± 4.8^a	3.6 ± 4.6^a	0.579
Fast-Food intake (times/month)	0.20	16.0 ± 16.5^a	14.7 ± 14.5^a	12.1 ± 10.0^b	**<0.001**
BMI (kg/m^2)[††]	0.34	28.2 ± 7.7^a	27.2 ± 6.7^b	25.1 ± 5.7^c	**<0.001**

ANOVA tests used to examine differences in unadjusted means by socioeconomic status

[abc] Within each outcome, cells that share a superscript do not significantly differ at $p < 0.05$

Bold values indicate statistical significance at $p < 0.05$

SES: socioeconomic status; MVPA: moderate-to-vigorous physical activity; SSB: sugar-sweetened beverage; BMI: body mass index

Table 2-6. Relationships of health behaviors by weight teasing status in young people, effect sizes and marginal means, for variables with evidence of effect modification by ethnicity/race or socioeconomic status, stratified models

Outcome	d Statistic	Marginal Mean (95% CI)		p-value	d Statistic	Marginal Mean (95% CI)		p-value
		Not Teased	Teased			Not Teased	Teased	
EAT 2010 Cross-Sectional		Black/African American				White		
MVPA (hours/week)	0.30	6.0 (5.4, 6.6)	4.6 (3.6, 5.5)	**0.012**	0.14	6.8 (6.2, 7.4)	7.5 (6.7, 8.4)	0.181
EAT 2018 Cross-Sectional								
Sleep duration (hours/night)	0.42	8.9 (8.6, 9.1)	8.2 (7.9, 8.5)	**0.003**	0.02	8.3 (8.2, 8.5)	8.3 (8.1, 8.5)	0.884
Longitudinal (EAT 2010-2018)								
Screen Time (hours/week)	0.30	25.2 (23.7, 26.8)	21.3 (18.8, 23.7)	**0.009**	0.06	24.8 (23.4, 26.2)	25.5 (23.5, 27.5)	0.592
Vegetable intake (svgs/day)	0.21	1.9 (1.6, 2.2)	2.3 (1.8, 2.7)	0.128	0.19	2.3 (2.1, 2.6)	2.0 (1.7, 2.3)	0.106
SSB intake (servings/week)	0.18	4.0 (3.2, 4.8)	3.0 (1.7 4.3)	0.188	0.16	3.7 (2.9, 4.4)	4.6 (3.5, 5.6)	0.161
EAT 2010 Cross-Sectional		Asian American				White		
Vegetable intake (svgs/day)	0.11	1.3 (1.3, 1.5)	1.2 (1.0, 1.4)	0.326	0.26	1.2 (1.1, 1.4)	1.6 (1.3, 1.8)	**0.020**
EAT 2018 Cross-Sectional		Middle SES				High SES		
MVPA (hours/week)	0.22	4.9 (4.5, 5.4)	4.0 (3.4, 4.5)	**0.009**	0.08	5.0 (4.4, 5.6)	5.4 (4.7, 6.1)	0.289
Breakfast intake (days/week)†	0.31	4.0 (3.7, 4.2)	3.2 (2.9, 3.5)	**<0.001**	0.14	4.3 (4.0, 4.6)	3.9 (3.5, 4.3)	0.186
Fast-Food intake (times/mo)	0.18	14.8 (13.0, 16.6)	17.6 (15.6, 19.6)	0.258	0.38	12.2 (10.7, 13.7)	17.7 (15.9, 19.6)	**<0.001**

†Low SES results: d=0.05, Not Teased: 3.5 (3.2, 3.8); Teased: 3.6 (3.3, 3.9); p=0.548. Cross-sectional models adjusted for ethnicity/race, socioeconomic status, gender, and weight status. Longitudinal models adjusted for ethnicity/race, socioeconomic status, gender, outcome assessed at baseline, and weight status. Gender assessed at follow-up; other covariates assessed at baseline. Weighted analyses; Bold values indicate statistical significance at p <0.05. SES: socioeconomic status; MVPA: moderate-to-vigorous physical activity; SSB: sugar-sweetened beverage.

2.D. Discussion

In an ethnically/racially and socioeconomically diverse population-based sample of young people, the experience of weight teasing was common and was associated with higher BMI cross-sectionally during both adolescence and young adulthood, and longitudinally over an eight-year follow-up. Weight teasing was cross-sectionally associated with some adverse health behaviors (e.g., shorter sleep duration, less frequent breakfast intake, higher SSB and fast-food intake, longer screen time), although these relationships did not persist longitudinally. BIPOC young people and those from low SES backgrounds had higher weight status, lower MVPA and breakfast frequency, and higher fast-food intake than their respective counterparts. Despite some evidence of effect modification by ethnicity/race and adolescent SES in the weight teasing-health behavior relationship for a minority of behaviors, we did not observe patterns across subgroups or behaviors that suggest weight teasing is more or less harmful for any specific group or outcome. In general, effect sizes were small, although when measuring effects at a population-level, even relatively small differences between exposed and unexposed groups can be important to health outcomes. Results indicate that experiencing weight teasing is cross-sectionally associated with some concerning health behaviors and is a risk factor for future weight gain across ethnic/racial and socioeconomic groups of young people. Overall, these findings provide evidence against potential hypotheses that being exposed to weight teasing might serve as a motivator toward positive changes in eating and activity behaviors.

Findings that weight teasing was associated with higher BMI cross-sectionally during adolescence, cross-sectionally during young adulthood, and longitudinally are consistent with our hypothesis and previous literature [22,29,31,102,103]. Because of our large, diverse study population and longitudinal design, findings strengthen previous evidence that weight stigma is a risk factor for elevated weight status. To our knowledge, this study is the first in adolescents and young adults to examine the relationship between weight stigma and a comprehensive set of weight-related health behaviors. Some studies in young people have examined the relationship between weight stigma and individual health behaviors. For example, a 2019 study by Puhl, Himmelstein, and Watson found that weight teasing from family – but not peers – was associated with difficulty falling asleep [60]. That study population was limited to sexual and gender minorities which may have affected the findings in that youth may have experienced the intersectional effects of weight stigma combined with homophobia and/or transphobia. In comparison, our study found that weight teasing was cross-sectionally associated with shorter sleep duration during both adolescence and young adulthood, after accounting for ethnicity/race, adolescent SES, gender, and weight status. Also, in our measure of weight teasing, we did not assess the teasing source. Further, our study also revealed a cross-sectional relationship between weight teasing and shorter sleep duration in Black/African American adolescents, versus no relationship in white adolescents. These findings and those of Puhl, Himmelstein, and Watson [60] might suggest that intersectionality plays a role in the relationship between weight-based mistreatment and sleep patterns for young people with marginalized identities. However, in our study, there were no differences across ethnic/racial and adolescent SES subgroups in the longitudinal relationship between weight teasing and sleep duration or the cross-sectional relationship in young adulthood.

In addition to shorter sleep duration, weight teasing was cross-sectionally associated with longer screen time during adolescence; cross-sectionally associated with less frequent breakfast intake, higher SSB intake, higher fast-food intake during young adulthood; and longitudinally associated with higher BMI in this sample. These findings align with Tomiyama's Cyclic Obesity/Weight-Based Stigma (COBWEBS) model, which proposes a "positive feedback loop" between weight-stigmatizing experiences and weight gain [39]. Specifically, Tomiyama postulates that weight-stigmatizing experiences lead to increased stress, which leads to increased cortisol and eating/activity behaviors that promote weight gain, which together lead to elevated weight status, which leads to further weight-stigmatizing experiences [39]. While several prior studies, including our own, have linked weight-stigmatizing experiences to disordered eating behaviors [21,22,100], and such behaviors are established risk factors for subsequent weight gain [43–45], the present study may provide evidence for the link between weight-stigmatizing experiences and a different group of eating/activity behaviors that may promote weight gain: shorter sleep duration, longer screen time, less frequent breakfast intake, higher SSB intake, and higher fast-food intake. However, effect sizes were small and there was no evidence of a longitudinal relationship between weight teasing and these behaviors.

Evidence from our study should be interpreted within the context of its strengths and limitations. Strengths include the large, ethnically/racially and socioeconomically diverse sample, allowing us to examine our key research questions through a health equity lens which is important given inequities in numerous nutrition-, fitness- and weight-related health outcomes in young people [7,12,13]. Also, pilot testing was a key strength of this study as it allowed the survey items to be phrased in a way that met the developmental needs of participants. Despite its strengths, this study also had several limitations. A single survey item was used to assess some measures (e.g., weight teasing), and it is optimal to use more comprehensive measures. At follow up, height and weight were self-reported, which may have introduced recall or other types of bias. Further, gender/sex was assessed as "male," "female," and "different identity." A more appropriate assessment of these constructs includes the two-question method of birth-assigned sex and gender identity [142]. We did not collect data on sexual orientation, which is a shortcoming, given our health equity lens and our interest in understanding the potential for intersectional impacts of weight stigma. Attrition occurred at follow-up, however, analyses used inverse probability weighting which allowed for extrapolation back to the original sample based on characteristics associated with missingness at follow-up (e.g., lower education of parent/guardian, being born outside the U.S., and identifying as BIPOC). Finally, baseline recruitment took place in one geographic area in Minnesota, U.S., which may limit generalizability of the findings.

2.E. Conclusions

Our study found that weight teasing was cross-sectionally, but not longitudinally, associated with shorter sleep duration, longer screen time, less frequent breakfast intake, higher fast-food intake, and higher SSB intake in an ethnically/racially and socioeconomically diverse sample of young people. The finding that weight teasing was cross-sectionally and longitudinally associated with higher BMI extends previous evidence that weight teasing is both a more common experience for people with high weight and a longitudinal risk factor for weight gain. BIPOC young people and those from low SES backgrounds were disproportionately affected by high weight status, low MVPA, low breakfast intake, and high fast-food intake, and young people across ethnic/racial and adolescent SES subgroups experienced similar effects of weight teasing. When taken together, our findings suggest that clinicians, community-based organizations, public health practitioners, and researchers should view weight stigma as a distinct obstacle to their efforts to address weight-related health in diverse populations of young people. To this end, recommendations have been published and include: 1) increasing awareness of one's own weight-related biases [97,143]; 2) avoiding narratives that emphasize personal responsibility in addressing obesity [97,143]; 3) improving training in strengths-based approaches (e.g., for clinicians, motivational interviewing training) [97,136]; 4) making the environment of youth-serving clinics and organizations more welcoming for people diverse in body size, ethnicity, race, and SES [97,136]; 5) reflecting diversity in advertising, media, and brochures, including respectful images of people with high weight [97,136]; 6) strengthening anti-bullying policies in schools to protect youth from weight-based teasing and bullying [97]; 7) participating in broader advocacy for legislative protections to address body size discrimination [97]; and 8) engaging youth in these efforts [136]. Our findings underscore the importance of these recommendations and the need for increased attention to stigma-reduction efforts. As an initial priority, training for healthcare providers on this topic can foster more compassionate patient care for young people diverse in body size, ethnicity, race, and socioeconomic status; better equip them with tools to address the harms of weight stigma; and create a positive environment to promote health-supporting behaviors.

Table 2-7. Cross-sectional relationships of health behaviors and weight status by weight teasing status: means at baseline (EAT 2010, adolescence)

Outcome	Model 1				Model 2			
	Cohen's d Statistic	Mean (95% CI) Not Teased	Teased	p-value	Cohen's d Statistic	Marginal Mean (95% CI) Not Teased	Teased	p-value
Screen Time (hr/week)	0.10	38.9 (37.3, 40.6)	41.6 (39.3, 43.8)	0.061	0.13	39.0 (37.4, 40.6)	42.4 (40.1, 44.6)	**0.015**
MVPA (hr/week)	0.05	5.9 (5.6, 6.2)	5.5 (5.1, 5.9)	0.087	0.06	5.9 (5.6, 6.1)	5.6 (5.2, 6.0)	0.313
Sleep duration (hr/day)	0.11	8.6 (8.5, 8.7)	8.4 (8.3, 8.5)	**0.035**	0.12	8.6 (8.5, 8.6)	8.4 (8.3, 8.5)	**0.024**
Breakfast intake (days/week)	0.13	4.4 (4.2, 4.6)	4.0 (3.8, 4.3)	**0.011**	0.13	4.4 (4.2, 4.6)	4.0 (3.8, 4.3)	**0.010**
Fruit intake (svg/day)	0.05	2.1 (2.0, 2.2)	2.2 (2.1, 2.4)	0.336	0.07	2.1 (2.0, 2.2)	2.2 (2.1, 2.4)	0.220
Vegetable intake (svg/day)	0.14	1.3 (1.2, 1.3)	1.5 (1.3, 1.6)	**0.007**	0.16	1.3 (1.2, 1.4)	1.5 (1.4, 1.6)	**0.003**
SSB intake (svg/week)	0.02	5.3 (4.9, 5.7)	5.4 (4.8, 5.9)	0.781	0.00	5.4 (5.0, 5.8)	5.5 (5.0, 6.0)	0.820
Fast-Food intake (times/month)	0.06	12.6 (11.7, 13.6)	13.6 (12.3, 14.9)	0.232	0.05	12.6 (11.8, 13.6)	13.4 (12.2, 14.7)	0.350
BMI-for-age (percentile)	0.30	66.3 (64.6, 68.0)	75.0 (72.6, 77.4)	**<0.001**	See Table 2			

Model 1: unadjusted. Model 2: adjusted for ethnicity/race, socioeconomic status, and gender. Gender assessed at follow-up; other covariates assessed at baseline. Sample size range: 1383-1479; Weighted analyses. MVPA: moderate-to-vigorous physical activity; SSB: sugar-sweetened beverage; BMI: body mass index

Table 2-8. Cross-sectional relationships of health behaviors and weight status by weight teasing status: means at follow-up (EAT 2018, young adulthood)

Outcome	Model 1				Model 2			
	Cohen's d Statistic	Mean (95% CI)		p-value	Cohen's d Statistic	Marginal Mean (95% CI)		p-value
		Not Teased	Teased			Not Teased	Teased	
Screen Time (hours/week)	0.14	24.5 (23.7, 25.3)	26.2 (25.3, 27.2)	**0.007**	0.11	24.8 (23.9, 25.6)	26.1 (25.2, 27.1)	**0.032**
MVPA (hours/week)	0.10	4.6 (4.3, 4.8)	4.2 (3.8, 4.5)	0.052	0.06	4.6 (4.3, 4.8)	4.3 (4.0, 4.6)	0.236
Sleep duration (hours/night)	0.21	8.6 (8.5, 8.7)	8.3 (8.2, 8.4)	**<0.001**	0.23	8.6 (8.5, 8.7)	8.3 (8.1, 8.4)	**<0.001**
Breakfast intake (days/week)	0.16	3.9 (3.7, 4.0)	3.5 (3.3, 3.7)	**0.002**	0.13	3.8 (3.7, 4.0)	3.5 (3.3, 3.7)	**0.011**
Fruit intake (servings/day)	0.02	1.9 (1.8, 2.1)	1.9 (1.8, 2.1)	0.759	0.03	2.0 (1.9, 2.1)	1.9 (1.8, 2.1)	0.558
Vegetable intake (servings/day)	0.07	2.2 (2.1, 2.3)	2.1 (1.9, 2.2)	0.253	0.06	2.2 (2.1, 2.3)	2.1 (1.9, 2.2)	0.337
SSB intake (servings/week)	0.10	3.5 (3.2, 3.9)	4.0 (3.6, 4.5)	0.083	0.13	3.5 (3.2, 3.9)	4.2 (3.7, 4.6)	**0.026**
Fast-Food intake (times/month)	0.21	13.2 (12.3, 14.2)	16.3 (15.2, 17.4)	**<0.001**	0.22	13.3 (12.3, 14.2)	16.5 (15.3, 17.6)	**<0.001**
BMI (kg/m^2)	0.48	25.8 (25.4, 26.2)	29.1 (28.5, 29.6)	**<0.001**	See Table 2			

Model 1: unadjusted. Model 2: adjusted for ethnicity/race, socioeconomic status, and gender. Gender assessed at follow-up; other covariates assessed at baseline. Sample size range: 1190-1442; Weighted analyses. MVPA: moderate-to-vigorous physical activity; SSB: sugar-sweetened beverage; BMI: body mass index

Table 2-9. Longitudinal relationships of physical activity, nutrition habits, and weight status at 8-year follow-up by weight teasing status at baseline: means (EAT 2010-2018, from adolescence to young adulthood)

Outcome	Model 1				Model 2			
	Cohen's d Statistic	Mean (95% CI) Not Teased	Mean (95% CI) Teased	p-value	Cohen's d Statistic	Marginal Mean (95% CI) Not Teased	Marginal Mean (95% CI) Teased	p-value
Screen Time (hours/week)	0.06	24.9 (24.2, 25.7)	25.7 (24.7, 26.8)	0.223	0.00	25.2 (24.4, 25.9)	25.4 (24.3, 26.4)	0.789
MVPA (hours/week)	0.02	4.4 (4.2, 4.7)	4.4 (4.0, 4.7)	0.708	0.02	4.4 (4.2, 4.7)	4.5 (4.2, 4.8)	0.645
Sleep duration (hours/night)	0.08	8.5 (8.4, 8.6)	8.4 (8.3, 8.5)	0.123	0.09	8.5 (8.4, 8.6)	8.4 (8.2, 8.5)	0.095
Breakfast intake (days/week)	0.00	3.7 (3.5, 3.8)	3.7 (3.5, 3.9)	0.989	0.03	3.7 (3.5, 3.8)	3.8 (3.6, 4.0)	0.489
Fruit intake (servings/day)	0.02	1.9 (1.8, 2.0)	2.0 (1.8, 2.1)	0.744	0.03	1.9 (1.8, 2.1)	2.0 (1.8, 2.2)	0.547
Vegetable intake (servings/day)	0.03	2.1 (2.0, 2.2)	2.2 (2.0, 2.3)	0.562	0.05	2.1 (2.0, 2.3)	2.2 (2.1, 2.4)	0.460
SSB intake (svg/week)	0.06	3.6 (3.3, 4.0)	3.9 (3.4, 4.4)	0.322	0.06	3.6 (3.3, 4.0)	3.9 (3.4, 4.4)	0.316
Fast-Food intake (times/month)	0.00	14.6 (13.7, 15.5)	14.7 (13.5, 15.9)	0.937	0.02	14.5 (13.6, 15.4)	14.8 (13.6, 16.0)	0.765
BMI-for-age (percentile)	0.45	26.1 (25.6, 26.5)	29.3 (28.7, 29.9)	**<0.001**	See Table 3			

Model 1: unadjusted. Model 2: adjusted for ethnicity/race, socioeconomic status, gender, and outcome assessed at baseline. Gender assessed at follow-up; other covariates assessed at baseline. Sample size range: 1130-1475; Weighted analyses.

MVPA: moderate-to-vigorous physical activity; SSB: sugar-sweetened beverage; BMI: body mass index

Chapter 3

Weight teasing experienced during adolescence and young adulthood: cross-sectional and longitudinal associations with disordered eating behaviors in an ethnically/racially and socioeconomically diverse sample*

***Published version available: Int J Eat Disord. 2021 Aug;54(8):1449-1462**

Objective: This study assessed cross-sectional and longitudinal relationships between weight teasing and disordered eating in an ethnically/racially and socioeconomically diverse sample of young people and examined these relationships across sociodemographic characteristics.

Method: The EAT 2010-2018 study surveyed adolescents (n=1534) in the Minneapolis/St. Paul public schools (mean age=14.4 years) and eight years later (mean age=22.2 years).

Results: Weight teasing was prevalent in adolescence (34.1%) and young adulthood (41.5%). In analyses adjusted for sociodemographic characteristics and body mass index, weight teasing was cross-sectionally associated with a higher prevalence of all disordered eating behaviors during both adolescence and young adulthood. For example, 64.5% of young adults who reported being teased about their weight engaged in unhealthy weight control behaviors, compared with 47.9% among those not teased ($p<0.001$). There were fewer observed associations in longitudinal analyses, although weight teasing still predicted prevalent overeating and both prevalent and incident dieting (incident dieting - teased: 48.4% versus not teased: 38.0%, $p=0.016$). Weight teasing and disordered eating were more prevalent among Black, Indigenous, and People of Color (BIPOC) young people and those from low socioeconomic backgrounds, and the relationship between weight teasing and disordered eating was similar across ethnic/racial, socioeconomic, and gender demographic groups.

Discussion: Results indicate that weight teasing is strongly correlated with disordered eating in both adolescence and young adulthood regardless of ethnicity/race, socioeconomic status, or gender. Finding suggest that future research and policy interventions should address weight stigma and prioritize the needs of BIPOC young people and young people from low socioeconomic backgrounds.

3.A. Introduction

Weight Stigma and Disordered Eating in Adolescence and Young Adulthood

Weight stigma involves the social devaluation of people due to their high body weight or body size. It may stem from unfounded stereotypes that individuals with higher weight lack willpower or discipline, are lazy, or are unmotivated, and can be experienced both structurally and interpersonally [1]. The transition from adolescence to young adulthood is a critical period of development during which prevention and intervention efforts may decrease health threats and alter health trajectories for the adult population [5]. Forming social relationships is an important part of healthy psychosocial development during this transition, thus peer rejection may be especially potent [5,6]. Exposure to weight stigma during adolescence and young adulthood is associated with poor psychosocial health outcomes including higher depressive symptoms [15–17], substance use [18], body dissatisfaction [15,19], self-harm [15], social isolation [24], school avoidance [25], and lower self-esteem [15,17,26,27]. Studies have also examined the relationship between weight stigma and BMI, and longitudinal evidence indicates that weight stigma experienced in adolescence predicts increases in BMI [22,29,31].

For young people, the experience of weight stigma is common, with U.S. studies estimating prevalence at 23-32% [3,4]. A recent meta-analysis determined that while some studies have found that weight stigma is more prevalent among female participants, others have found no gender differences [28]. Questions exist about the prevalence and impact of weight stigma in Black, Indigenous, and other People of Color (BIPOC) young people and those from low socioeconomic backgrounds [28]. Several studies have found no difference in weight stigma prevalence across ethnicity/race [99,101] while other work has found that weight teasing by family members is more prevalent among BIPOC adolescents when compared to white adolescents [14].

Disordered eating behaviors (DEBs) include binge eating, food restriction and purging behaviors (e.g. vomiting or laxative use) to control one's body shape or size [76]. DEBs are associated with higher risk for adverse health outcomes, even when a young person does not meet the full criteria for a clinical eating disorder (e.g. bulimia nervosa) [64–66]. DEBs are a prevalent problem among young people across demographic groups. For example, while they are more prevalent in girls and women (58.8% in adolescents, 54.8% in young adults), they remain a highly prevalent problem for boys and men (31.7% in adolescents, 32.6% in young adults) [144]. Population-based studies have demonstrated that DEBs are more prevalent among BIPOC youth when compared to white youth [75,145–147], and more prevalent among youth from low versus high socioeconomic status (SES) backgrounds [76]. Despite these findings, assumptions persist that DEBs primarily affect young people who are affluent and white, and these assumptions may contribute to health inequities, such as barriers to identification and treatment of clinical eating disorders [148]. Thus a health equity framework, which seeks to improve the health of the entire population by reducing health disparities in underserved populations, may be useful to understand how to prevent and address DEBs in young people, especially in populations already at risk for myriad nutrition- and weight-related health disparities [7,12,13]. A health equity framework acknowledges and attempts to address the fact that health research participants and investigators are often part of the majority population (e.g., largely white and middle class), and therefore the conclusions drawn from research and corresponding interventions developed may miss key elements relevant to meeting the health needs of vulnerable populations [7].

Previous research investigating the relationship between experiencing weight stigma and DEBs in young people has found that exposure to weight stigma is associated with higher prevalence of DEBs both cross-sectionally [14,23,149] and longitudinally [20–22]. Studies examining whether this relationship varies by demographic characteristics in young people have yielded mixed results by gender [14,20,22,28,149] and no differences across ethnicity/race [14,21,28]. One study examined differences by SES and found that family weight teasing during adolescence was a risk factor for binge eating five years later in the higher SES group but found no association in the lower SES group [150].

Shortcomings of Existing Research on Associations

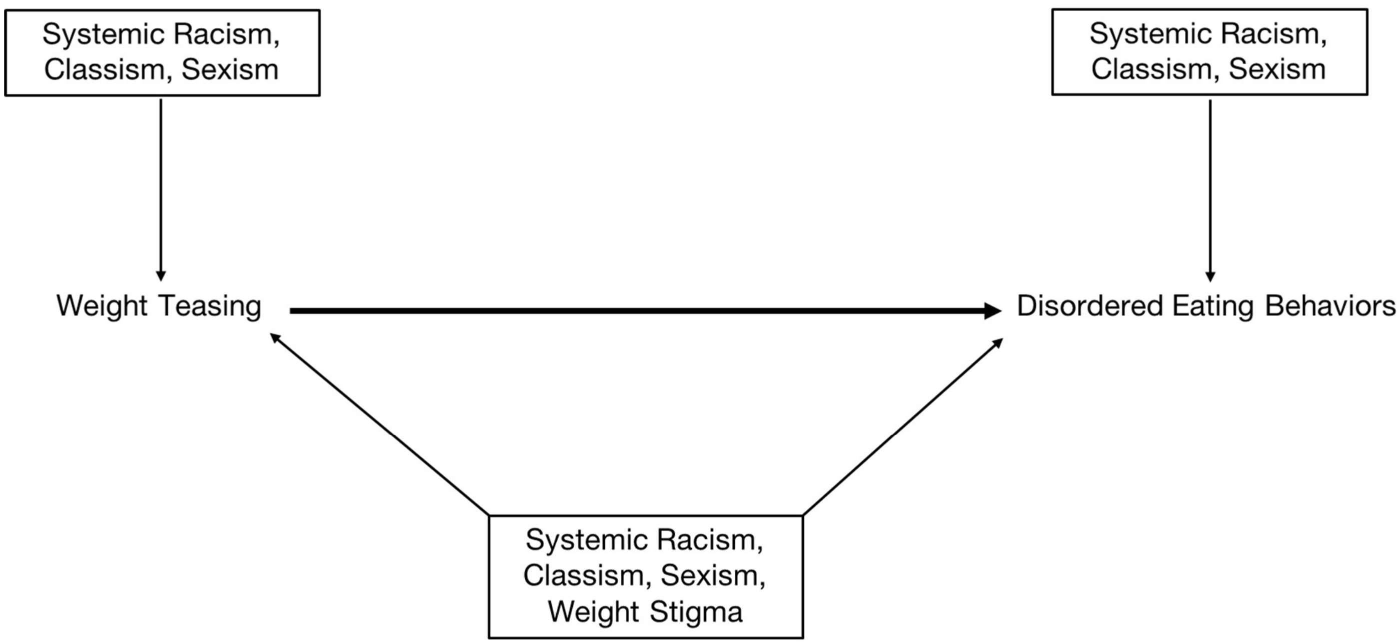
Importantly, existing literature has established that the weight stigma-DEB relationship exists among BIPOC youth and young people from low SES backgrounds [14,21,23], and that exposure to weight stigma precedes DEBs [20–22]. However, to our knowledge, no single study has included both of these elements: a longitudinal study design and a sample statistically powered to detect differences by ethnicity/race and SES. As our study sample is large, has longitudinal data, and participants are ethnically/racially diverse and largely from low SES backgrounds, it provides an opportunity to use a health equity framework to deepen the understanding of the weight stigma-DEB relationship and help clarify where health inequities exist for young people.

The Current Study

For young people, weight stigma often occurs in the form of weight teasing [6]. In this study, we examine associations between weight teasing and DEBs in adolescents and young adults, both cross-sectionally and longitudinally, and aim to assess possible effect modification in an ethnically/racially diverse, primarily lower SES cohort. Specifically, we test the following hypotheses. First, we hypothesize that exposure to weight teasing will be cross-sectionally associated with DEBs at both time points (in adolescence and in young adulthood) and longitudinally associated with incident and prevalent DEBs eight years later (from adolescence to young adulthood). Second, we expect that health disparities will present in our sample. Specifically, we hypothesize that the prevalence of both weight teasing and DEBs will be higher in BIPOC young people, young people from low SES backgrounds, and female participants, when compared to white, higher SES, and male participants, respectively (see Figure 3-1 for hypothesized relationship of study variables). Third, we will explore whether ethnicity/race, SES, and gender are effect modifiers in the relationship between weight teasing and DEBs. Given the mixed literature on this topic, this research question is exploratory with no *a priori* hypothesis.

Examining these understudied questions can expand current understanding of the weight teasing-DEB relationship among underserved populations of young people. Our cross-sectional analyses allow for examining associations at one point in time, while our longitudinal analyses allow for a determination of temporality. Furthermore, this study can help clarify whether and how health inequities related to weight teasing and disordered eating occur, which can inform current knowledge of weight teasing as a universal risk factor for disordered eating. Findings will provide insights for future studies seeking to target the overall population-level distribution of disordered eating with attention to the needs of young people from low SES backgrounds and those of BIPOC young people.

Figure 3-1. Directed Acyclic Graph for hypothesized relationship between weight teasing and disordered eating behaviors



Measures of ethnicity/race, socioeconomic status, gender, and body mass index are used in statistical models as imperfect proxies for exposure to the systemic forms of racism, classism, sexism, and weight stigma, respectively.

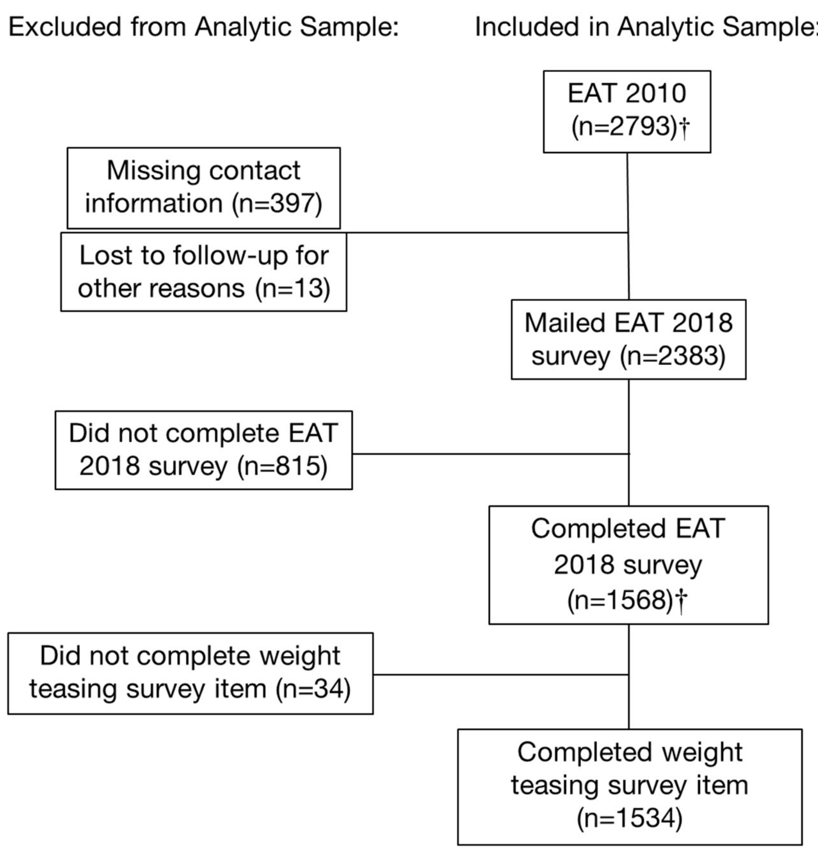
3.B. Methods

Study Design and Participants

Data were collected as a part of EAT 2010-2018 (Eating and Activity over Time), a population-based, longitudinal study designed to examine dietary intake, physical activity, weight control behaviors, weight status, and factors associated with these outcomes in young people [113]. Participants enrolled in the EAT 2010 study as adolescents during the 2009-2010 academic year (mean age=14.4± 2.0 years) and completed a follow-up EAT 2018 survey online or via mail as young adults in 2017-2018 (mean age=22.2 ± 2.0 years). The study population was largely low SES and ethnically/racially diverse. In the analytic sample, distribution by ethnicity/race was 28.6% African American or Black, 20.0% Asian American, 19.1% white, 17.2% Latinx or Hispanic, 15.2% mixed or other. Distribution across SES was 39.5% low, 22.2% low middle, 17.6% middle, 13.2% upper middle, 7.5% high. At baseline, 46.3% of participants identified as male and 53.7% as female.

The EAT 2010 study population included adolescents from 20 public middle and high schools in Minneapolis/St. Paul, Minnesota. Adolescents completed classroom surveys and anthropometric measures at school [114]. The follow-up EAT 2018 assessment was designed to examine changes in weight-related outcomes as participants progressed through adolescence and into young adulthood. This time frame allowed the youngest participants from EAT 2010 to move onto their next stage of development by the time of the EAT 2018 assessment. To be included in the analytic sample, (n=1534), participants needed to have completed both surveys including the weight teasing item (see Figure 3-2). The University of Minnesota's Institutional Review Board Human Subjects Committee approved all study protocols.

Figure 3-2. Flow diagram demonstrating how participants were selected into the analytic sample from the original EAT 2010 study sample



† Participants completing at least 25% of survey items were considered completers.

Survey Development

The EAT 2010 survey, a 235-item self-report instrument, assessed test-retest reliability of measure and internal consistency of survey items in a separate sample of 129 middle and high school students over a one-week period [114]. Key items from the EAT 2010 survey were retained on the EAT 2018 survey, allowing for longitudinal comparisons [113]. All survey items were selected after a thorough review of the literature, including items used to assess similar behaviors in other large population-based studies of adolescents and young adults, thus the use of these items allows for comparisons with other studies. The choice of items was based on focus group discussions with young people from diverse backgrounds at different stages of survey development, in addition to multiple reviews by content experts (e.g. in the fields of adolescent health, eating disorders, nutrition, psychology, and physical activity). In addition, the psychometric properties of these survey items have been tested [75]. For EAT 2018, test-retest reliability measures were assessed in a subgroup of 112 young adult participants over a three-week period.

Primary Measures

Weight Teasing: Weight teasing was assessed at baseline and follow-up using the question, “How often do any of the following things happen? ..... You are teased about your weight.” Responses included “never, less than once a year, a few times a year, a few times a month, and at least once a week” [120]. This variable was dichotomized with “never” coded “no” and all other response options coded “yes” (test-retest agreement=85%). Dichotomous coding was used because previous studies in young people have shown that reports of ever experiencing weight teasing (versus never) are predictive of adverse health outcomes [14,15,22].

Dieting: Dieting was assessed by asking, "How often have you gone on a diet during the last year? By 'diet' we mean changing the way you eat so you can lose weight." Responses included "never, 1-4 times, 5-10 times, more than 10 times, I am always dieting." Two variables, "dieting" and "chronic dieting" were derived from this item, and both outcomes were dichotomized. "Dieting" was defined as dieting one or more times in the past year versus never. "Chronic dieting" was defined as dieting five or more times in the past year versus four or fewer times in the past year. [75,120]. Test-retest agreement was 82%.

Unhealthy Weight Control Behaviors: To assess unhealthy weight control behaviors (UWCB), participants were asked, "Have you done any of the following things in order to lose weight or keep from gaining weight during the past year?" Responses included "fasted, ate very little food, used a food substitute, skipped meals, smoked more cigarettes, took diet pills, made myself vomit, used laxatives, and used diuretics." Of these items, the following were further categorized as extreme weight control behaviors (EWCB): "took diet pills, made myself vomit, used laxatives, and used diuretics." [75,120]. Responses were dichotomized with a positive response for one or more behaviors coded as "yes," and no positive responses coded as "no" (test-retest agreement=85% for UWCB, 96% for EWCB).

Overeating and Binge Eating: Two questions adapted from the adult version of the Questionnaire on Eating and Weight Patterns-Revised assessed overeating and binge eating [151], which has demonstrated good psychometric properties in adolescent samples [152]. To assess overeating, participants were asked, "In the past year, have you ever eaten so much food in a short period of time that you would be embarrassed if others saw you (binge-eating)?" Among those who answered yes, binge eating was assessed by asking, "During the times when you ate this way, did you feel you couldn't stop eating or control what or how much you were eating?" (test-retest agreement=89% for overeating, 75% for binge eating). We were interested in overeating as an outcome because of the cardiometabolic health risks associated with this eating pattern [153].

Sociodemographic Measures

Age: Birthdate was self-reported by adolescents. Age at both time points was derived from birthdate and the survey completion date.

Gender/sex: Gender/sex was assessed at baseline with two response options: "male" or "female." At follow-up, "different identity" with a written response option was additionally offered. There were too few participants who responded with a different identity (n=11) to conduct valid statistical analysis using this categorization, and we did not want to exclude these participants. Therefore, we categorized participants based on baseline responses. For simplicity, throughout the remainder of this article, gender/sex will be referred to as "gender."

Socioeconomic status: Classification tree methodology generated five categories of SES [75,131]; details are described in Supporting Information. Baseline SES was used for all analyses because SES during childhood and adolescence is known as a good predictor of health outcomes during adulthood regardless of adult experiences [135].

Ethnicity/race: Ethnicity/race was assessed with the following question: "Do you think of yourself as…? (You may choose more than one) (1) White, (2) Black or African American, (3) Hispanic or Latino, (4) Asian American, (5) Native Hawaiian or Pacific Islander, (6) American Indian or Native American, or (7) Other" (test-retest agreement=98-100%). If a participant responded "Other" in addition to reporting another ethnicity/race, they were categorized as "Other." Due to small numbers, Native Hawaiian or Pacific Islander, American Indian or Native American, and Other were coded together as ''Mixed or Other Race" [75,114].

Body Mass Index (BMI): At baseline, adolescent weight and height were measured by trained staff in a private area, using standardized procedures. BMI at follow-up was based on self-reported height and weight, which highly correlate with measured height and weight in adolescents (r=0.88 for boys and 0.85 for girls) [129]. BMI percentile at baseline and BMI at follow-up were derived from weight and height using the Centers for Disease Control and Prevention guidelines [130].

Statistical Analysis

Chi-square tests assessed frequencies and percentages of ethnicity/race, baseline SES, and gender by weight teasing status. T-tests assessed the mean and standard deviation of age and BMI by weight teasing status. To achieve the primary objective of this study, unadjusted associations (probabilities and frequencies) between weight teasing and DEBs (dieting, chronic dieting, UWCB, EWCB, overeating, and binge eating), were examined using chi-square tests. Logistic regression models, adjusted for ethnicity/race, baseline SES, gender, and BMI/BMI percentile, examined the relationship between weight teasing and DEBs and estimated marginal probabilities and 95% confidence intervals. Adjusted models used Huber-White robust sandwich estimators to adjust for potential clustering by school status at baseline. Both chi-square tests and logistic regression analyses were used for cross-sectional analyses at baseline, cross-sectional analyses at follow-up, and longitudinal analyses (incidence and prevalence). Analyses were run with and without adjustment for BMI. In both sets of analyses, point estimates were approximately the same and the direction of the association did not change. However, some outcomes were de-attenuated when BMI was removed from the models. We opted to keep BMI in the model as it represents an imperfect proxy for societal weight stigma and therefore, we consider it a confounding variable. See Figure 3-1 for our directed acyclic graph (DAG), a visual representation of variables used in statistical models which serves as an aid in the scientific discussion about causal inference in the field of epidemiology. DAGs help identify the presence of confounders, variables which are associated with both predictor and outcome variables but are not in the causal pathway [137,138]. Post hoc analyses were conducted in all models to assess whether the odds of DEBs were higher in participants who were teased more frequently.

To assess whether the prevalence of weight teasing and DEBs differed by ethnicity/race (BIPOC versus white), baseline SES (lowest SES versus higher SES categories), or gender (female versus male), chi-square tests were conducted at baseline and follow-up. To examine whether the relationship between weight teasing and DEBs varied by ethnicity/race, baseline SES, or gender, interaction terms between sociodemographic variables and weight teasing were added to fully-adjusted logistic regression models. Separate models were fit for each sociodemographic characteristic (a model with interaction term for ethnicity/race, a model with interaction term for gender, etc). Dichotomous comparisons were used for the prevalence estimates and interaction terms using the measures of ethnicity/race, baseline SES, and gender as proxies for exposure to the systemic forms of racism, classism, and sexism, respectively. Such measures are imperfect proxies for systemic oppression, given the considerable heterogeneity of experiences within these groups and the inability to capture the complexity of such oppression through simple categorization of demographic characteristics.

Because attrition did not occur completely at random, inverse probability weighting (IPW) was used for all analyses to account for missing data [140,141]. IPW minimizes potential response bias due to missing data and allows for extrapolation back to the original EAT 2010 sample. The probability of responding to the 2018 survey was calculated using logistic regression of yes/no responder status predicted by baseline 2010 survey variables: age, gender, U.S. born, race, ethnicity, SES, dieting, BMI, and an indicator of obesity status. The 25th and 75th percentile of the weights (inverse of the probability of responding rescaled to have mean 1) ranged from 0.81 to 1.10. Because there were no extreme weights (minimum=0.606, maximum=2.914) there was no need for trimming the weights, and they are used in all analyses. All analyses were conducted using SAS 9.4 (Cary, NC, copyright 2002-2012).

3.C. Results

Sociodemographic Characteristics

Weight teasing was prevalent in the sample with 34% of participants teased about their weight during adolescence and 42% during young adulthood (Table 3-1). At both baseline and follow-up, higher BMI/BMI percentile was associated with higher prevalence of weight teasing ($p<0.001$). Ethnicity/race was also associated with weight teasing status ($p=0.036$ at baseline, $p<0.001$ at follow-up) with Asian American participants experiencing the highest prevalence of weight teasing (41.3% at baseline, 52.6% at follow-up). At baseline but not follow-up, lower SES ($p=0.011$) and female gender ($p=0.029$) were associated with a higher prevalence of weight teasing. There were no observed differences in weight teasing by age.

Table 3-1. Sociodemographic characteristics and body mass index among young people in Minneapolis-St Paul, Minnesota by weight teasing status at baseline (EAT 2010) and eight-year follow up (EAT 2018), unadjusted estimates

Characteristics		Adolescence (EAT 2010)			Young Adulthood (EAT 2018)		
	Total Mean ± SD or % (n)	Not Teased Mean ± SD or % (n)	Teased Mean ± SD or % (n)	p-value	Not Teased Mean ± SD or % (n)	Teased Mean ± SD or % (n)	p-value
Total	1534	65.9 (1010)	34.1 (523)	n/a	58.5 (871)	41.5 (618)	n/a
Ethnicity / Race (%)				**0.036**			**<0.001**
Black or African American	28.6 (437)	69.7 (304)	30.3 (132)		61.4 (258)	38.6 (162)	
Asian American	20.0 (306)	58.7 (180)	41.3 (126)		47.4 (142)	52.6 (158)	
White	19.1 (292)	67.6 (197)	32.4 (94)		67.6 (194)	32.4 (93)	
Latinx or Hispanic	17.2 (263)	65.4 (172)	34.6 (91)		55.3 (138)	44.7 (112)	
Mixed or Other Race	15.2 (232)	66.4 (154)	33.6 (78)		59.9 (135)	40.2 (91)	
Socioeconomic Status (%)				**0.011**			0.133
Low	39.5 (588)	61.1 (360)	38.9 (229)		55.3 (315)	44.7 (254)	
Low Middle	22.2 (331)	65.5 (217)	34.5 (114)		57.7 (188)	42.3 (138)	
Middle	17.6 (262)	70.5 (185)	29.5 (77)		62.0 (155)	38.1 (95)	
Upper Middle	13.2 (196)	69.5 (136)	30.5 (60)		59.5 (113)	40.5 (77)	
High	7.5 (112)	74.3 (83)	25.7 (29)		67.1 (74)	32.9 (36)	

Table 3-1. Continued.

Characteristics	Total Mean ± SD or % (n)	Adolescence (EAT 2010) Not Teased Mean ± SD or % (n)	Adolescence (EAT 2010) Teased Mean ± SD or % (n)	Adolescence (EAT 2010) p-value	Young Adulthood (EAT 2018) Not Teased Mean ± SD or % (n)	Young Adulthood (EAT 2018) Teased Mean ± SD or % (n)	Young Adulthood (EAT 2018) p-value
Total	1534	65.9 (1010)	34.1 (523)	n/a	58.5 (871)	41.5 (618)	n/a
Gender (%)				**0.029**			0.383
Female	53.7 (823)	63.4 (522)	36.6 (301)		57.5 (459)	42.6 (340)	
Male	46.3 (711)	68.7 (488)	31.3 (222)		59.7 (412)	40.3 (278)	
Age (mean years)	14.4 ± 2.0† 22.2 ± 2.0‡	14.4 ± 2.0	14.5 ± 2.0	0.139	22.1 ± 2.0	22.2 ± 2.0	0.876
BMI (mean percentile or mean kg/m^2)§	69.2 ± 27.8† 27.2 ± 7.0‡	66.3 ± 26.9	75.0 ± 28.6	**<0.001**	25.8 ± 5.9	29.1 ± 7.6	**<0.001**

BMI: body mass index

† Assessed at baseline (EAT 2010)

‡ Assessed at follow up (EAT 2018)

§ Mean BMI percentile is reported for adolescence, and mean BMI (raw value) is listed for young adulthood.

Cross-sectional Findings during Adolescence and Young Adulthood

At baseline and follow-up, for every DEB (dieting, chronic dieting, UWCB, EWCB, overeating, and binge eating), the prevalence was higher in participants who experienced weight teasing when compared to those with no weight teasing (Table 3-2). For example, EAT 2010 adjusted analyses showed that 12.3% (95% CI: 9.2-16.2%) of adolescents who were teased about their weight engaged in binge eating, compared to 4.3% (95% CI: 3.1-6.0%) among those not teased. EAT 2018 adjusted analyses showed that 64.5% (95% CI: 60.7-68.1%) of young adults teased about their weight engaged in UWCB, compared to 47.9% (95% CI: 44.0-51.8%) among those not teased.

Table 3-2. Cross-sectional relationships of disordered eating behaviors by weight teasing status: unadjusted percent and predicted prevalence at baseline (EAT 2010, adolescents) and at follow-up (EAT 2018, young adults)

Outcome	Unadjusted Percent (n)		p-value	Predicted Prevalence (95% CI)		p-value
	Not Teased	Teased		Not Teased	Teased	
Adolescence (EAT 2010)						
Dieting	31.2 (314)	55.5 (291)	**<0.001**	29.0 (25.4, 33.0)	46.9 (41.5, 52.2)	**<0.001**
Chronic dieting	7.3 (73)	16.2 (85)	**<0.001**	5.5 (3.9, 7.7)	10.3 (7.0, 14.9)	**<0.001**
UWCB	35.9 (360)	58.4 (305)	**<0.001**	35.9 (32.7, 39.2)	53.5 (47.2, 59.7)	**<0.001**
EWCB	2.6 (26)	7.4 (39)	**<0.001**	2.2 (1.3, 3.7)	5.9 (4.3, 8.0)	**<0.001**
Overeating	8.1 (81)	23.3 (120)	**<0.001**	7.6 (6.0, 9.4)	20.0 (15.5, 25.4)	**<0.001**
Binge eating	4.7 (47)	14.2 (73)	**<0.001**	4.3 (3.1, 6.0)	12.3 (9.2, 16.2)	**<0.001**
Young Adulthood (EAT 2018)						
Outcome	Unadjusted Percent (n)		p-value	Predicted Prevalence (95% CI)		p-value
	Not Teased	Teased		Not Teased	Teased	
Dieting	44.2 (383)	66.8 (407)	**<0.001**	48.9 (45.5, 52.3)	64.0 (60.0, 67.9)	**<0.001**
Chronic dieting	9.4 (81)	16.0 (98)	**<0.001**	9.3 (7.7, 11.1)	14.5 (12.0, 17.4)	**<0.001**
UWCB	43.3 (372)	66.5 (398)	**<0.001**	47.9 (44.0, 51.8)	64.5 (60.7, 68.1)	**<0.001**
EWCB	7.3 (62)	20.8 (125)	**<0.001**	6.7 (5.4, 8.3)	16.9 (13.8, 20.6)	**<0.001**
Overeating	14.5 (125)	29.0 (175)	**<0.001**	14.4 (12.8, 16.1)	26.0 (22.6, 29.7)	**<0.001**
Binge eating	7.4 (64)	18.5 (111)	**<0.001**	7.1 (5.5, 8.5)	15.3 (12.7, 18.2)	**<0.001**

Chi-square tests were used to estimate unadjusted percent.

Logistic regression models were used to estimate predicted prevalence and 95% confidence intervals for each outcome variable.

Predicted prevalence analyses adjusted for ethnicity/race, socioeconomic status, gender, body mass index (or body mass index percentile for EAT 2010 analyses), and clustering by baseline school status.

Weighted analyses

UWCB: unhealthy weight control behaviors

EWCB: extreme weight control behaviors

Longitudinal Findings and Graded Relationship between Weight Teasing and Disordered Eating

In the longitudinal adjusted analyses, weight teasing was associated with higher incidence of dieting and higher prevalence of both dieting and overeating (Table 3-3). For example, new onset dieting was higher in young adults who had experienced weight teasing during adolescence (48.4%, 95% CI: 41.5-55.2%) when compared to those who had not been teased (38.0%, 95% CI: 34.7-41.3%). For all cross-sectional and longitudinal main effects models, post hoc analyses reveal that the odds of DEBs were higher amongst participants experiencing more frequent weight teasing (see Supporting Information, Tables 3-6 and 3-7).

Table 3-3. Longitudinal relationships of disordered eating behaviors at 8-year follow-up by weight teasing status at baseline: unadjusted and adjusted estimates, restricted to participants without the outcome at baseline (Incidence) and full sample (Predicted Prevalence)

Incidence – sample restricted to participants without the outcome at baseline							
Outcome	Total†	Unadjusted Estimates % (n)		p-value	Adjusted Estimates % (95% CI)		p-value
		Not Teased	Teased		Not Teased	Teased	
Dieting	918	38.5 (264)	50.7 (118)	**0.001**	38.0 (34.7, 41.3)	48.4 (41.5, 55.2)	**0.016**
Chronic dieting	1361	9.6 (89)	12.3 (54)	0.130	8.9 (7.2, 11.0)	10.1 (7.1, 14.1)	0.579
UWCB	840	29.8 (249)	49.2 (105)	**0.016**	40.1 (36.5, 43.7)	45.9 (37.0, 55.0)	0.243
EWCB	1439	10.3 (99)	15.7 (75)	**0.003**	9.4 (7.6, 11.5)	11.6 (8.4, 15.9)	0.264
Overeating	1298	16.4 (149)	20.4 (79)	0.081	15.8 (13.6, 18.4)	16.5 (12.9, 21.0)	0.681
Binge eating	1371	9.4 (88)	13.4 (58)	**0.025**	8.8 (7.2, 10.7)	10.0 (8.1, 12.2)	0.467
Predicted Prevalence – full sample							
	Total‡	Unadjusted Percent (n)		p-value	Predicted Prevalence (95% CI)		p-value
		Not Teased	Teased		Not Teased	Teased	
Dieting	1518	48.5 (485)	63.0 (326)	**<0.001**	50.9 (47.3, 54.5)	58.6 (54.1, 63.4)	**0.013**
Chronic dieting	1518	10.7 (106)	15.4 (80)	**0.007**	9.9 (8.2, 12.1)	12.0 (9.1, 15.6)	0.255
UWCB	1503	47.7 (472)	61.4 (316)	**<0.001**	50.5 (48.0, 53.1)	56.7 (50.1, 63.0)	0.100
EWCB	1509	11.0 (109)	16.1 (83)	**0.005**	10.1 (8.3, 12.4)	11.8 (8.8, 15.7)	0.402
Overeating	1511	17.7 (176)	25.2 (130)	**<0.001**	17.2 (15.1, 19.5)	20.4 (17.7, 23.5)	**0.028**
Binge eating	1507	9.9 (98)	15.6 (80)	**0.001**	9.2 (7.5, 11.3)	11.6 (9.9, 13.6)	0.070

Chi-square tests estimated unadjusted percent. Logistic regression models adjusted for sociodemographic characteristics, weight status, and clustering by school status estimated incidence and longitudinal prevalence. Weighted analyses; UWCB: unhealthy weight control behaviors; EWCB: extreme weight control behaviors † Incidence represents the number of participants without the outcome at baseline. ‡ Predicted prevalence, represents the total number of participants.

Weight Teasing and Disordered Eating Across Demographic Groups

The prevalence of weight teasing and all DEBs except overeating during young adulthood, was higher among BIPOC participants when compared to white participants, with statistically significant differences in weight teasing during young adulthood; dieting, chronic dieting, and UWCB at both time points; and EWCB during adolescence (Tables 3-4 and 3-5). The same trend was true for baseline SES and gender. For weight teasing and all DEBs except chronic dieting and overeating during young adulthood, the prevalence was higher in participants from low SES backgrounds than higher SES backgrounds with statistically significant differences in weight teasing and dieting during adolescence, UWCB at both time points, and EWCB during young adulthood. Weight teasing and all DEBs were higher in female compared to male participants with statistically significant differences in all measures except weight teasing during young adulthood and chronic dieting at both time points. When interaction terms were added to statistical models, there was no evidence that the relationship between weight teasing and DEBs varied by ethnicity/race, baseline SES, or gender.

Table 3-4. Prevalence of weight teasing and disordered eating behaviors by sociodemographic variables at baseline (EAT 2010, adolescence), unadjusted estimates

Outcome or Predictor		Ethnicity/Race			Socioeconomic Status			Gender		
	Total % (n)	BIPOC % (n)	White % (n)	p-value	Low SES % (n)	Higher SES % (n)	p-value	Female % (n)	Male % (n)	p-value
Total	n/a	80.9 (1237)	19.1 (292)	n/a	39.5 (588)	60.5 (901)	n/a	53.7 (823)	46.3 (711)	n/a
Weight teasing	34.1 (523)	34.6 (427)	32.4 (94)	0.482	38.9 (229)	31.1 (280)	**0.002**	36.6 (301)	31.3 (222)	**0.029**
Dieting	39.5 (604)	42.4 (523)	27.4 (80)	**<0.001**	44.5 (262)	36.0 (323)	**0.001**	44.2 (364)	34.0 (240)	**<0.001**
Chronic dieting	10.3 (158)	11.5 (142)	5.0 (15)	**0.001**	10.8 (64)	9.5 (86)	0.415	10.7 (88)	9.9 (70)	0.622
UWCB	43.6 (665)	46.7 (574)	30.8 (89)	**<0.001**	51.0 (299)	38.7 (346)	**<0.001**	49.4 (405)	37.0 (261)	**<0.001**
EWCB	4.2 (64)	4.8 (59)	2.0 (6)	**0.033**	5.2 (31)	3.6 (32)	0.132	5.5 (45)	2.8 (20)	**0.009**
Overeating	13.3 (202)	13.8 (169)	11.2 (33)	0.243	14.0 (82)	12.5 (112)	0.385	17.4 (142)	8.5 (60)	**<0.001**
Binge eating	7.9 (120)	8.4 (103)	6.0 (17)	0.169	8.6 (50)	7.1 (63)	0.290	10.0 (81)	5.4 (38)	**0.001**

Weighted chi-square tests were used to estimate prevalence measures; UWCB: unhealthy weight control behaviors; EWCB: extreme weight control behaviors; BIPOC: Black, Indigenous, and People of Color; SES: socioeconomic status

Table 3-5. Prevalence of weight teasing and disordered eating behaviors by sociodemographic variables at follow-up (EAT 2018, young adulthood), unadjusted estimates

Outcome or Predictor		Ethnicity/Race			Socioeconomic Status			Gender		
	Total % (n)	BIPOC % (n)	White % (n)	p-value	Low SES % (n)	Higher SES % (n)	p-value	Female % (n)	Male % (n)	p-value
Total	n/a	80.9 (1237)	19.1 (292)	n/a	39.5 (588)	60.5 (901)	n/a	53.7 (823)	46.3 (711)	n/a
Weight teasing	41.5 (618)	43.7 (523)	32.4 (93)	**<0.001**	44.7 (254)	39.5 (346)	0.053	42.6 (340)	40.3 (278)	0.383
Dieting	53.4 (811)	56.1 (686)	42.2 (122)	**<0.001**	55.9 (325)	51.9 (464)	0.139	58.0 (472)	48.1 (339)	**<0.001**
Chronic dieting	12.3 (186)	13.3 (163)	7.6 (22)	**0.007**	11.9 (69)	12.7 (114)	0.623	13.7 (112)	10.6 (74)	0.063
UWCB	52.4 (788)	54.9 (665)	41.9 (120)	**<0.001**	58.8 (339)	49.0(432)	**<0.001**	56.2 (453)	48.0 (335)	**0.002**
EWCB	12.7 (192)	13.5 (164)	9.5 (27)	0.068	16.5 (95)	10.6 (94)	**0.001**	17.7 (143)	7.0 (49)	**<0.001**
Overeating	20.2 (306)	19.8 (241)	22.1 (63)	0.377	19.6 (113)	20.7 (184)	0.618	23.8 (193)	16.1 (113)	**<0.001**
Binge eating	11.8 (178)	12.1 (146)	10.6 (30)	0.489	13.3 (76)	11.2 (99.0)	0.222	15.6 (126)	7.5 (52)	**<0.001**

Weighted chi-square tests were used to estimate prevalence measures; UWCB: unhealthy weight control behavior; EWCB: extreme weight control behaviors; BIPOC: Black, Indigenous, and People of Color; SES: socioeconomic status

3.D. Discussion

In a primarily lower SES, ethnically/racially diverse population-based sample of young people, the experience of weight teasing was common. Weight teasing predicted a higher prevalence of DEBs, including dieting, chronic dieting, UWCB, EWCB, overeating, and binge eating, although the prevalence of DEBs was high in all participants, regardless of whether they had been teased about their weight. These associations were statistically significant in the fully adjusted cross-sectional models during both adolescence and young adulthood. There were fewer observed associations in the longitudinal analyses, although weight teasing during adolescence significantly predicted prevalent overeating and both incident and prevalent dieting eight years later. Both weight teasing and DEBs were more prevalent among BIPOC young people compared to white young people, among low SES young people compared to higher SES young people, and among female compared to male participants. In this sample, the relationship between weight teasing and DEBs did not vary by ethnicity/race, SES, or gender.

These findings are consistent with our hypotheses and align with previous studies, indicating that the experience of weight stigma predicts engagement in DEBs in young people both cross-sectionally [14,23,149] and longitudinally [20–22]. For example, in a cohort of 14-year-old African-American and white girls (n=4036), being labeled "fat" by family members was associated with more disordered eating five years later and these findings did not vary by race [21]. Our study adds to this longitudinal evidence and suggests that the relationship between weight teasing and DEBs does not differ by gender, which aligns with some previous findings [14,28] but not others [20,22,149]. Overall, our findings indicate that weight teasing may be harmful to young people regardless of sociodemographic characteristics.

For many years, it was thought that weight teasing may be less harmful to the well-being of BIPOC youth when compared to white youth because of cultural differences in the meaning and intensity of weight teasing [154]. Moreover, a previous study by our research team in a cohort who were adolescents in the late 1990's found that girls who identified as Black, Asian-American, and Mixed/other race were less likely to be bothered by family-based weight teasing in comparison to white girls [101]. However, our data suggest that weight teasing may have deleterious effects on young people's health regardless of sociodemographic characteristics. One explanation for these findings is that generational changes have occurred since the late 1990's, and factors which link weight teasing to DEBs (e.g. body dissatisfaction) are now more ubiquitous among young people across sociodemographic characteristics [114]. It is also possible that, with regards to body dissatisfaction and the unrealistic thin white beauty ideal, young people who both live in larger bodies and identify as BIPOC have similar pressures to their white counterparts, but also have distinct experiences shaped by interconnected systems of weight stigma and racism [155].

This study found that (1) the relationship between weight teasing and DEBs did not vary based on ethnicity/race, SES or gender, (2) the prevalence of DEBs and weight teasing was higher in BIPOC, low SES, and female participants when compared to their respective counterparts. When taken together, these findings provide evidence against persistent assumptions that DEBs primarily affect young people who are affluent and white [148] and suggest that future studies should center the unique experiences of individuals more broadly oppressed by society such as young people who are BIPOC, low SES, female, or a combination of these identities. In addition, previous research has shown that young people living in larger bodies are disproportionately affected by both weight teasing and DEBs, and societal weight stigma, not biology, is thought to be the driving force for these associations [145,156]. Future studies should also investigate health disparities based on body size, including whether the relationship between weight teasing and DEBs differs by BMI.

Strengths and Limitations

Our study has several strengths. First, our large sample included socioeconomically and ethnically/racially diverse adolescents and young adults. This factor offered a unique opportunity to use a health equity framework to comprehensively investigate relationships between weight teasing and DEBs across demographic groups. Second, extensive pilot testing ensured that the survey items were developmentally appropriate for the study population. Third, our longitudinal design allowed for examination of the temporal nature of the relationship between weight teasing and DEBs. Several limitations should also be noted. We relied on self-reported measures, so recall bias may be a limitation. However, self-report is likely the best measure for certain variables, such as experiencing weight stigma. Also, weight teasing was assessed with a single item; future research should focus on the broad construct of weight stigma and use a comprehensive measure. Additionally, our longitudinal analyses did not assess whether weight teasing that persisted from adolescence to young adulthood was a risk factor for DEBs, but future studies should investigate this question to enhance understanding of these relationships. Due to low numbers, our "Mixed or Other Race" category included a heterogeneous group (Native Hawaiian or Pacific Islander, American Indian or Native American, Other, Other and another ethnicity/race), and the inability to consider these groups separately is a limitation. Finally, the binary nature of our gender variable and absence of data on sexual orientation are shortcomings, given that young people who identify as sexual minorities and/or gender minorities experience a higher prevalence of DEBs when compared to their respective straight and cisgender peers [157,158]. Future studies should inquire about sexual orientation and non-binary gender identity and should aim to ameliorate these health disparities.

Implications

Given that in our sample, weight teasing and DEBs were more prevalent in BIPOC young people and those from low SES backgrounds, innovative approaches to research and policy development may be required to meet the needs of these young people. To this end, it may be useful to directly engage young people from these demographic groups who have experienced weight teasing and seek their input to inform future approaches to research and prevention efforts. For example, while weight-based bullying is the most common reason for harassment among adolescents [3], it is often absent from anti-bullying policies in schools [159]. Young people could be asked directly for their input on ways to make anti-bullying policies appropriately inclusive of weight-based harassment. Additional targets to help mitigate the potential harms of weight teasing and other forms of weight-based mistreatment may be primary care providers, family members, coaches, teachers, and guidance counselors [97,160]. These initiatives should attend to the needs of young people from low SES backgrounds and BIPOC young people and should include legal protections for those who experience weight-based mistreatment.

3.E. Conclusions

Our study found that weight teasing was cross-sectionally associated with DEBs during both adolescence and young adulthood. There were fewer longitudinal associations, although weight teasing during adolescence predicted new onset dieting, prevalent dieting, and prevalent overeating during young adulthood. The relationship between weight teasing and DEBs was similar across ethnicity/race, SES, and gender categories. Because both weight teasing and DEBs were more prevalent in BIPOC young people and those from low SES backgrounds, our findings demonstrate the importance of meeting the needs of young people from these demographic groups, and these efforts will likely require innovative approaches to future research and prevention efforts. Our findings add to the evidence that, when it comes to promoting health-supporting eating behaviors in young people, conveying stigma based on weight is not helpful and should be avoided by peers, family members, and healthcare providers.

Table 3-6. Cross-sectional Adjusted Analyses: Assessing whether higher weight teasing frequency is associated with higher odds of disordered eating behaviors

	Adolescence (EAT 2010)		Young Adulthood (EAT 2018)	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Dieting				
Group 1 vs Never	2.07	1.55, 2.77	1.90	1.46, 2.47
Group 2 vs Never	2.33	1.59, 3.42	1.75	1.17, 2.62
Chronic dieting				
Group 1 vs Never	1.36	0.88, 2.11	1.40	0.97, 2.04
Group 2 vs Never	3.48	2.19, 5.53	2.51	1.57, 4.02
UWCB				
Group 1 vs Never	1.82	1.39, 2.40	1.81	1.40, 2.35
Group 2 vs Never	2.65	1.83, 3.84	2.66	1.72, 4.10
EWCB				
Group 1 vs Never	2.28	1.23, 4.22	2.18	1.49, 3.19
Group 2 vs Never	3.90	2.02, 7.51	5.37	3.38, 8.54
Overeating				
Group 1 vs Never	2.43	1.68, 3.53	1.19	1.42, 2.60
Group 2 vs Never	4.59	3.00, 7.01	2.68	1.78, 4.06
Binge eating				
Group 1 vs Never	2.26	1.40, 3.65	1.99	1.35, 2.93
Group 2 vs Never	5.12	3.10, 8.47	3.61	2.24, 5.84

Group 1: Reported weight teasing less than once a year and reported weight teasing a few times a year

Group 2: Reported weight teasing a few times a month and reported weight teasing at least once a week

Never: Reported never experiencing weight teasing

Logistic regression models were used to estimate odds ratios and 95% confidence intervals for each outcome variable.

Models adjusted for ethnicity/race, socioeconomic status, gender, body mass index (or body mass index percentile for EAT 2010 analyses), and clustering by baseline school status.

Weighted analyses

UWCB: unhealthy weight control behaviors

EWCB: extreme weight control behaviors

Table 3-7. Longitudinal Adjusted Analyses: Assessing whether higher weight teasing frequency during adolescence is associated with higher odds of disordered eating behaviors eight years later

	Incident Outcomes		Prevalent Outcomes	
	Odds Ratio	95% Confidence Interval	Odds Ratio	95% Confidence Interval
Dieting				
Group 1 vs Never	1.44	0.98, 2.11	1.30	0.98, 1.73
Group 2 vs Never	1.76	1.02, 3.03	1.51	1.03, 2.21
Chronic dieting				
Group 1 vs Never	0.99	0.64, 1.54	0.97	0.65, 1.45
Group 2 vs Never	1.51	0.88, 2.60	1.82	1.16, 2.85
UWCB				
Group 1 vs Never	1.21	0.83, 1.79	1.25	0.95, 1.65
Group 2 vs Never	1.41	0.79, 2.53	1.34	0.93, 1.94
EWCB				
Group 1 vs Never	1.26	0.85, 1.87	1.13	0.77, 1.65
Group 2 vs Never	1.29	0.77, 2.16	1.30	0.81, 2.10
Overeating				
Group 1 vs Never	1.05	0.73, 1.51	1.18	0.86, 1.62
Group 2 vs Never	1.07	0.64, 1.80	1.37	0.91, 2.05
Binge eating				
Group 1 vs Never	1.17	0.77, 1.78	1.20	0.81, 1.78
Group 2 vs Never	1.11	0.62, 2.00	1.49	0.92, 2.42

Group 1: Reported weight teasing less than once a year and reported weight teasing a few times a year

Group 2: Reported weight teasing a few times a month and reported weight teasing at least once a week

Never: Reported never experiencing weight teasing

Logistic regression models were used to estimate odds ratios and 95% confidence intervals for each outcome variable.

Models adjusted for ethnicity/race, socioeconomic status, gender, body mass index percentile, and clustering by baseline school status.

Weighted analyses

UWCB: unhealthy weight control behaviors

EWCB: extreme weight control behaviors

3.F. Supporting Information

Description of the Socioeconomic Status variable using Classification Tree Methodology

Classification and Regression Trees were initially used in the original Project EAT I-IV cohort, and the same methodology was also used in the EAT 2010-2018 cohort [75,131,161]. The primary factor used to determine socioeconomic status (SES) was parental education level, defined by the highest level of any parent. For parental education level, response options were “did not finish high school; finished high school or general equivalency diploma; some college or training after high school; finished college; advanced degree (e.g. Master’s degree, PhD, MD); and I don’t know.” Additional variables used to estimate SES included family eligibility for public assistance (yes/no/I don’t know), eligibility for free or reduced-cost school meals (yes/no/I don’t know), and employment status of mother and father (full-time/part-time/not working/I don’t know). To avoid misclassifying young people as high SES, an algorithm was developed. The algorithm prevented a young person from being classified as high SES if parental education levels were high, but the family was receiving public assistance, were eligible for free or reduced-cost school meals, or had two unemployed parents (or one unemployed parent if from a single-parent household). When data was missing or “I don’t know” responses were given for both parents’ education level, these variables (public assistance, free or reduced-cost school meals, and two unemployed parents) were used to assess SES. In the original EAT I-IV cohort, the use of Classification and Regression Trees showed that receiving public assistance, being eligible for free or reduced-cost school meals, or having two unemployed parents were predictive of parental education and reduced the percentage of missing values for the SES variable to 4.1% (n=196) [161].

Chapter 4

Are cross-sectional and longitudinal relationships between weight-stigmatizing experiences and disordered eating behaviors influenced by family and parenting factors in a sample of adolescents?

Purpose: Weight stigma is a prevalent adolescent problem and a risk factor for disordered eating behaviors (DEBs). This study examined the relationship between weight-stigmatizing experiences and DEBs in an ethnically/racially and socioeconomically diverse sample of young people. It also examined whether positive family/parenting factors were protective for DEBs among adolescents with and without weight-stigmatizing experiences.

Methods: In Project EAT 2010-2018, 1568 adolescents (mean age=14.4±2.0 years) were surveyed and followed into young adulthood (mean age=22.2±2.0 years). Modified Poisson regression models assessed the relationships between four weight-stigmatizing experiences and four DEBs in models adjusted for sociodemographic characteristics and weight status. Interaction terms and stratified models assessed whether family/parenting factors were protective for DEBs based on weight stigma status.

Results: In main effects cross-sectional and longitudinal models, weight-stigmatizing experiences were associated with higher prevalence of DEBs or associations were null. Stratified models revealed that higher family functioning and support for psychological autonomy were protective for DEBs, particularly in adolescents who did not experience weight stigma. However, these factors did not fully buffer the relationship between weight-stigmatizing experiences and DEBs.

Conclusions: General positive family and parenting factors did not entirely offset the effects of weight-stigmatizing experiences on DEBs, which may reflect the strength of weight stigma as a risk factor for DEBs. Published guidelines for healthcare providers recommend that they screen for and address weight stigma experienced by youth. Future research should build upon these guidelines and aim to understand effective strategies family members can use to support youth who experience weight stigma.

4.A. Introduction

Weight stigma is a prevalent problem in adolescents [3,4] associated with adverse psychosocial health outcomes such as higher prevalence of body dissatisfaction [15,19], low self-esteem [15,17,26,27], school avoidance [25], depressive symptoms [15–17], self-harm behaviors [15], social isolation [24], and substance use [18]. A growing body of evidence demonstrates that experiencing weight stigma during adolescence is predictive of disordered eating behaviors (DEBs) [14,20–23,100], including our previous study which found these relationships persist across ethnic/racial, socioeconomic, and gender subgroups [100]. DEBs are symptoms of clinical eating disorders such as binge eating, purging, and food restriction used to control body shape or size [76]. These subclinical behaviors are prevalent in adolescents and young adults [76,144] and are associated with their own detrimental health consequences [64–66].

Prior studies have shown that the family environment and parenting factors are an important source of support for young people and play a crucial role in adolescent health and psychosocial development [77,86–88]. Studies have also shown that specific positive family and parenting factors, such as higher family functioning and parental support for psychological autonomy, provide a key form of social support for adolescents, play a vital role in identity formation, and have influence on adolescents' overall health and well-being [77–80]. Family functioning includes communication within the family, problem solving, affective responsiveness, structural and organizational properties of the family unit, and unconditional acceptance of family members [77–79]. Parental support for psychological autonomy is the absence of coercion and manipulation of the adolescent [78,79].

Further, evidence suggests that higher family functioning and parental support for psychological autonomy are protective for DEBs in young people [77,83–85]. Family functioning and support for psychological autonomy are considered more modifiable than parenting styles (e.g., permissive, authoritarian, neglectful, authoritative) and are thus potentially more effective targets for public health interventions [25,30,31]. Thus, it is important to determine whether these factors might be potent enough to counteract the ill effects of weight stigma on DEB risk in young people. Understanding these relationships might identify factors that could diminish the harmful effects of weight stigma. It may be that strong family functioning and parental support for psychological autonomy are protective for adolescents who have experienced weight stigma [90]. A review of the literature identified no previously published studies investigating this research question.

The present study fills an important gap in the adolescent health literature by examining the relationships between weight-stigmatizing experiences and DEBs, and whether family functioning and parental support for psychological autonomy operate as buffers in these relationships. Cross-sectional and longitudinal analyses were conducted in an ethnically/racially and socioeconomically diverse sample of adolescents. Relationships were tested using four types of weight-stigmatizing experiences: general weight teasing (from any source), peer weight teasing, family weight teasing, hurtful weight-related comments from family; and four DEBs including unhealthy weight control behaviors, extreme weight control behaviors, overeating, and binge eating. We hypothesized that weight-stigmatizing experiences would be cross-sectionally and longitudinally associated with higher prevalence of DEBs. Based on literature suggesting that high family functioning and parental support for psychological autonomy are protective for DEBs, we hypothesized that these positive family and parenting factors would have a protective effect on DEBs, especially for young people who experienced weight stigma. Elucidating these relationships in diverse study populations may improve understanding of potentially modifiable family and parenting factors as targets for public health and clinical interventions and provide direction for future research aimed at mitigating the harmful effects of weight stigma experienced by young people.

4.B. Methods

Study Design and Participants

Participants were drawn from EAT 2010-2018 (Eating and Activity over Time), a population-based, longitudinal study designed to examine weight control behaviors, dietary intake, physical activity, and psychosocial and structural factors associated with these outcomes in young people [113]. The EAT 2010-2018 study population included adolescents (mean age=14.4± 2.0 years) recruited from 20 public middle and high schools in Minneapolis/St. Paul, Minnesota. Anthropometric measures and classroom surveys were completed in 2009-2010 [114], and follow-up surveys were completed via mail or online in 2017-2018 (mean age=22.2 ± 2.0 years) [162]. Participants were excluded from this study if they did not complete at least 25% of the survey at both baseline and follow-up. The analytic sample size was 1568. All protocols were approved by the University of Minnesota's Institutional Review Board Human Subjects Committee

(Federal Wide Assurance number FWA00000312) and followed all applicable institutional guidelines. All participants provided assent and had consent from a parent/guardian prior to enrolling in this study. For simplicity, both parents and guardians will be referred to as “parents” for the remainder of this article.

The ethnic/racial distribution of the study population was 19.9% Asian American, 29.1% Black/African American, 17.0% Latinx/Hispanic, 15.2% mixed/other, and 18.8% white. Socioeconomic status (SES) distribution was 39.4% low, 22.2% low middle, 17.9% middle, 13.1% upper middle, 7.5% high. Gender distribution was 46.3% male, 53.1% female, and 0.6% different identity.

Survey Development

The EAT 2010 and EAT 2018 surveys were used to collect all data utilized in this study, including exposure and outcome variables, covariates, and potential effect modifiers. Focus groups with young people informed the development of the EAT 2010 and EAT 2018 surveys, and both surveys were found to be psychometrically sound for the age groups studied [114,162,163]. The EAT 2018 survey was developed using items from the EAT 2010 survey, which allowed for longitudinal comparisons [113]. In developing the EAT 2018 survey, decisions to retain or drop items from EAT 2010 were based on their relevance to aims of this longitudinal study, their use in earlier analyses, and the performance of represented constructs in the peer-reviewed literature. Changes were also made to reflect secular trends and participants’ developmental transition from adolescence to young adulthood. Item wording and response options for all survey measures are presented in Table 4-1.

Exposure Variables

Weight-stigmatizing experiences were assessed using self-reported items at baseline. They included general weight teasing, peer weight teasing, family weight teasing, and hurtful weight-related comments from family (Table 4-1).

Outcome Variables

At baseline and follow-up, disordered eating behaviors were assessed using four separate variables: unhealthy weight control behaviors (UWCB), extreme weight control behaviors (EWCB), overeating, and binge eating (Table 4-1).

Potential Effect Modifiers

Family functioning and parental support for psychological autonomy were assessed at baseline (Table 4-1).

Sociodemographic Characteristics and Weight Status

Age, ethnicity/race, socioeconomic status, and weight status were assessed at baseline; gender was assessed at follow-up (Table 4-1).

Table 4-1. Survey Items

Measure	Description
Weight-Stigmatizing Experiences: Exposure Variables Assessed at Baseline (EAT 2010)	
General Weight Teasing†	The following question assessed general weight teasing, "How often do any of the following things happen? ..... You are teased about your weight." Responses were: "never, less than once a year, a few times a year, a few times a month, and at least once a week" [120] (test-retest reliability=85%)."Never" was coded as "no"; remaining responses were coded as "yes."
Peer Weight Teasing	Peer weight teasing was assessed with the following question, "Have you ever been teased or made fun of by other kids because of your weight?" (test-retest reliability =98%). Response options included "yes" and "no" and were coded as such.
Family Weight Teasing	Family weight teasing was assessed with the following question [14], "Have you ever been teased or made fun of by family members because of your weight?" (test-retest reliability=96%). Response options included "yes" and "no" and were coded as such.
Hurtful Weight-Related Comments from Family†	The construct hurtful weight-related comments from family was assessed with the following question, "How often do family members make comments to you about your weight or your eating that make you feel bad?" Response options included: "never, less than once a year, a few times a year, a few times a month, a few times a week." "Never" was coded as "no"; remaining responses were coded as "yes."
Disordered Eating Behaviors: Outcome Variables Assessed at Baseline (EAT 2010) and Follow-up (EAT 2018)	
Unhealthy weight control behaviors (UWCB)	UWCB were assessed with the measure developed previously by our team [75]. Participants were asked, "Have you done any of the following things in order to lose weight or keep from gaining weight during the past year?" Responses included "fasted, ate very little food, used a food substitute, skipped meals, smoked more cigarettes, took diet pills, made myself vomit, used laxatives, and used diuretics" (test-retest reliability=85%). A positive response for one or more behaviors was coded as "yes," and no positive responses was coded as "no."

Extreme Weight Control Behaviors (EWCB)	Consistent with our prior use of this measure [75], the following UWCB items were further categorized as EWCB: "took diet pills, made myself vomit, used laxatives, and used diuretics" [75,120]. (test-retest reliability=96%). A positive response for one or more behaviors was coded as "yes," and no positive responses was coded as "no."
Overeating	The Questionnaire on Eating and Weight Patterns-Revised [151], a measure with good psychometric properties in adolescents [152] was adapted to assess overeating and binge eating. To assess overeating, participants were asked, "In the past year, have you ever eaten so much food in a short period of time that you would be embarrassed if others saw you (binge-eating)?" (test-retest reliability=89%).
Binge Eating	To assess binge eating, participants who answered "yes" to the overeating item were additionally asked, "During the times when you ate this way, did you feel you couldn't stop eating or control what or how much you were eating?" (test-retest reliability=75%).
Family and Parenting Factors: Potential Effect Modifiers	
Family Functioning	The General Functioning Scale of the Family Assessment Device [81,82] measures communication among family members, as well as other patterns like affective responsiveness, problem solving, behavior control, and structural and organizational properties of the family unit. Prior work has demonstrated high internal consistency (Cronbach's α=0.92; test-retest reliability=0.71) for this scale with populations diverse in ethnicity/race and socioeconomic status. [77,81,82]. Six items from the General Functioning Scale of the FAD were used to assess family functioning. Adolescents completed these survey items and they included, "How strongly do you agree with the following statements? For these questions, think about your family in general (including your parents and your brothers and sisters) (1) Family members are accepted for who they are; (2) Making decisions is a problem for the family; (3) We don't get along well together; (4) We can express feelings to each other; (5) Planning family activities is difficult because we misunderstand each other; (6) We confide in each other (By 'confide' we mean to trust your family members enough to tell them something that is important to you)." Response options were "strongly disagree, somewhat disagree, somewhat agree, strongly agree." For scoring, statements were first converted to the positive form; response options were then assigned a value (1-4); then scores were summed. Responses ranged from 6 to 24. Higher scores represented higher family functioning; Cronbach's alpha was 0.70 [77].

Parental Support for Psychological Autonomy	Parental support for psychological autonomy was developed based on the family social science literature and Barber's research which identifies that it is one of three key parenting practices that are protective in supporting healthy adolescent development [77–79]. To assess this construct, adolescents were asked, "My mother/father is a person who …. (1) is always trying to change how I feel or think about things; (2) brings up past mistakes when she/he criticizes me; (3) is less friendly with me if I do not see things her/his way." Response options were, "not like her/him, somewhat like her/him, a lot like her/him." Responses were summed together for each parent/guardian. For adolescents who responded about two parents, the average score for both parents was used (Cronbach's alpha=0.79, test-retest reliability=0.70) [77].
Sociodemographic Characteristics and Weight Status	
Age	Participants self-reported birthdate at baseline, and age was derived from this date and the survey completion date.
Gender	The following question was used to assess gender at EAT 2018 (the follow-up time point), "Are you….?" Male, Female, Different identity (please specify): ____."
Socioeconomic Status (SES)	Classification tree methodology was used to create five SES categories generate five categories of adolescent SES [75,131]. The primary variable used was parental education attainment (highest level, if more than one parent). Subsidiary variables used to estimate SES included parental employment status, household receipt of public assistance, household eligibility for free/reduced price lunch.
Ethnicity/Race	At baseline, the following question was used to assess ethnicity/race: "Do you think of yourself as…? White, Black or African American, Hispanic or Latino, Asian American, Native Hawaiian or Pacific Islander, American Indian or Native American, or Other: ____." Native Hawaiian or Pacific Islander, American Indian or Native American, and Other were coded together as "Mixed or Other Race"; this decision was made because of small numbers of participants in those categories (test-retest reliability=98=100%) [75,114].
Weight Status	Standardized procedures were used by trained staff to measure height and weight in a private area at baseline. The Centers for Disease Control and Prevention guidelines were then used to calculate BMI-for-age percentile[130].

† Previous studies have demonstrated that any reported experience of weight stigma (when compared to no experience) is associated with adverse health outcomes [14,15,22]. Therefore, dichotomous variables were generated for general weight teasing and hurtful weight-related comments from family.

Statistical Analysis

Chi-square statistics were used to assess the difference in frequency and prevalence of weight-stigmatizing experiences by ethnicity/race, SES, and gender. T-tests were used to assess the mean and standard deviation of BMI-for-age percentile by weight-stigmatizing experiences. Modified Poisson regression analyses examined the relationship between weight-stigmatizing experiences (general weight teasing, peer weight teasing, family weight teasing, hurtful weight-related comments from family) and disordered eating behaviors (UWCB, EWCB, overeating, binge eating), cross-sectionally at baseline and longitudinally. Model 1 was adjusted for ethnicity/race, SES, and gender; Model 2 was additionally adjusted for weight status. We consider measures of ethnicity/race, SES, gender, and weight status to be proxies for exposure to structural oppression (e.g., racism, classism, sexism, weight stigma); we acknowledge they are imperfect measures because of the heterogeneity of experiences within oppressed groups and inherent limitations associated with this type of categorization [95,100,136–138]. The threshold for statistical significance for these analyses was set *a priori* at $p<0.05$, and all exposure and outcome variables, potential confounders, and potential effect modifiers were selected *a priori*.

Family functioning and support for psychological autonomy were investigated as potential effect modifiers in the relationships between weight-stigmatizing experiences and DEBs. To achieve this goal, interaction terms between 1) family functioning and weight-stigmatizing experiences, and 2) support for psychological autonomy and weight-stigmatizing experiences were added to fully adjusted cross-sectional and longitudinal models (separate models). The threshold for statistical significance for interactions was set *a priori* at $p<0.1$. In models stratified by weight stigma status (yes/no), chi-square statistics were used to assess unadjusted associations between family and parenting factors and DEBs, and Modified Poisson regression analyses examined associations adjusted for ethnicity/race, SES, gender, and weight status. Family functioning and support for psychological autonomy both had distributions that were skewed slightly to the left. Therefore, the median, rather than the mean, was used to determine low/high family functioning and low/high support for psychological autonomy in stratified models.

Attrition did not occur completely at random; the analytic sample was more likely to identify as Black, Indigenous and other people of color (BIPOC), have parents/guardians with low educational attainment, and be born outside the United States. Therefore, inverse probability weighting was used for all analyses to account for missing data [140,141]; this method minimizes potential response bias and allows for extrapolation back to the baseline sample. Inverse probability weights were based on several participant characteristics obtained during EAT 2010 data collection (baseline) and were calculated using the invers of the estimated probability that a participant responded at both time points. All analyses were conducted using SAS 9.4 (Cary, NC, copyright 2002-2012).

4.C. Results

Weight-stigmatizing Experiences by Sociodemographic Characteristics

Weight-stigmatizing experiences were prevalent in our sample, with 34.1% of adolescents reporting general weight teasing [100], 26.6% reporting peer weight teasing, 24.2% reporting family weight teasing, and 41.6% reporting hurtful weight-related comments from family (Table 4-2). Lower SES and female gender were associated with higher prevalence of family weight teasing (Chi-square analysis – SES: $p=0.005$; gender: $p=0.008$) and hurtful weight-related comments from family (Chi-square analysis – SES: $p=0.003$; gender: $p<0.001$). Also, ethnicity/race was associated with family weight teasing with BIPOC participants reporting significantly higher prevalence than white participants and Asian Americans reporting the highest prevalence (Chi-square analysis – $p<0.001$). Ethnicity/race was also associated with hurtful weight-related comments from family members with Asian American participants reporting the highest prevalence, followed by participants with the following identities (highest to lowest prevalence): Latinx/Hispanic, mixed/other race, white, Black/African American (Chi-square analysis – $p<0.001$). Although, white participants' prevalence was not statistically different than that of participants with identities of Black/African American and mixed/other race. Peer weight teasing, family weight teasing, and hurtful weight-related comments were each associated with higher weight status during adolescence (Table 4-2, $p<0.001$ for each t-test).

Table 4-2. Weight-stigmatizing experiences by sociodemographic characteristics and weight status of adolescents in Minneapolis-St Paul, Minnesota (EAT 2010)

Characteristics	Mean±SD or % (n) Total	Peer Weight Teasing Mean ± SD or % (n) No	Yes	p-value	Family Weight Teasing Mean ± SD or % (n) No	Yes	p-value	Hurtful Weight-Related Comments from Family Mean ± SD or % (n) No	Yes	p-value
Total	1568	73.4 (1133)	26.6 (410)	n/a	75.8 (1167)	24.2 (373)	n/a	58.4 (900)	41.6 (640)	n/a
Ethnicity / Race (%)				0.952			**<0.001**			**<0.001**
Asian American	19.9 (311)	74.0 (228)	26.0 (80)		66.0 (203)	34.0 (105)[c]		42.6 (131)	57.4 (177)[c]	
Black/African American	29.1 (454)	74.5 (330)	25.5 (113)		76.8 (340)	23.2 (103)[b]		65.8 (290)	34.3 (151)[a]	
Latinx/ Hispanic	17.0 (265)	73.4 (192)	26.6 (70)		75.5 (198)	24.5 (64)[b]		54.2 (142)	45.8 (120)[bd]	
Mixed/Other Race	15.2 (238)	72.0 (167)	28.0 (65)		77.0 (177)	23.0 (53)[b]		61.7 (142)	38.3 (88)[ad]	
White	18.8 (294)	72.5 (213)	27.5 (81)		84.4 (247)	15.6 (46)[a]		65.5 (192)	34.5 (101)[a]	

Table 4-2. Continued.

Characteristics	Mean±SD or % (n) Total	Peer Weight Teasing Mean ± SD or % (n) No	Yes	p-value	Family Weight Teasing Mean ± SD or % (n) No	Yes	p-value	Hurtful Weight-Related Comments from Family Mean ± SD or % (n) No	Yes	p-value
Socioeconomic Status (%)				0.400			**0.005**			**0.003**
Low	39.4 (594)	71.2 (420)	28.8 (170)		72.5 (427)	27.6 (162)		53.7 (317)	46.3 (273)	
Low Middle	22.2 (334)	72.8 (241)	27.2 (90)		73.9 (244)	26.1 (86)		56.9 (187)	43.1 (142)	
Middle	17.9 (269)	77.7 (206)	22.3 (59)		77.6 (206)	22.4 (59)		61.5 (164)	38.5 (102)	
Upper Middle	13.1 (197)	73.4 (144)	26.6 (52)		77.9 (152)	22.1 (43)		62.2 (122)	37.8 (74)	
High	7.5 (113)	71.5 (80)	28.5 (32)		88.5 (99)	11.5 (13)		71.8 (80)	28.2 (32)	
Gender (%)†				0.546			**0.008**			**<0.001**
Male	46.3 (719)	74.4 (521)	25.6 (180)		79.1 (554)	20.9 (146)		64.5 (451)	35.5 (249)	
Female	53.1 (825)	72.5 (593)	27.5 (225)		72.8 (594)	27.3 (223)		53.1 (434)	46.9 (383)	
Different Identity	0.6 (9)	62.7 (6)	37.3 (3)		92.0 (8)	8.0 (1)		92.0 (8)	8.0 (1)	
BMI-for-age (percentile)	69.2 ± 27.9	66.5 ± 26.8	76.4 ± 29.4	**<0.001**	66.3 ± 28.2	78.3 ± 25.1	**<0.001**	64.7 ± 28.2	75.5 ± 26.2	**<0.001**

Weighted Chi-square and T-test analyses. [abcd] Within each outcome, cells that share a superscript do not significantly differ at $p < 0.05$. †Assessed at follow-up (EAT 2018). All other variables were assessed at baseline (EAT 2010). BMI: body mass index. Note: General Weight Teasing by ethnicity/race, socioeconomic status, gender, and BMI-for-age reported elsewhere [100].

Main Effects Results: Associations between Weight Stigma and Disordered Eating Behaviors

At baseline, weight-stigmatizing experiences were cross-sectionally associated with higher prevalence of DEBs for every weight stigmatizing experience-DEB relationship in main effects adjusted models (Table 4-3). For example, participants who experienced hurtful weight-related comments from family had 3.8 times the prevalence of binge eating compared to those who did not experience such comments after accounting for the effects of sociodemographic characteristics and weight status (PR: 3.81, 95% CI: 2.39, 6.05).

In longitudinal models, weight-stigmatizing experiences (general weight teasing, peer weight teasing, family weight teasing, and hurtful weight-related comments from family) during adolescence were associated with higher prevalence of DEBs (UWCB, EWCB, overeating, and binge eating) eight years later for all Model 1 analyses (adjusted for sociodemographic characteristics) except analyses examining the general weight teasing-EWCB and family weight teasing-binge eating relationships (Table 4-3). In Model 2 (adjusted for sociodemographic characteristics and weight status), results were attenuated with the family weight teasing-UWCB, hurtful weight-related comments from family-UWCB, and family weight teasing-EWCB relationships remaining statistically significant. For example, in the fully adjusted models, adolescents who experienced family weight teasing had 35% higher prevalence of EWCB eight years later, compared to those who did not experience such teasing (PR: 1.35, 95% CI: 1.02, 1.78).

Table 4-3. Examination of cross-sectional and longitudinal associations between weight-stigmatizing experiences and prevalence of disordered eating behaviors, adjusted main effects models

Weight-Stigmatizing Experience:	**Cross-sectional (EAT 2010)**		**Longitudinal (EAT 2010-2018)**	
	Unhealthy Weight Control Behaviors		**Unhealthy Weight Control Behaviors**	
	Prevalence Ratio (95% Confidence Interval)		Prevalence Ratio (95% Confidence Interval)	
	Model 1	Model 2	Model 1	Model 2
General Weight Teasing	1.53 (1.37, 1.72)*	1.38 (1.23, 1.54)*	1.21 (1.10, 1.34)*	1.08 (0.98, 1.19)
Peer Weight Teasing	1.55 (1.39, 1.74)*	1.37 (1.23, 1.53)*	1.17 (1.06, 1.30)*	1.01 (0.92, 1.12)
Family Weight Teasing	1.65 (1.48, 1.84)*	1.43 (1.27, 1.60)*	1.29 (1.17, 1.43)*	1.14 (1.03, 1.25)*
Hurtful Weight Comments from Family	1.70 (1.51, 1.92)*	1.50 (1.33, 1.70)*	1.28 (1.15, 1.41)*	1.14 (1.03, 1.26)*
	Extreme Weight Control Behaviors		**Extreme Weight Control Behaviors**	
	Prevalence Ratio (95% Confidence Interval)		Prevalence Ratio (95% Confidence Interval)	
	Model 1	Model 2	Model 1	Model 2
General Weight Teasing	3.21 (1.91, 5.39)*	2.87 (1.66, 4.97)*	1.30 (1.00, 1.70)	1.16 (0.88, 1.53)
Peer Weight Teasing	2.05 (1.24, 3.37)*	1.77 (1.02, 3.07)*	1.41 (1.08, 1.85)*	1.25 (0.94, 1.66)
Family Weight Teasing	2.25 (1.35, 3.75)*	1.93 (1.15, 3.22)*	1.51 (1.16, 1.98)*	1.35 (1.02, 1.78)*
Hurtful Weight Comments from Family	2.49 (1.44, 4.29)*	2.16 (1.17, 3.97)*	1.41 (1.07, 1.85)*	1.25 (0.94, 1.66)

Table 4-3. Continued

Weight-Stigmatizing Experience:	**Cross-sectional (EAT 2010)**		**Longitudinal (EAT 2010-2018)**	
	Overeating		**Overeating**	
	Prevalence Ratio (95% Confidence Interval)		Prevalence Ratio (95% Confidence Interval)	
	Model 1	Model 2	Model 1	Model 2
General Weight Teasing	2.75 (2.10, 3.60)*	2.57 (1.96, 3.37)*	1.38 (1.12, 1.69)*	1.17 (0.95, 1.44)
Peer Weight Teasing	1.99 (1.53, 2.59)*	1.84 (1.41, 2.41)*	1.35 (1.09, 1.68)*	1.16 (0.94, 1.44)
Family Weight Teasing	2.18 (1.67, 2.85)*	1.98 (1.51, 2.60)*	1.29 (1.03, 1.62)*	1.10 (0.88, 1.38)
Hurtful Weight Comments from Family	3.26 (2.42, 4.40)*	2.98 (2.17, 4.09)*	1.40 (1.13, 1.72)*	1.16 (0.94, 1.44)
	Binge Eating		**Binge Eating**	
	Prevalence Ratio (95% Confidence Interval)		Prevalence Ratio (95% Confidence Interval)	
	Model 1	Model 2	Model 1	Model 2
General Weight Teasing	3.00 (2.07, 4.37)*	2.87 (1.98, 4.17)*	1.44 (1.09, 1.91)*	1.24 (0.93, 1.65)
Peer Weight Teasing	2.00 (1.39, 2.88)*	1.81 (1.26, 2.59)*	1.47 (1.11, 1.95)*	1.26 (0.95, 1.69)
Family Weight Teasing	2.42 (1.66, 3.51)*	2.32 (1.59, 3.37)*	1.14 (0.82, 1.60)	1.04 (0.77, 1.40)
Hurtful Weight Comments from Family	4.09 (2.64, 6.33)*	3.81 (2.39, 6.05)*	1.33 (1.00, 1.75)*	1.11 (0.83, 1.49)

Model 1: adjusted for ethnicity/race, socioeconomic status, gender. Model 2: adjusted for ethnicity/race, socioeconomic status, gender, weight status. Weighted modified Poisson regression analyses. * Indicates $p<0.05$

Effect Modification and Stratified Unadjusted Results: The Relationship between Family/Parenting Factors and Disordered Eating Behaviors by Weight Stigmatizing Experiences in Adolescents

When interaction terms were added to fully adjusted cross-sectional models, the interaction ($p<0.1$ in 50% of models) suggested that family functioning and parental support for psychological autonomy operate as effect modifiers in the cross-sectional relationships between weight-stigmatizing experiences and DEBs. For longitudinal models, when interaction terms were added, few (<10%) had a p-value less than 0.1, suggesting that family functioning and parental support for psychological autonomy are not effect modifiers in these relationships. As a result of these findings, stratified models were examined for cross-sectional but not longitudinal analyses.

Stratified cross-sectional unadjusted models revealed that higher family and parenting factors were associated with lower prevalence of DEBs, which was consistent with our hypothesis. This pattern was primarily observed in adolescents who did not experience weight stigma. In adolescents who experienced weight stigma, the associations were in the expected direction – lower prevalence of DEBs was observed in the context of high (versus low) family functioning and support for psychological autonomy. However, many null associations were observed, thus in those instances, our hypothesis that positive family and parenting factors would have a protective effect on DEBs in young people who experience weight stigma was not supported.

The pattern of a protective relationship between positive family and parenting factors and DEBs for adolescents without weight-stigmatizing experiences and a null association for adolescents with weight stigmatizing experiences was observed for several of the family/parenting factor-DEB relationships (Tables 4-4 and 4-5). For example, in adolescents who did not experience family weight teasing, high support for psychological autonomy was associated with lower prevalence of UWCB (high support for psychological autonomy: 31.2%, low support for psychological autonomy: 46.5%, $p<0.001$). However, in participants who experienced family weight teasing, the difference in prevalence of UWCB based on support for psychological autonomy (high/low) was in the expected direction, but not statistically significant (high support for psychological autonomy: 62.3%, low support for psychological autonomy: 68.5%, $p=0.213$) (Table 4-4). In a second example, in adolescents who did not experience peer weight teasing, high family functioning was associated with lower prevalence of binge eating (high family functioning: 3.2%, low family functioning: 10.5%, $p<0.001$). In participants who experienced peer weight teasing, the difference in prevalence of binge eating based on family functioning (high/low) was in the expected direction but not statistically significant (high family functioning: 11.6%, low family functioning: 13.1%, $p=0.653$) (Table 4-5).

Table 4-4. Cross-sectional prevalences and frequencies of unhealthy and extreme weight control behaviors by weight-stigmatizing experiences, stratified by family/parenting factors, during adolescence (EAT 2010), unadjusted estimates

		Unhealthy Weight Control Behaviors % (n)			**Extreme Weight Control Behaviors** % (n)		
		Family Functioning			Family Functioning		
		Low	High	p-value	Low	High	p-value
Total		52.7 (366)	35.8 (303)	**<0.001**	6.3 (44)	2.7 (23)	**<0.001**
Any Weight Teasing	Yes	64.5 (192)	50.8 (112)	**0.002**	10.3 (31)	3.6 (8)	**0.004**
	No	44.0 (171)	30.6 (186)	**<0.001**	3.0 (12)	2.3 (14)	0.464
Peer Weight Teasing	Yes	65.8 (135)	52.6 (106)	**0.007**	8.5 (17)	4.5 (9)	0.105
	No	47.4 (230)	30.3 (192)	**<0.001**	5.2 (24)	2.0 (13)	**0.004**
Family Weight Teasing	Yes	68.7 (159)	60.3 (84)	0.100	8.5 (20)	5.5 (8)	0.293
	No	44.7 (204)	30.6 (213)	**<0.001**	5.1 (23)	2.0 (14)	**0.005**
Hurtful Family Weight Comments	Yes	65.2 (228)	53.4 (150)	**0.003**	8.8 (31)	4.7 (13)	**0.044**
	No	40.3 (135)	26.7 (148)	**<0.001**	3.6 (12)	1.8 (10)	0.091

Table 4-4. Continued

		Unhealthy Weight Control Behaviors % (n)			**Extreme Weight Control Behaviors** % (n)		
		Support for Psychological Autonomy			Support for Psychological Autonomy		
		Low	High	p-value	Low	High	p-value
Total		53.9 (345)	36.9 (324)	**<0.001**	6.4 (41)	2.9 (26)	**0.001**
Any Weight Teasing	Yes	65.4 (175)	51.8 (130)	**0.002**	8.3 (22)	6.6 (17)	0.471
	No	45.4 (166)	30.8 (192)	**<0.001**	4.6 (17)	1.4 (9)	**0.003**
Peer Weight Teasing	Yes	65.2 (132)	54.2 (110)	**0.025**	7.9 (16)	5.2 (10)	0.260
	No	48.7 (212)	31.5 (211)	**<0.001**	5.2 (25)	2.0 (13)	**0.004**
Family Weight Teasing	Yes	68.5 (144)	62.3 (97)	0.213	7.3 (15)	7.7 (12)	0.883
	No	46.5 (197)	31.2 (224)	**<0.001**	5.8 (25)	1.8 (13)	**<0.001**
Hurtful Family Weight Comments	Yes	66.4 (221)	53.2 (158)	**<0.001**	8.3 (28)	5.5 (16)	0.172
	No	40.7 (123)	28.3 (163)	**<0.001**	4.4 (13)	1.5 (8)	**0.007**

Weighted Chi-square analyses. All stratified results displayed here regardless of whether there was evidence of effect modification by family functioning and support for psychological autonomy. Bold p-value indicates statistical significance (p<0.05).

Table 4-5. Cross-sectional prevalences and frequencies of overeating and binge eating by weight-stigmatizing experiences, stratified by family/parenting factors, during adolescence (EAT 2010), unadjusted estimates

		Overeating % (n)			**Binge Eating** % (n)		
		Family Functioning			Family Functioning		
		Low	High	p-value	Low	High	p-value
Total		17.8 (123)	9.6 (81)	**<0.001**	11.2 (77)	5.2 (44)	**<0.001**
Any Weight Teasing	Yes	25.4 (75)	20.7 (45)	0.213	16.6 (49)	11.1 (24)	0.078
	No	12.0 (46)	5.8 (35)	**<0.001**	7.2 (28)	3.2 (19)	**0.004**
Peer Weight Teasing	Yes	23.2 (47)	19.6 (39)	0.385	13.1 (27)	11.6 (23)	0.653
	No	15.6 (75)	6.5 (41)	**<0.001**	10.5 (51)	3.2 (20)	**<0.001**
Family Weight Teasing	Yes	27.0 (62)	19.2 (27)	0.089	16.9 (39)	12.1 (17)	0.217
	No	13.2 (60)	7.6 (53)	**0.002**	8.5 (38)	3.8 (26)	**<0.001**
Hurtful Family Weight Comments	Yes	28.0 (98)	16.2 (45)	**<0.001**	18.7 (65)	9.3 (26)	**0.001**
	No	7.3 (24)	6.3 (35)	0.557	3.7 (12)	3.1 (17)	0.662

Table 4-5. Continued.

		Overeating % (n)			**Binge Eating** % (n)		
		Support for Psychological Autonomy			Support for Psychological Autonomy		
		Low	High	p-value	Low	High	p-value
Total		17.4 (112)	10.6 (92)	**<0.001**	11.3 (73)	5.6 (49)	**<0.001**
Any Weight Teasing	Yes	27.4 (74)	19.1 (47)	**0.026**	17.7 (47)	10.5 (26)	**0.020**
	No	10.0 (37)	7.2 (44)	0.119	6.6 (24)	3.6 (22)	**0.032**
Peer Weight Teasing	Yes	23.5 (47)	19.5 (39)	0.335	14.5 (29)	10.3 (20)	0.207
	No	14.8 (65)	7.8 (52)	**<0.001**	9.9 (43)	4.2 (28)	**<0.001**
Family Weight Teasing	Yes	27.0 (57)	20.9 (32)	0.185	15.9 (33)	14.5 (22)	0.721
	No	13.0 (56)	8.1 (57)	**0.007**	9.2 (39)	3.6 (26)	**<0.001**
Hurtful Family Weight Comments	Yes	25.7 (86)	19.6 (57)	0.069	17.5 (59)	11.3 (32)	**0.029**
	No	8.6 (26)	5.8 (33)	0.123	4.7 (14)	2.7 (16)	0.131

Weighted Chi-square analyses. All stratified results displayed here regardless of whether there was evidence of effect modification by family functioning and support for psychological autonomy. Bold p-value indicates statistical significance (p<0.05)

Stratified Adjusted Results: The Relationship between Family/Parenting Factors and Disordered Eating Behaviors, by Weight-Stigmatizing Experiences in Adolescents

Stratified analyses adjusted for sociodemographic characteristics and weight status also revealed that higher family functioning and support for psychological autonomy tended to be more protective for adolescents who did not experienced weight stigma when compared to those who experienced weight stigma (Figure 4-1). For example, higher support for psychological autonomy was significantly associated with 28% lower prevalence of UWCB in adolescents who did not experience peer weight teasing (PR: 0.72, 95% CI: 0.62, 0.84). Whereas, in adolescents who experienced peer weight teasing, higher support for psychological autonomy was not significantly associated with the prevalence of UWCB (PR: 0.85, 95% CI: 0.73, 1.00). Additionally, higher family functioning was significantly associated with 60% lower prevalence of overeating in adolescents who did not experience weight teasing (from any source) (PR: 0.40, 95% CI: 0.25, 0.63). In contrast, in adolescents who experienced weight teasing (from any source), higher family functioning was not significantly associated with the prevalence of overeating (PR: 0.82, 95% CI: 0.59, 1.15). None of the observed patterns in stratified models provided evidence that family functioning and support for psychological autonomy are more or less protective based on the source of weight stigma (e.g., whether it came from within or outside the family).

Figure 4-1. Differential Cross-Sectional Associations between Family Factors and Disordered Eating Behaviors by Weight-Stigmatizing Experiences

Figure 4-1A. Unhealthy Weight Control Behaviors and Family Factors by Weight-Stigmatizing Experiences - Prevalence Ratios

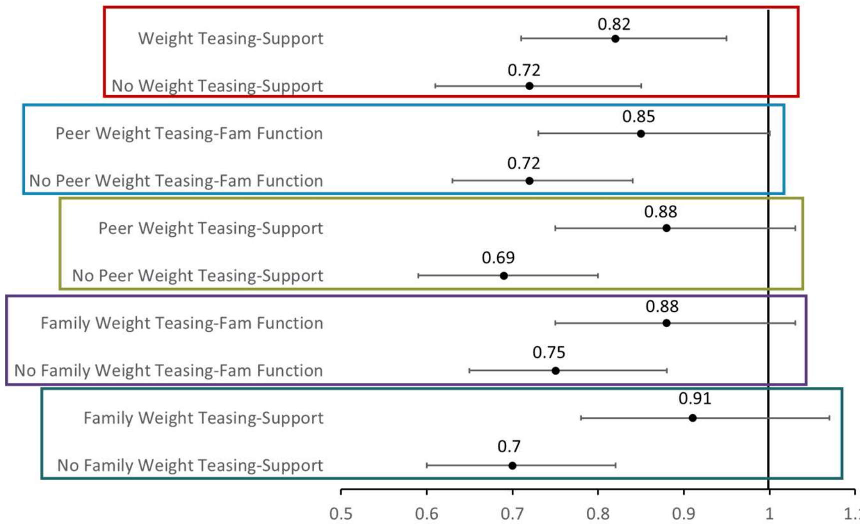


Figure 4-1B. Extreme Weight Control Behaviors and Family Factors by Weight-Stigmatizing Experiences - Prevalence Ratios

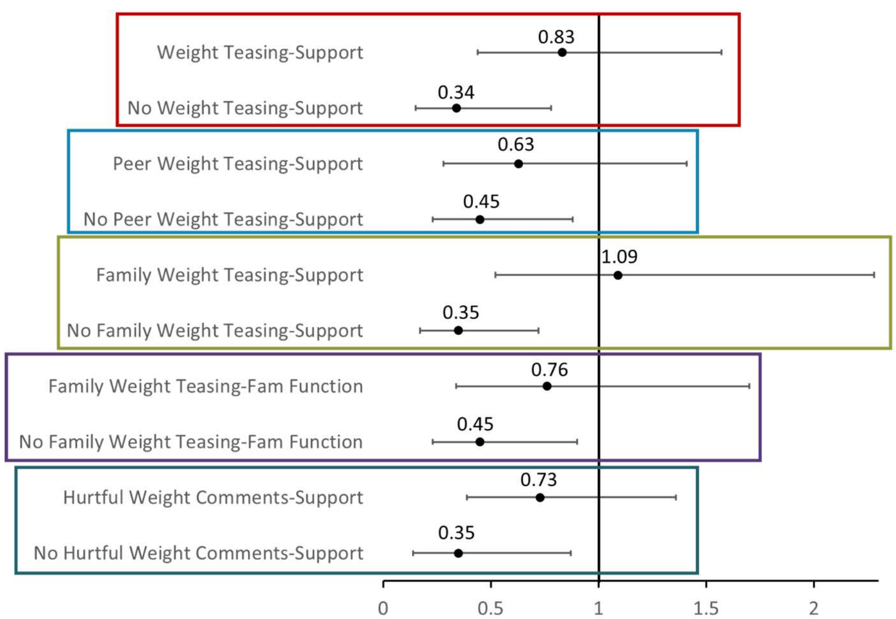


Figure 4-1C. Overeating and Family Factors by Weight-Stigmatizing Experiences - Prevalence Ratios

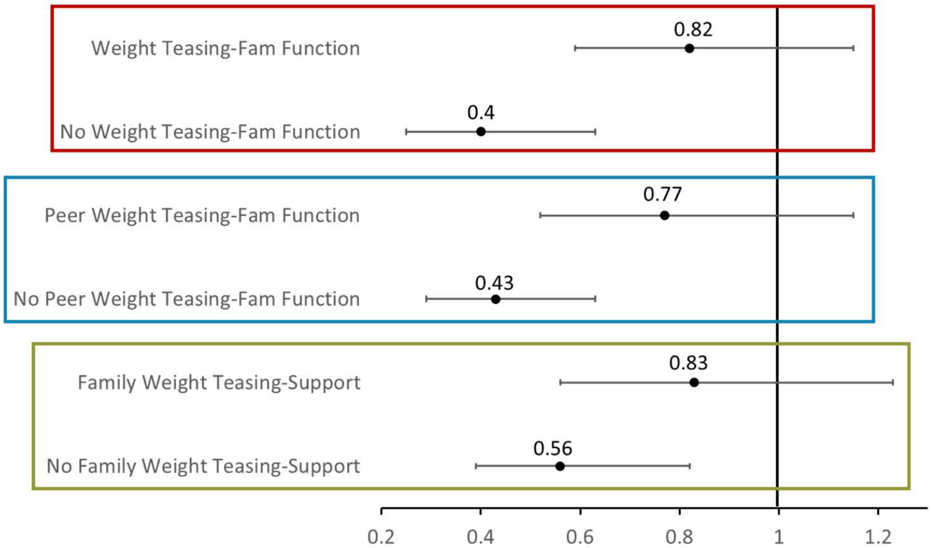
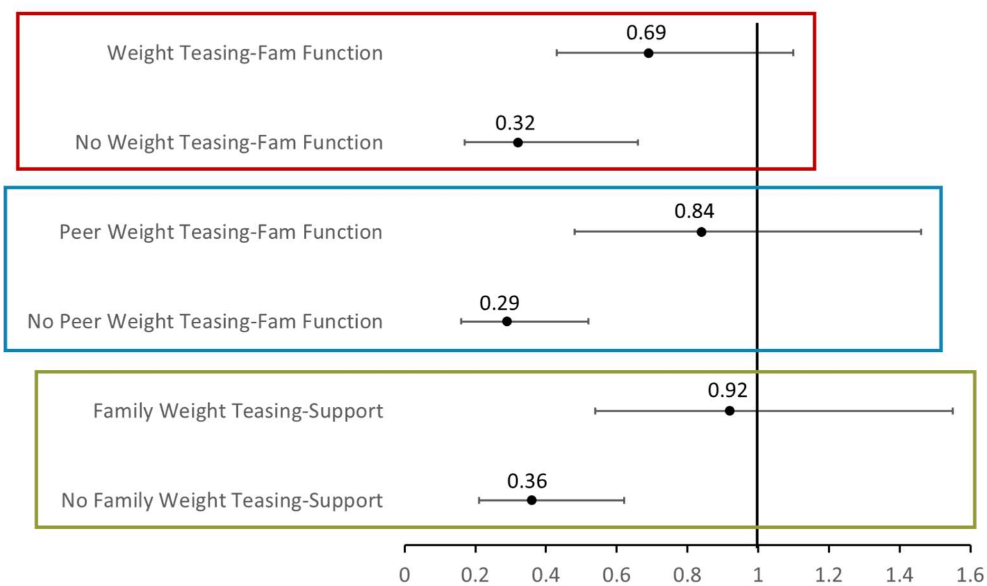


Figure 4-1D. Binge Eating and Family Factors by Weight-Stigmatizing Experiences - Prevalence Ratios



Interaction terms were added to the fully adjusted models to assess for effect modification by family functioning and support for psychological autonomy. When the interaction ($p<0.1$) suggested effect modification, stratified models were examined, and results are displayed here. Weighted modified Poisson regression analyses adjusted for ethnicity/race, socioeconomic status, gender, weight status; Support: Parental Support for Psychological Autonomy; Fam Function: Family Functioning

4.D. Discussion

The purpose of this study was to investigate cross-sectional and longitudinal relationships between weight-stigmatizing experiences and DEBs in young people and to assess whether positive family and parenting factors are protective for DEBs in adolescents who experience weight stigma. In main effects cross-sectional and longitudinal analyses, weight-stigmatizing experiences were associated with higher prevalence of DEBs in young people. There were some instances of null associations, but weight-stigmatizing experiences were never associated with lower prevalence of DEBs. These findings align with our hypothesis and strengthen prior evidence because of the socioeconomic and ethnic/racial diversity of our sample. High family functioning and support for psychological autonomy were associated with lower prevalence of DEBs, especially in adolescents who did not experience weight stigma. However, these positive family and parenting factors did not fully buffer the relationship between weight-stigmatizing experiences and DEBs, contrasting with our hypothesis. Thus, questions remain about how parents and other family members can be supportive and help mitigate DEB risk in their adolescent children who experience weight stigma.

Family members were a common source of weight stigma in this sample, with 24.2% of adolescents reporting family weight teasing and 41.6% reporting hurtful weight-related comments from family. Prior work has similarly found that weight stigma conveyed by family members is highly prevalent among adolescents, with some variation based on weight status, sexual orientation, and gender identity. For example, in Project EAT I-IV, a school-based sample of adolescents, 22.4% of participants endorsed family weight teasing [164]. Among a U.S. sample of adolescents identifying as sexual and gender minorities, 55.4% reported weight-based victimization from family members [18]. Also, in a United States sample of adolescents with high weight status seeking weight management care, 37% reported weigh teasing from parents [165].

Our study found that higher family functioning and higher support for psychological autonomy were associated with lower prevalence of DEBs in young people. However, stratified cross-sectional models adjusted for sociodemographic characteristics and weight status revealed that higher family functioning and support for psychological autonomy tended to be more protective for adolescents who did not experienced weight stigma when compared to those who experienced weight stigma. The reason for these findings may be that weight-stigmatizing experiences are powerful risk factors for DEBs that cannot be entirely offset by positive family and parenting factors. In sum, findings from this study build on prior evidence that higher family functioning and higher support for psychological autonomy are protective for DEBs and suggest that these factors are more likely to be protective in youth who do not experience weight stigma.

To our knowledge, this study is the first to examine the role of family functioning and parental support for psychological autonomy in the relationship between weight-stigmatizing experiences and DEBs in young people. Prior research has focused on family and parenting factors specific to weight and eating behaviors (e.g., parental restrictive feeding practices [88], weight-focused conversations [87], and encouragement to diet [86]) as risk factors for DEBs. It may be that parental support specific to weight and eating behaviors is needed to offset the effects of weight stigma on DEBs. However, these family and parenting constructs are difficult to clearly differentiate from weight-stigmatizing experiences. For example, in a qualitative study, young adults reflecting back on their childhood identified parental restrictive feeding practices as weight-stigmatizing experiences [166]. Additionally, a cross-sectional study found that parents' own weight-stigmatizing experiences and weight bias internalization were associated with more restrictive feeding practices [167]. Therefore, qualitative research may be important to further elucidate how parental restrictive feeding practices are linked with adolescents' experiences of weight stigma and whether parents' own weight-stigmatizing experiences are linked with DEB risk in their adolescent children.

Strengths and Limitations

Several study strengths should be noted. Our sample of adolescents was ethnically/racially and socioeconomically diverse, and this strength is important for several reasons. First, it is common for health research participants to overrepresent privileged groups (e.g., white, middle- to upper-class), which means conclusions and corresponding interventions may miss key elements important to the goals of decreasing relevant health inequities and meeting the health needs of underserved populations [7]. Second, DEBs are similarly prevalent [168] if not more prevalent [75,100,145–147] in BIPOC youth, and among youth from low SES backgrounds [76,100] when compared to white and higher SES participants, respectively. Third, despite this evidence, assumptions that DEBs primarily affect affluent, white young people contribute to barriers to adequate and timely treatment for clinical eating disorders in other populations, which may create health inequities [148]. Another study strength is our thorough pilot testing which allowed survey items to meet the developmental needs of our adolescent and young adult participants. Also, we were able to assess temporal ordering in the relationship between weight-stigmatizing experiences and DEBs because of the longitudinal study design. Further, adolescents were asked about both mothers and fathers in assessment of family and parenting factors. Finally, the family functioning measure has shown high internal consistency within ethnically and socioeconomically diverse populations, which is a strength of this study [77,81,82]. However, the measure for parental support for psychological autonomy has not been rigorously tested in these populations [77], which is a limitation. Additional study limitations should also be considered when interpreting our findings. The self-reported measures could have introduced recall bias, but self-report may be the optimal way to measure weight-stigmatizing experiences and other similar constructs. This study recruited from a single geographic area at baseline, and this factor may limit the generalizability of our findings. Finally, attrition occurred at EAT 2018 (the follow-up time point), although to extrapolate back to the baseline sample, inverse probability weighting was used in all analyses.

4.E. Conclusions

This study found that weight-stigmatizing experiences in adolescents were cross-sectionally and longitudinally associated with higher prevalence of DEBs. Additionally, higher family functioning and parental support for psychological autonomy were found to be protective for DEBs, but primarily in young people who did not experience weight stigma. Thus, general family and parenting factors did not entirely offset the effects of weight-stigmatizing experiences on DEBs, and future studies should consider use of qualitative methods to expand understanding of how parental practices specific to weight and eating behaviors, as well as parents' own weight stigmatizing experiences may be linked with weight stigma and DEB outcomes in their adolescent children. Importantly, this study and others have found that family members and parents are common sources of weight stigma for young people. Published guidelines for healthcare providers recommend addressing weight stigma in youth and families in healthcare settings [97], and they include screening youth for weight stigma. Providers may therefore need to have candid conversations with families if they learn that family members are engaging in weight stigma toward the adolescent patient. Future work should expand upon these guidelines while identifying effective strategies for family members to support young people who have experienced weight stigma.

Chapter 5

Discussion

This dissertation research found that weight teasing was associated with higher weight status and higher prevalence of disordered eating behaviors, cross-sectionally during adolescence, cross-sectionally during young adulthood, and longitudinally, in a sample of ethnically/racially and socioeconomically diverse young people. It also found that weight teasing was cross-sectionally associated with primarily adverse weight-related health behaviors: shorter sleep duration, longer screen time, higher vegetable intake, less frequent breakfast intake, and higher fast-food and sugar-sweetened beverage intake. However, these relationships did not persist longitudinally. Each of these observed relationships accounted for the effects of sociodemographic characteristics and weight status. This dissertation found that the effects of weight teasing were similar across ethnic/racial and SES subgroups. Additionally, it found that participants who were BIPOC and those from low SES backgrounds had higher prevalence of weight teasing, disordered eating behaviors, higher weight status, lower moderate-to-vigorous physical activity, less frequent breakfast intake, and higher fast-food intake when compared to their respective counterparts. Results from this dissertation also demonstrate that weight-stigmatizing experiences are more common for young people with high weight status. When taken together, these findings suggest that weight stigma creates barriers to nutrition-, fitness-, body image-, and weight-related health, especially for young people who are BIPOC, from low SES backgrounds, and/or of high weight status. Thus, engaging these young people and utilizing their input may be key to improving the relevance and effectiveness of future prevention and treatment efforts.

In addition to these findings, this dissertation research also examined the role of positive parenting and family factors in the relationships between four weight-stigmatizing experiences – general weight teasing (from any source), peer weight teasing, family weight teasing, hurtful weight-related comments from family – and four disordered eating behaviors – unhealthy weight control behaviors, extreme weight control behaviors, overeating, binge eating). This dissertation found that family members were common sources of weight stigma. After accounting for sociodemographic characteristics and weight status, weight-stigmatizing experiences were associated with higher prevalence of disordered eating behaviors, both cross-sectionally and longitudinally, or associations were null. It also found that high family functioning and parental support for psychological autonomy were protective for disordered eating behaviors in young people, especially in those who did not experience weight stigma. However, these general positive family and parenting factors did not fully buffer the relationship between weight stigma and disordered eating behaviors. Given these findings, qualitative methods may be necessary to better understand if other parenting practices (e.g., those specific to weight and eating behaviors) are useful in mitigating DEB risk in young people who have experienced weight stigma. Published guidelines for healthcare providers recommend that they screen for and address weight stigma experienced by youth. Future research should build upon these guidelines, while simultaneously aiming to improve understanding of what parents and family members can do to support young people who have experienced weight stigma.

5.A. Summary of Findings and Contributions to the Field

Specific Aim 1: Cross-sectional and longitudinal associations of weight teasing with weight-related health behaviors and weight status, in an ethnically/racially and socioeconomically diverse sample of young people

Study findings from Specific Aim 1 showed that during adolescence, weight teasing was cross-sectionally associated with some adverse health behaviors (longer screen time, shorter sleep duration), associated with one health-supporting behavior (higher vegetable intake) and not associated with some health behaviors (moderate-to-vigorous physical activity, fruit intake, breakfast intake, sugar-sweetened beverage intake, and fast-food intake) after accounting for sociodemographic characteristics and weight status. During young adulthood, weight teasing was cross-sectionally associated with some adverse health behaviors (shorter sleep duration, less frequent breakfast intake, higher sugar-sweetened beverage and fast-food intake) and not associated with other health behaviors (screen time, moderate-to-vigorous physical activity, fruit intake, vegetable intake) after accounting for sociodemographic characteristics and weight status. Weight teasing was not longitudinally associated with any health behaviors in unadjusted and adjusted models. This is the first research study, to my knowledge, to investigate the relationship between a weight-stigmatizing experience such as weight teasing and a comprehensive set of weight-related health behaviors in adolescents and young adults. The finding that weight teasing was cross-sectionally associated with shorter sleep duration in adolescence and young adulthood is in alignment with findings from Puhl, Himmelstein, and Watson that weight teasing from family members was cross-sectionally associated with difficulty falling asleep in a sample of adolescents who identified as sexual and gender minorities [60].

Further, study findings indicated that weight teasing was not associated with moderate-to-vigorous physical activity, and the lack of associations may be explained in part by different reactions to weight-based mistreatment amongst young people. For example, it is possible that some young people who are teased about their weight increase physical activity in an effort to lose weight and counteract the reason for the teasing [169]. Others may decrease their physical activity because of loss of confidence, self-efficacy and motivation [16,17,19] or as a strategy to avoid the weight stigma experienced while participating in physical activity [25,170]. Another possibility is that experiencing weight stigma affects the way young people feel about physical activity, but not whether they actually engage in it. This pattern was observed by Vartanian and colleagues who found that experiencing weight stigma was associated with lower physical activity motivation, but not reported physical activity levels among female young adults [19]. It will be important for future research to include in-depth examinations (e.g., mixed methods study designs) to improve understanding of whether, how, and for whom weight stigma is linked with physical activity self-efficacy, motivations, emotions, and behaviors in young people.

Weight teasing was associated with higher weigh status, cross-sectionally during adolescence, cross-sectionally during young adulthood, and longitudinally, after accounting for sociodemographic characteristics, as well as baseline weight status for the longitudinal analysis. These findings align with my *a priori* hypothesis, and because of the large diverse study population and longitudinal design of the present study, they strengthen prior evidence that weight stigma is a risk factor for high weight status. Moreover, these results, coupled with the observed cross-sectional associations between weight teasing and shorter sleep duration, longer screen time, less frequent breakfast intake, higher sugar-sweetened beverage intake, and higher fast-food intake align with Tomiyama's Cyclic Obesity/Weight-Based Stigma (COBWEBS) model [39]. Tomiyama's model proposes a "positive feedback loop" between weight-stigmatizing experiences and weight gain. Specifically, in the COBWEBS model, it is postulated that weight-stigmatizing experiences lead to increased stress, which leads to increased cortisol and eating/activity behaviors that promote weight gain, which together lead to elevated weight status, which leads to further weight-stigmatizing experiences. While several prior studies have linked weight-stigmatizing experiences to disordered eating behaviors [21,22,100], and such behaviors are established risk factors for subsequent weight gain [43–45], the findings from Specific Aim 1 may provide evidence for the link between weight-stigmatizing experiences and a different group of eating/activity behaviors that may promote weight gain: shorter sleep duration, longer screen time, less frequent breakfast intake, higher sugar-sweetened beverage intake, and higher fast-food intake. However, effect sizes were small and there was no evidence of a longitudinal relationship between weight teasing and these behaviors. Furthermore, research in the Project EAT I-IV cohort has found that, in young people, disordered eating behaviors are more consistent predictors of higher weight status than the health behaviors examined in Specific Aim 1 [31,43–45]. Therefore, it is possible that disordered eating behaviors are more commonly responsible for the relationships proposed in Tomiyama's COBWEBS model. More research is needed to improve understanding of potential targets for public health and clinical interventions that can mitigate the harmful effects of weight stigma experienced by young people.

This dissertation is the first study, to my knowledge to examine SES and ethnicity/race as effect modifiers in the relationships of a weight-stigmatizing experience - weight teasing - with weight-related health behaviors and weight status. It found that the effects of weight teasing were similar across ethnic/racial and SES subgroups. It also found that BIPOC young people and those from low SES backgrounds had higher weight status, lower moderate-to-vigorous physical activity and breakfast frequency, and higher fast-food intake than their respective counterparts. These latter findings are consistent with the *a priori* hypothesis and are attributed to socio-environmental inequities in the U.S., which contribute to worse nutrition-, fitness-, and weight-related health outcomes for BIPOC young people and young people from low SES backgrounds when compared to their respective counterparts [12,13]. These socio-environmental contributions include inequitable access to: 1) healthcare [95,96], 2) opportunities to safely walk and play in one's own neighborhood [107,108], 3) developmentally-appropriate organized physical activities (i.e., dance, sports) [108], and 4) nutritious food [12,95,109]. The present study's observed differences in weight status, moderate-to-vigorous physical activity, breakfast frequency, and fast-food intake remind public health and health equity researchers that these young people remain underserved by current prevention and treatment efforts. Future research should focus on ways to engage young people with these identities and backgrounds in strengths-based approaches to research in this area. It should also focus on broad non-stigmatizing upstream solutions that create policies, systems, and environments that promote equity and support all young people to thrive.

Specific Aim 2: Cross-sectional and longitudinal associations of weight teasing with disordered eating behaviors, in an ethnically/racially and socioeconomically diverse sample of young people

In Specific Aim 2, study findings showed that the prevalence of weight teasing and disordered eating behaviors was high in adolescence and in young adulthood. For example, 34% of participants were teased about their weight during adolescence and 42%

during young adulthood. Also, 44% of participants reported engaging in unhealthy weight control behaviors in adolescence and 52% in young adulthood. Weight teasing was cross-sectionally associated with higher prevalence of all six disordered eating behaviors (dieting, chronic dieting, unhealthy weight control behaviors, extreme weight control behaviors, overeating, binge eating) in adolescence and young adulthood, in unadjusted models and in models adjusted for sociodemographic characteristics and weight status. In unadjusted models, weight teasing in adolescence was longitudinally associated with higher prevalence of all six disordered eating behaviors in young adulthood. When accounting for sociodemographic characteristics and weight status, weight teasing remained longitudinally associated with higher prevalence of dieting and overeating in young adulthood. In unadjusted models, weight teasing in adolescence was longitudinally associated with higher incidence of dieting, unhealthy weight control behaviors, extreme weight control behaviors, and binge eating eight years later. When accounting for sociodemographic characteristics and weight status, weight teasing remained longitudinally associated with higher incidence of dieting in young adulthood. Overall, these findings are in alignment with *a priori* hypotheses and evidence from earlier studies that the experience of weight stigma predicts engagement in disordered eating in young people both cross-sectionally [14,23,149] and longitudinally [20–22]. For example, in a cohort of 14-year-old African-American and white girls (n=4036), being labeled “fat” by family members was associated with more disordered eating five years later [21].

In this sample, cross-sectional and longitudinal relationships between weight teasing and disordered eating behaviors did not vary by ethnicity/race, SES, and gender. This research question was exploratory with no *a priori* hypothesis, given the mixed literature on gender and the scant literature on ethnicity/race and SES. Regarding gender, these results align with some previous findings [14,28] but not others [20,22,149]. Finally, in this sample, the prevalence of weight teasing and disordered eating behaviors was generally higher in BIPOC young people when compared to white young people, and generally higher in young people from lower SES backgrounds when compared to higher SES backgrounds. These findings are consistent with the *a priori* hypothesis and prior evidence on this topic [14,28,63,75,76,145–147], although they differ from other studies which found no difference in prevalence of weight-stigmatizing experiences by gender [28] and ethnicity/race [99,101].

Overall, because of the socioeconomic and ethnic/racial diversity of this sample, findings strengthen prior evidence that weight stigma is a risk factor for disordered eating behaviors for all young people. This dissertation adds to the evidence base by demonstrating that these relationships persist across gender, ethnic/racial, and socioeconomic subgroups, and that young people who identify as female, BIPOC, and those from low SES backgrounds have higher prevalence of weight teasing and disordered eating when compared to their respective counterparts. These findings also provide evidence against persistent assumptions that disordered eating primarily affects young people who are affluent and white [148]. Thus, future studies should seek to better understand how to meet the needs of individuals more broadly oppressed by society such as young people who identify as female, BIPOC, those from low SES backgrounds, or a combination of these identities. In addition, future studies should seek to meet the needs of people with elevated weight status, given that they are also disproportionally affected by both disordered eating behaviors and weight stigma [145,156], findings also observed in the present study. Understanding how to meet these needs will likely require innovative approaches to future research, such as strengths-based frameworks; mixed methods; and research informed by community partnerships with youth-serving organizations. These recommendations are discussed in below in section 5.c. Study Implications and Directions for Future Research.

Specific Aim 3: Understanding whether the cross-sectional and longitudinal relationships between weight-stigmatizing experiences and disordered eating behaviors are influenced by family and parenting factors in a sample of young people

Study findings from Specific Aim 3 showed that four types of weight-stigmatizing experiences (any weight teasing, peer weight teasing, family weight teasing, hurtful weight-related comments from family) were associated with higher prevalence of four disordered eating behaviors (unhealthy weight control behaviors, extreme weight control behaviors, overeating, binge eating). These findings describe cross-sectional relationships and account for sociodemographic characteristics and weight status. Some associations were null in the longitudinal adjusted models, but without exception, weight-stigmatizing experiences were not associated with lower prevalence of disordered eating behaviors. These findings are consistent with the *a priori* hypothesis and prior evidence [14,20–23,149].

Family functioning and parental support for psychological autonomy were found to be protective for disordered eating behaviors in main effects models, aligning with the *a priori* hypothesis. In contrast to the *a priori* hypothesis, these family and parenting factors did not have a protective effect on disordered eating behaviors in adolescents who experienced weight stigma. However, the interaction suggested that family functioning and parental support for psychological autonomy operate as effect modifiers in the cross-sectional relationship between weight-stigmatizing experiences and disordered eating behaviors. As a result, stratified cross-sectional models were examined and revealed that higher family functioning and support for psychological autonomy tended to be more protective for young people who did experience weight stigma. The reason for these findings may be that weight-stigmatizing experiences are powerful risk factors for disordered eating behaviors and that the influence of generally positive family and parenting factors is not enough to offset their effect. In sum, our findings build on prior evidence that higher family functioning and support for psychological autonomy are protective for disordered eating behaviors. They suggest that these positive family and parenting factors may be especially protective for adolescents who do not experience weight stigma.

To my knowledge, this dissertation is the first study to examine the role of family functioning and parental support for psychological autonomy as potential buffers in the relationship between weight-stigmatizing experiences and disordered eating behaviors in young people. Relatedly, two studies have linked weight-stigmatizing experiences with parental restrictive feeding practices [166,167], which are established risk factors for disordered eating behaviors [88]. One study found that parents' own weight-stigmatizing experiences and weight bias internalization were associated with restrictive feeding practices [167]. Another study found that among young adults reflecting back on their childhood, parental restrictive feeding practices were experienced as weight stigma conveyed by parents [166]. Consequently, it may be relevant for future studies to focus on further elucidating the link between restrictive feeding practices and experiences of weight stigma and whether parents' own experiences with weight stigma contribute to disordered eating risk for their adolescent children.

Finally, this study found that family members are common sources of weight stigma for young people, and this finding aligns with previous evidence [14,21,90,91]. 24% of adolescents reported weight teasing from family and 42% reported hurtful weight-related comments from family. Despite being sources of weight stigma, parents and family members can also be sources of support. This study also found that high family functioning and parental support for psychological autonomy were generally protective for disordered eating behaviors in young people which is consistent with previous evidence [77,83–85]. Future research should aim to investigate how parents and other family members can avoid conveying weight stigma to adolescents. Studies should also focus on what family members should do and say to support young people and help mitigate risk when they experience weight stigma.

5.B. Strengths and Limitations

This dissertation research has several strengths. First, the large sample included socioeconomically and ethnically/racially diverse adolescents and young adults. This strength is important for several reasons. First, it is common for health research participants to overrepresent privileged groups (e.g., white, middle- to upper-class), which means conclusions and corresponding interventions may miss key elements important to decreasing relevant health inequities in the population and meeting the health needs of underserved populations [7]. Second, inequities in numerous nutrition-, fitness-, and weight-related health outcomes in young people have been well-documented [7,12,13]. These inequities are considered especially intractable given that their causes are socio-environmental and decreasing them will require substantial changes to policies, systems, environments, and social norms. Third, disordered eating behaviors are similarly prevalent [168] if not more prevalent in BIPOC youth when compared to white youth [75,100,145–147], and more prevalent among youth from low versus high SES backgrounds [76,100]. Despite this evidence, assumptions persist that disordered eating behaviors primarily affect young people who are affluent and white, and these assumptions may contribute to health inequities, such as barriers to identification and treatment of clinical eating disorders [148].

In developing the survey measures, EAT 2010-2018 was guided by previous Project EAT I-IV surveys, extensive pilot testing with young people from diverse ethnic/racial and socioeconomic backgrounds, and expert review to determine face validity [75,77]. This pilot testing as well as test-retest reliability testing ensured that final survey items were developmentally appropriate for the study population [171,172]. Also, baseline weight and height were measured by trained research staff using standardized procedures. At follow-up, weight and height were self-reported. At baseline, the correlation between reported and measured BMI was high (r = 0.88 for both females and for males) [173]. Additionally, in the Project EAT I-IV cohort, self-reported weight and height were validated in a subsample of 62 female and 63 male participants at 10-year follow-up. This validation study found very high correlation between self-reported BMI and measured BMI (males: r=0.95, females: r=0.98) [31,124].

An additional strength of this dissertation is its longitudinal design, which allowed for examination of the temporal nature of the relationships of weigh teasing with weight-related health behaviors, weight status, and disordered eating behaviors. It also allowed for examination of the temporal nature of the relationship between four types of weight-stigmatizing experiences and disordered eating behaviors and whether family and parenting factors are protective in those relationships. The comprehensive nature of the survey not only allowed this dissertation to focus on nutrition-, fitness-, body image-, and weight-related outcomes, but also on the psychosocial, familial, and structural factors that contribute to those outcomes. For example, this important aspect of the survey allowed for examination of the role of family functioning and parental support for psychological autonomy in the relationship between weight-stigmatizing experiences and disordered eating behaviors in Specific Aim 3. A final strength of this dissertation is that the family functioning measure has shown high internal consistency within ethnically and socioeconomically diverse populations [77,81,82]. However the measure of parental support for psychological autonomy has not been rigorously tested in these populations [77], which is a limitation.

Additional limitations should be noted. Most of the measures used in this dissertation were self-reported, so recall bias may have affected the results. However, self-report is likely the best measure for certain variables, such as experiencing weight stigma. Also, most survey items were brief (e.g., weight teasing in Specific Aims 1 and 2), and it is optimal to use more comprehensive measures. For the EAT 2010-2018 survey, the decision was made to include brief survey items to decrease participant burden, given the extensive survey length required to achieve the overall study aims. Future research focused on weight stigma should use validated assessment tools such as the Modified Weight Bias Internalization Scale [174], which assesses the extent to which individuals are emotionally affected by weight stigma, including beliefs about their own abilities and self-worth [175]. The Stigmatizing Situations Inventory is another validated tool, which is used to assess the extent to which individuals experience weight stigma [27]; it has also been adapted for adolescents [23].

Due to low numbers, the "Mixed or Other Race" category included a heterogeneous group (Native Hawaiian or Pacific Islander, American Indian or Native American, Other, Other and another ethnicity/race), and the inability to consider these groups separately is a limitation. Further, gender/sex was assessed as "male," "female," and "different identity," and no data was collected about sexual orientation, which are shortcomings, given that young people who identify as sexual and/or gender minorities experience a higher prevalence of disordered eating behaviors when compared to their respective straight and cisgender peers [157,158]. Future studies should inquire about sexual orientation and use the two-question method of birth-assigned sex and gender identity [142]. In addition, attrition occurred at follow-up, however, analyses used inverse probability weighting which allowed for extrapolation back to the original sample based on characteristics associated with missingness at follow-up. Finally, baseline recruitment took place in one geographic area in Minnesota, U.S., which may limit the generalizability of these findings.

5.C. Study Implications and Directions for Future Research

Findings from this dissertation provide evidence that weight teasing, a weight-stigmatizing experience, is a common experience and a risk factor for disordered eating behaviors and high weight status in ethnically/racially and socioeconomically diverse youth. When taken together, these findings suggest that weight-stigmatizing experiences may create barriers to nutrition-, fitness-, body image-, and weight-related health in adolescents and young adults. These findings highlight the need for clinicians, public health practitioners, and policymakers to view weight stigma as a distinct obstacle to their efforts to effectively prevent and treat these health problems in diverse populations of young people. To this end, recommendations have been published by the American Academy of Pediatrics [97] and in the Joint International Consensus Statement for Ending Stigma of Obesity [143]. These recommendations (see Table 5-1) include: increasing awareness of one's own weight-related biases; creating welcoming environments for people with high weight status in youth-serving organizations, clinics, and hospitals; avoiding narratives that emphasize personal responsibility in addressing obesity; reflecting body size diversity in public health campaigns, media, and brochures; using respectful images of people with high weight status, work to strengthening anti-bullying policies in schools to enumerate weight-based teasing and bullying; participate in advocacy for legislation to protect people from body size discrimination [97,143]. The findings from this dissertation underscore the importance of these recommendations and the need for increased attention to weight stigma-reduction efforts. It may be useful to use these recommendations to inform future clinical practice, public health work, policy work, and research.

Table 5-1. Published Recommendations to Decrease Weight Stigma Conveyed to Young People through Clinical, Public Health, and Policy Work
• Increase awareness of one's own weight-related biases and work to reduce them • Create welcoming environments for people with high weight status in youth-serving organizations, clinics, and hospitals • Avoid narratives that emphasize personal responsibility when addressing weight-related health • Reflect body size diversity in public health campaigns; use respectful and positive images of people with high weight status • Participate in advocacy for legislation to protect people from body size discrimination • Work to strengthen anti-bullying policies in schools to protect young people from weight-based teasing and bullying

Select recommendations from the American Academy of Pediatrics [97] and the Joint International Consensus Statement for Ending Stigma of Obesity [143]. These recommendations were included due to their relevance to the implications of the findings from this dissertation.

Use of a Health Equity Lens to Address Weight Stigma and its Effects

This dissertation's findings indicate that weight teasing was a risk factor for disordered eating behaviors and high weight status in an ethnically/racially and socioeconomically diverse sample of young people. Findings also extend previous evidence that weight teasing is a more common experience for people with high weight status. Furthermore, in this dissertation, it was found that the effects of weight teasing were similar across ethnic/racial and SES subgroups and that young people from low SES backgrounds and BIPOC young people were disproportionately affected by weight teasing, disordered eating behaviors, adverse weight-related health behaviors, and high weight status. When taken together, these findings suggest that weight-stigmatizing experiences may create barriers to health, especially for young people who are BIPOC, from low SES backgrounds, and/or of high weight status. Findings also suggest that these populations may be underserved by current prevention and treatment efforts. Thus, future nutrition-, fitness-, body image-, weight-, and weight stigma-related health research should focus on engaging these young people in novel ways.

While high weight status and weight-related health behaviors have long been acknowledged by the health science and healthcare communities as problems that disproportionately affect BIPOC youth and youth from low SES backgrounds [12,13], the issues of weight stigma and disordered eating have primarily been considered problems for young people who are affluent and white [148], and problems that may not have relevance for weight-related health, despite evidence to the contrary [43,64,176]. Given the complexity and interconnectedness of problems related to weight stigma experienced by young people, it is important for future research aimed at decreasing weight stigma and its negative effects to use innovative approaches.

Moreover, weight stigma is a form of oppression that can be experienced both structurally and interpersonally [1,2,177], so it is important that future research studies frame it as such. Framing weight stigma as an equity issue will allow researchers to investigate and correct the ways in which it creates health disparities for people of high weight status, similar to approaches used by health equity scholars and social scientists to investigate how homophobia, transphobia, racism, sexism, and ableism affect health outcomes for people who are queer, trans, BIPOC, women/girls, and living with a disability, respectively. To that end, much can be learned from social scientists and health equity scholars who study other forms of oppression; their frameworks, approaches, and research methods should be applied in weight stigma research. Thus, weight stigma scholars – especially those who do not come from a social science background – will likely benefit by investing extra time to find mentors and take coursework in the fields of social science and health equity. One important approach to health equity work is to center the perspectives, viewpoints, and ideas of people who have been stigmatized, in this instance, people in larger bodies who experience weight stigma. Centering the perspective, viewpoints, and ideas of people in larger bodies is an approach that can be applied in clinical practice, public health work, policy work, and research.

Use Innovative Approaches When Aiming to Decrease Weight Stigma and its Health Effects in Diverse Populations of Young People

Direct engagement with young people who are disproportionately affected by weight stigma may be key to the development of effective weight-stigma prevention efforts. For example, while weight-based bullying is the most common reason for harassment among adolescents [3], it is oftentimes absent from anti-bullying policies in schools [159]. So, as a potential solution, a youth advisory board made up of youth who are BIPOC, from low SES backgrounds, of high weight status, and youth with a combination of these identities could be directly involved in updating anti-bullying policies in schools. The board's ideas could drive changes to make these policies both appropriately inclusive of weight-based harassment and realistically applicable to the lives of young people (e.g., inclusive of weight-based bullying on social media).

Engage Community Partnerships in Research

Another approach to health equity work that centers the lived experiences of people who have been stigmatized is to conduct research that engages community partnerships, including community-based participatory research (CBPR) and youth-led participatory action research (YPAR) [8,136,178]. Community engaged research makes the research relevant to the lives of people who have been affected by the form of oppression by involving participants in the research planning, execution of research methodology, analysis, summary of results and description of implications of those results, and write-up and dissemination of results to peer-reviewed outlets, community outlets, policy outlets, and other relevant audiences. An example of research that engages community partnerships is work I'm planning through Move and Thrive, a research team I co-founded. Move and Thrive (https://move-and-thrive.org/) aims to provide free, welcoming, safe, and fun online physical activity to adolescents diverse in body size and shape, race, ethnicity, gender identity and sexual orientation in a way that affirms their identities and avoids use of weight stigma, pressure to lose weight, and body shaming during the physical activity instruction. One of the long-term goals of this work is to remove barriers for adolescents in larger bodies who are trying to access physical activity in a way that promotes their physical and psychosocial well-being and does not convey weight stigma. We plan to partner with Youthprise, a youth-serving organization which aims to decrease inequities based on SES, geography, race, and ethnicity for youth in Minnesota. In partnership with young people at Youthprise, we plan to utilize YPAR to evaluate and further develop this online resource for youth.

Strengths-Based Approaches to Research

Use of positive youth development and other strengths-based approaches to research. Positive youth development is an intentional, prosocial approach to youth-focused programming and research that engages adolescents in a manner that recognizes, utilizes, and enhances their strengths [179,180]. It promotes positive outcomes for young people by providing opportunities, fostering positive relationships, and furnishing the support they need to build on their leadership strengths [179,180]. It is built upon scientific understanding and knowledge of the tremendous physical, cognitive, and psychosocial development that adolescents undergo, second only to infancy in its rapidity [179,180]. This approach to research has demonstrated effectiveness at improving adolescent outcomes such as violence prevention [181] and sexual health [182]. However, positive youth development is underutilized in adolescent research focused on weight stigma and nutrition-, fitness-, body image-, and weight-related health, and it should be used in future work in this area.

For weight stigma researchers who work with participants outside of the adolescent age group, strengths-based and asset-based framing should also be considered. This type of framing has been useful to health equity researchers studying other forms of oppression [8]. It counteracts the negative impact that deficit-framing has had on people with marginalized identities and their communities. [8]. It instead humanizes and empowers individuals and communities, and it can be useful in finding overlooked solutions to seemingly intractable problems [8].

The Role of Intersectionality in Research

Research should consider the role of intersectionality which describes the cumulative effects of multiple forms of oppression and views them as interconnected and overlapping [99,155,183]. Viewing weight stigma as a health equity issue allows researchers to begin to investigate ways in which it might intersect with other forms of oppression (e.g., homophobia, transphobia, racism, sexism, ableism, classism). In Specific Aim 1, the large, diverse study sample allowed for preliminary examination of whether intersectionality plays a role in the weight teasing-health behavior relationship. For example, ethnicity/race was found to be an effect modifier in the cross-sectional relationships of weight teasing with moderate-to-vigorous physical activity and sleep duration during adolescence. Stratified analyses revealed that weight teasing was associated with lower moderate-to-vigorous physical activity and shorter sleep duration in Black/African American adolescents, but weight teasing was not associated with either outcome in white adolescents. Relatedly, Puhl, Himmelstein, and Watson found that weight teasing from family – but not peers – was associated with difficulty falling asleep [60]. That adolescent study population was limited to sexual and gender minorities, so it is possible that the intersectional effects of weight stigma combined with homophobia and/or transphobia affected their findings. My findings and those of Puhl, Himmelstein, and Watson [60] might suggest that intersectionality plays a role in the relationship between weight-based mistreatment and health behaviors for young people with marginalized identities. However, in the present study, there was evidence of effect modification by ethnicity/race and SES in the weight teasing-health behavior relationship for a minority of behaviors, and no consistent patterns emerged across subgroups or behaviors. More research is needed to understand the role intersectionality might play in the relationship between weight stigma and health behaviors.

Understanding How Parents and Family Members Can Support Adolescents Who Have Experienced Weight Stigma

In addition to research that frames weight stigma as an equity issue, public health and clinical interventions aimed at reducing weight stigma in adolescents should also consider ways that parents and other family members should be involved. Because of the vital role parents and the home environment play in supporting adolescent psychosocial development and overall well-being, it is important to involve parents and other family members in stigma-reduction efforts for adolescents [160,184]. The present study found that high family functioning and high parental support for psychological autonomy were protective for disordered eating behaviors in young people, but primarily in adolescents who did not report weight-stigmatizing experiences. These general family and parenting factors did not fully buffer the effects of weight-stigmatizing experiences on disordered eating behaviors in young people. Therefore, much remains to be understood about the role of parents and family members in supporting young people who have experienced weight stigma in mitigating adolescents' risk for disordered eating behaviors.

It is recommended that healthcare providers screen for weight stigma in adolescent patients [97], but studies have not focused on whether, how, and for whom to implement this type of screening. Findings from this dissertation and other studies [14,21,90,91] demonstrate that family members are common sources of weight stigma. Thus, implementing such screening may require that providers have candid conversations with family members if they learn that the family members are the source of weight stigma experienced by the adolescent. Having such conversations in a compassionate and effective manner, while supporting both the adolescent and the family members, may require that healthcare providers receive additional training. Moreover, allowing time for such conversations may necessitate structural changes to clinical operations and/or training for others in the clinic (e.g., nurses, social workers, dietitians) to allow for an interdisciplinary team approach to this complex topic. Effective implementation of a clinical change such as screening for weight stigma in a primary care setting could be the target of future research using implementation science.

To my knowledge, this dissertation is the first study to examine the role of family functioning and parental support for psychological autonomy as potential buffers for the effects of weight-stigmatizing experiences on disordered eating behaviors in young people. Relatedly, a prior study found that parents' own weight-stigmatizing experiences and weight bias internalization are linked with higher parental restrictive feeding practices [167], established risk factors for disordered eating behaviors [88]. Thus, it may be important for future studies to target parents' own weight-stigmatizing experiences and weight bias internalization as potential upstream solutions to mitigating disordered eating risk in adolescents.

While the positive family and parenting factors examined in this dissertation did not buffer the effects of weight-stigmatizing experiences on disordered eating behaviors, these factors were found to be generally protective for disordered eating behaviors which aligns with previous evidence [77,83–85]. In addition, findings from this dissertation suggest that positive family and parenting factors may be more protective for young people who do not experience weight stigma. Moreover, it is established that parents and family members are a powerful source of support for young people [77–80], and future studies should aim to investigate how they can help mitigate disordered eating risk in a young person who has experienced weight stigma. Mixed methods or qualitative study designs that involve both adolescents and family members as participants will likely be required. This work should also include in-depth exploration into understanding how to effectively help parents and other family members avoid actions and language that convey weight stigma to adolescents. Furthermore, this research should examine what parents and family members can do and say to support improved body image, self-esteem, and self-efficacy in adolescents as they develop into young adults.

The Potential for Additive Effects of Weight-Stigmatizing Experiences

In Specific Aim 3, four types of weight-stigmatizing experiences were assessed – general weight teasing (from any source), peer weight teasing, family weight teasing, hurtful weight-related comments from family. Each type of weight-stigmatizing experience was assessed as a single exposure variable. Future studies should examine whether there is an additive effect or dose response on disordered eating behaviors when young people experience more than one type of weight stigma. In addition, in Specific Aim 3, individual prevalence estimates were obtained for each type of weight-stigmatizing experience, and these results were alarmingly high (weight teasing from any source: 34%, peer weight teasing: 27%, family weight teasing: 24%, hurtful weight-related comments from family: 42%). This dissertation did not investigate whether participants who experienced one type of weight stigma also experienced another. Doing so in a future study will be important for assessing the overall prevalence of weight-stigmatizing experiences in youth, and this information will have public health relevance for understanding the how widespread this problem is in populations of young people.

Table 5-2. Recommendations for Clinical Practice, Public Health Work, Policy Work, and Research Based on Dissertation Findings and their Implications
• Use published recommendations to inform future clinical practice, public health work, policy work, and research • Use a health equity lens to address weight stigma and its health effects • Use innovative approaches when aiming to decrease weight stigma and its health effects in diverse populations of young people • Engage community partnerships in research • Pursue strengths-based approaches to research • Consider the role of intersectionality in research • Research should aim to understand how parents and family members can support adolescents who have experienced weight stigma • Investigate the potential for additive effects of weight-stigmatizing experiences

5.D. Conclusions

This dissertation found that weight teasing was associated with higher prevalence of disordered eating behaviors and high weight status, cross-sectionally during adolescence, cross-sectionally during young adulthood, and longitudinally in an ethnically/racially and socioeconomically diverse sample of young people. It also found that weight teasing was cross-sectionally associated with shorter sleep duration, longer screen time, and higher vegetable intake during adolescence as well as shorter sleep duration, less frequent breakfast intake, higher sugar-sweetened beverage intake, and higher fast-food intake during young adulthood. All analyses accounted for sociodemographic factors and weight status. The effects of weight teasing were similar across ethnic/racial, and SES subgroups. Also, BIPOC young people and young people from low SES backgrounds were disproportionately affected by weight teasing, disordered eating behaviors, adverse weight-related health behaviors, and high weight status. Together these findings suggest that weight stigma serves as a barrier to health for young people, and that young people of high weight status, BIPOC young people, and young people from low SES backgrounds may be underserved by current prevention and intervention efforts. Novel approaches to future research (e.g., mixed methods, youth-led participatory action research, a positive youth development framework, and implementation science) are needed as strategies to decrease inequities and promote well-being for all young people.

This dissertation also focused on the role of parents and family members. Findings reveal that positive family and parenting factors were generally protective for disordered eating behaviors, especially in young people who did not experience weight stigma. However, these positive factors did not buffer the effects of weight-stigmatizing experiences on disordered eating behaviors. Thus, more research is needed to understand what parents and family members can do to mitigate disordered eating risk in young people who have experienced weight stigma. Because this dissertation and other studies have found that parents and family members are common sources of weight stigma, future research should focus on understanding how to effectively help them avoid language and actions that convey weight stigma to adolescents. This work should simultaneously examine what family members can do and say to support the adolescent to feel better about their body, themselves, and the person they are becoming as they develop into a young adult.

Overall, findings from this dissertation add to the growing body of evidence that weight stigma is harmful – not helpful – to the nutrition-, fitness-, body image-, and weight-related health of young people. Published recommendations provide strategies to decrease weight stigma experienced by young people, and they should be used to inform clinical care, public health and policy work, and future research. Future weight stigma research should focus on broad, upstream solutions that create policies, systems, and environments that promote health equity and support all young people to thrive.

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