

THESIS

PRESSURE TO BE THIN AND INSULIN SENSITIVITY: AN INVESTIGATION OF THE
POTENTIAL MODERATING ROLE OF RACE/ETHNICITY AMONG
ADOLESCENT GIRLS AT RISK FOR TYPE 2 DIABETES

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ABSTRACT

PRESSURE TO BE THIN AND INSULIN SENSITIVITY: AN INVESTIGATION OF THE POTENTIAL MODERATING ROLE OF RACE/ETHNICITY AMONG ADOLESCENT GIRLS AT RISK FOR TYPE 2 DIABETES

The prevalence of youth-onset type 2 diabetes is a significant public health issue in the United States that disproportionately affects historically marginalized racial and ethnic groups. Previous research suggests that psychosocial stress resulting from poor body image and weight-related pressure may be associated with worsened metabolic health outcomes. This study examined the relationship between pressure to be thin and insulin sensitivity in adolescent girls at-risk for developing type 2 diabetes, who are susceptible to weight-based criticism and pubertal declines in insulin sensitivity. This study also aimed to explore the extent to which this association was moderated by racial/ethnic identity. Participants were 92 girls, (46% Hispanic; 34% non-Hispanic White; $M \pm SD$ age = 14.95 ± 1.82 y), who completed a self-report measure of pressure to be thin from friends, family members, and partners. Parents also reported pressure to be thin of their adolescents by questionnaire. At baseline, participants' body mass index (BMI; kg/m^2) was calculated, fasting blood samples were acquired to calculate insulin sensitivity, and body composition was measured with air displacement plethysmography. In contrast to hypotheses, there were no main effects, or interactional effects by race, of either adolescent-reported or parent-reported pressure to be thin on insulin sensitivity (all p -values $> .05$). Results indicate that future research is warranted to identify culturally relevant psychosocial stressors for adolescents of color.

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Literature Review

Adolescent Obesity and Type 2 Diabetes

In the United States, the increasing prevalence of adolescent-onset type 2 diabetes (T2D) is a significant public health issue (Mayer-Davis et al., 2017). Formerly considered a disease limited to older adulthood, adolescent-onset T2D disproportionately affects girls from historically marginalized racial and ethnic groups and appears to manifest more aggressively than adult-onset T2D, potentially accelerating morbidities and mortality (Mayer-Davis et al., 2017; Nadeau et al., 2016). In fact, youth-onset T2D is twice as common in girls as compared to boys, with lifetime risks of diagnosed T2D exceeding 50% among Hispanic and non-Hispanic Black women (Gregg et al., 2014; Mayer-Davis et al., 2017).

Over the past half-century, the manifestation and rising prevalence of adolescent-onset T2D among American youth have mirrored the dramatic increases in pediatric obesity (Ogden et al., 2016). Adolescent obesity, defined as a body mass index (BMI) equal to or exceeding the 95th percentile for age and sex, affects approximately 20% of individuals between the ages of 12 and 19 years (Ogden et al., 2016). Similar to adolescent-onset T2D, the majority of adolescent obesity incidence occurs in disadvantaged racial and ethnic groups, with elevated rates among Hispanic and non-Hispanic Black adolescent girls (Ogden et al., 2016). It should come as no surprise that these population trends are linked, given the well-established effect of excess adiposity on reduced insulin sensitivity or insulin resistance (Franks et al., 2007). Insulin resistance, the key physiological precursor to T2D, is the diminished sensitivity of the body's cells to respond to and use glucose (Lebovitz, 2001). Insulin resistance can eventually result in deterioration in insulin secretory capacity and permanent beta-cell failure, referring to the

inability of beta-cells of the pancreas to secrete sufficient insulin, giving rise to hyperglycemia and T2D (Lebovitz, 2001). Over and above a family history of T2D, poor insulin sensitivity and obesity in adolescence have been shown to increase one's risk of developing T2D in adulthood (Morrison et al., 2010; Sabin et al., 2015).

Considering that puberty is characterized by a natural decline in insulin sensitivity, pubertal insulin resistance can exacerbate the insulin resistance of obesity, rendering adolescence an especially sensitive period for youth at risk for T2D (Kelsey & Zeitler, 2016). Adolescence serves as an extremely important time for the study of potentially modifiable influences on insulin sensitivity, given the natural decreases in insulin sensitivity during puberty and the plethora of psychosocial stressors emerging during this developmental phase (Hannon et al., 2006; Pervanidou & Chrousos, 2012). Hallmark developmental stressors of adolescence include academic challenges, heightened interest in romantic relationships or experiences, role transitions, social pressures, pubertal maturation, and body dissatisfaction. Yet, despite the importance of this age span for insulin sensitivity and the marked increases in life stress during adolescence, most research on stress and T2D has focused on adults.

Stress, Weight Stigma, and Metabolic Health

In adults, stressful life events have been linked with the risk of having undetected T2D (Mooy et al., 2000). Stressors refer to adverse environmental or internal physical and/or emotional forces that threaten or are perceived to threaten one's homeostasis (Chrousos, 2009). The experience of chronic stressors leads to repeated, prolonged activation of the hypothalamic-pituitary-adrenocortical (HPA) axis (Chrousos, 2009). Bjorntorp (1997) formulated a theory on the biological plausibility of this stress-T2D association, stating that the most well-known activators of the HPA axis are psychological stressors that are perceived as overwhelmingly

stressful and elicit a defeatist reaction. Mechanistically, overactivity of the HPA axis results in hypersecretion of the stress hormone, cortisol, as well as inhibited secretion of sex steroid and growth hormones, and increased insulin secretion (Bjorntorp, 1997). Over time, this hormonal imbalance leads to visceral adiposity, amplifies insulin resistance, and heightens one's risk of developing T2D (Pervanidou & Chrousos, 2016).

Social-psychological stress specific to one's weight is one potent form of stress that may be relevant for T2D risk among individuals who have higher weight (Tsenkova et al., 2011). Research indicates that weight stigma is less studied than other forms of bias, even though it is considered more socially acceptable and may be more prevalent than sexism, racism, and other types of discrimination (Brochu & Esses, 2011; Puhl & Heuer, 2009). Estimates from community and general population samples show that approximately 40% of adults in the United States report a history of experiencing weight stigma, with higher prevalence rates in women compared to men (Himmelstein et al., 2017; Puhl et al., 2015; Puhl et al., 2020; Spahlholz et al., 2016). There is mounting evidence of weight discrimination across several key domains of living, with highly concerning, negative implications, including impairments in psychological well-being and physical health (Puhl & Heuer, 2009; Puhl et al., 2008). For example, in a sample of adults with overweight but without T2D, perceptions of having experienced weight stigma strengthened the association of women's degree of central adiposity with their poorer glycemic control, demonstrating that stressors related to weight-based discrimination could exacerbate adverse metabolic health consequences among individuals at-risk for T2D based upon their weight and adiposity (Tsenkova et al., 2011). In a similar sample of adults with obesity but without T2D, the odds of having high triglycerides and of meeting criteria for a metabolic syndrome, referring a cluster of metabolic problems that heighten risk for T2D, were

significantly increased among those with high weight bias internalization, or self-stigmatization about the negative attributes of obesity (Pearl et al., 2017). Relatedly, additional research exploring the role of psychological stressors in the association of weight or adiposity with metabolic health suggests that body norms may also be implicated in the pathophysiology of metabolic diseases like T2D. Body norms, defined as cultural standards of physical beauty, may elicit physiological stress responses that advance morbidity and mortality among individuals with obesity (Muennig, 2008). Together, these findings contribute to a growing body of literature demonstrating that the impacts of weight discrimination are not confined to psychosocial aspects of life but also extend to biomarkers of physical health.

Current research suggests that stress-related physiological mechanisms can be used to explain the association between social-psychological stressors and worsening health outcomes, as well as the cyclical nature of weight stigma (Tomiya, 2014). Rooted in health and social psychology theory, as well as neuroendocrinology, the cyclic obesity weight-based stigma or “COBWEBS” model represents weight stigma as a vicious cycle, or positive feedback loop (Tomiya, 2014). Social-evaluative stressors, such as weight stigma and pressure to be thin, are particularly threatening to individuals, as HPA activation is more likely to occur in social situations in which there is a heightened potential for negative judgment from others (Dickerson et al., 2004). Thus, experiences of weight-related psychosocial stress are particularly likely to activate the HPA axis and increase secretion of cortisol, initiating a cascade of biochemical, physiological, cognitive, and behavioral responses that promote maladaptive eating behaviors and weight gain (Tomiya, 2014). Substantial evidence demonstrates that chronically elevated levels of cortisol stimulate eating, increase the accumulation of visceral fat, and heighten insulin resistance (Bjorntorp & Rosmond, 2000; Chrousos, 2009). Although increased cortisol levels

play a role in eating behavior, it is common for individuals to increase their food intake in response to stress, as eating functions as a typical comfort-seeking behavioral response to stress (Tomiyama, 2014). Correlational studies indicate that, when exposed to higher levels of weight stigma, individuals with overweight and obesity are more likely to increase food intake (Myers & Rosen, 1999; Puhl & Brownell, 2006). Additionally, when considering the emotional mechanisms involved in generating behavioral responses, it is essential to note that experiences of weight stigma often evoke shame. Shame is a key emotional mechanism in the COBWEBS model because of its strength in engaging the HPA axis and increasing cortisol secretion (Kemeny et al., 2004). Ultimately, the physiological, emotional, and behavioral reactions that occur in response to weight stigma and weight-related pressure heighten one's risk of gaining additional weight, which can expose individuals to additional experiences of weight-based stigma and reactivate the cycle (Tomiyama, 2014).

Developmental Period of Adolescence and Pressure to be Thin

Although experiences of stress are harmful throughout the life span, adolescence is a particularly vulnerable developmental period to the effects of intense acute or chronic stress. Strong evidence suggests that stressful experiences during adolescence may exacerbate or lead to the development of many psychological, somatic, and metabolic conditions, such as depression, anxiety, obesity, metabolic syndrome, and T2D (Pervanidou & Chrousos, 2012). One particularly influential stressor among adolescents is pressure to be thin, defined as sociocultural messages supporting the thin-ideal, a culturally defined concept of physical attractiveness often characterized by ultrathin and lean body shapes (Stice, 2002). In the United States, the dominant culture equates beauty with success and social benefits for females, promoting thinness as the main requirement of feminine beauty (Schooler, 2008). Western media sources commonly

transmit these messages, and relationships function as proximal vehicles for the transmission of messages promoting the thin ideal. It is important to note that pressure to be thin includes any social reinforcement of thinness, including compliments regarding weight-loss and slenderness, as well as weight-related criticism and teasing. Studies exploring the influence of pressure to be thin consistently have found that these messages increase adolescents' risk of developing disordered eating, body dissatisfaction, and other unhealthy weight control behaviors (McKnight Investigators, 2003; Stice & Whitenton, 2002; Shomaker & Furman, 2009). Adolescents with higher weight report experiencing more pressure to be thin than lean youth (Neumark-Sztainer et al., 2002). Further, pressure to be thin has been associated with increases in adiposity and excess BMI gain during adolescence, particularly in adolescents with obesity (Suelter et al., 2018).

Schvey and colleagues (2016) have also linked pressure to be thin with insulin resistance, independent of BMI or body composition. However, to our knowledge, no other studies have investigated this association in adolescents. Additional research is needed to determine whether pressure to be thin relates to insulin resistance, particularly in adolescents who may be at heightened risk for T2D. If pressure to be thin and insulin resistance are connected, particularly independent of body composition or BMI, then intervening with pressure to be thin could potentially offer a novel approach to prevention efforts to reduce T2D risk among adolescents.

Ethnic and Racial Differences

Given that much of the research surrounding weight-related pressure has been conducted in samples of predominantly non-Hispanic White girls and women, there is a need for further exploration of differences in perceived pressure to be thin among individuals of varying ethnic and racial backgrounds (Grabe & Hyde, 2006; Himmelstein et al., 2017). With an increased prevalence of obesity among non-Hispanic Black and Hispanic females, it is crucial to examine

the influence of weight-related pressure on populations most affected by obesity and T2D (Himmelstein et al., 2017). On the one hand, some findings suggest that racial and ethnic minorities are more equipped to handle weight-related discrimination and are less affected by perceived pressure to be thin after experiencing stigmatization in a white-dominated culture (Neumark-Sztainer et al., 1998). However, on the other hand, these differences have been shown to vary across ethnic groups, and Grabe and Hyde (2006) underscore that racial and ethnic minority females should not be analyzed as a homogenous group. As cultural and social group contexts alter individuals' perceptions of beauty and body image ideals, individuals may differ in the extent to which they experience pressure to be thin. Across the literature, differences in perceived weight-related pressure are most apparent between non-Hispanic Black and White women (Himmelstein et al., 2017). However, to what extent there are differences among Asian American, Hispanic, and White women remains unclear (Grabe & Hyde, 2006).

More specifically, research indicates that non-Hispanic Black females, on average, are less fearful of being overweight, are more accepting of larger body sizes, report experiencing less weight-related pressure and higher body satisfaction, and do not feel obligated to adhere to the thin ideal (Grabe & Hyde, 2006; Himmelstein et al., 2017). Research exploring beauty or attractiveness ideals among non-Hispanic Black and White adolescents highlights the significance of physical traits among White adolescents and the value of personality characteristics among Black adolescents (Parker et al., 1995). Additionally, findings suggest that BMI is more likely to be underestimated by non-Hispanic Black girls and women, with many reporting body sizes that medically, would be considered overweight or obesity, as normal and acceptable (Himmelstein et al., 2017). Grabe and Hyde (2006) suggest that gender roles differ between Black and White women due to the effects of institutional racism. Unlike White women,

who are frequently socialized to function passively and depend on males, these traits present more risks for Black women, who are often taught to value autonomy, strength, and independence (Lovejoy, 2001). Altogether, research suggests that both a lessened focus on physical appearance and a greater appreciation for fuller body sizes could be anticipated to protect non-Hispanic Black adolescent girls from adverse effects of pressure to be thin on insulin sensitivity (Grabe & Hyde, 2006).

Conversely, levels of perceived weight-related pressure among other non-White groups, including Hispanic and Asian American women, may be more similar to those of White women (Himmelstein et al., 2017). These similarities are hypothesized to originate from the interaction of traditional cultural values with the thin ideal. For instance, Hispanic women often are expected to adhere to a feminine gender role, which is often associated with a greater emphasis on physical appearance (Grabe & Hyde, 2006). Among Asian American women, research suggests that this group's collectivistic values may increase their sense of obligation to conform to the thin ideal (Grabe & Hyde, 2006). Although anti-fat attitudes have been reported among White, Hispanic, and Asian Americans, it is unclear how each group internalizes and copes with the thin ideal (Himmelstein et al., 2017). Taken together, these findings illustrate the known differences and similarities in perceived pressure to be thin among these racial groups. However, there is a need for greater clarity regarding the characteristics that increase one's risk for worsened insulin resistance in response to weight-related pressure to be thin (Himmelstein et al., 2017).

Summary of Background Literature and Significance

Altogether, it is evident that there are a host of developmental implications and societal costs associated with heightened insulin resistance during adolescence. The psychosocial stressors associated with this developmental phase, in conjunction with the normative changes in decreased insulin sensitivity of puberty, make this a sensitive time period for individuals with increased risk of developing adolescent-onset T2D among youth who are already at-risk. Furthermore, race/ethnicity is often included as a control variable across the literature surrounding pressure to be thin, which eliminates the possibility of obtaining important information about the populations most affected by obesity and T2D. The lacking diversity in this line of research is alarming from a social justice and public health perspective. In failing to consider racial/ethnic differences in the association of perceived pressure to be thin with insulin resistance, researchers are missing the opportunity to learn how individuals' social identities overlap at structural and social levels to affect obesity and T2D risk. Thus, this study begins to fill this notable gap in the literature by examining how experienced pressure to be thin is associated with insulin resistance in a diverse sample of adolescent girls at risk for T2D.

Current Study

Although weight-related pressure has been linked to adverse health behaviors that contribute to obesity and poor insulin sensitivity, the literature to date is comprised of few studies, and none have examined how pressure to be thin manifests among adolescents across different racial/ethnic groups. The current study was specifically focused on Hispanic and non-Hispanic participants, as Hispanics represent the largest racial/ethnic minority group in Colorado, the geographic site of recruitment for this study. The first aim of the current study was to test the association between perceived pressure to be thin and insulin sensitivity, and the second aim was to explore the extent to which racial/ethnic identity moderated the association of pressure to be thin and insulin sensitivity in Hispanic and non-Hispanic participants. More specifically, this study addressed the following questions: (i) Is pressure to be thin associated with insulin sensitivity, even when accounting for body composition? and (ii) To what extent does racial/ethnic identity modify the association between pressure to be thin and insulin sensitivity? As discussed in the literature, psychosocial stressors have been shown to adversely relate to metabolic functioning (Schvey et al., 2016; Tomiyama, 2014). When addressing the first research question, we predicted that greater pressure to be thin would be associated with more impaired insulin sensitivity, even when accounting for body composition. This hypothesis was based upon the significant findings presented by Schvey and colleagues (2016), which demonstrated a positive association between pressure to be thin and reduced insulin sensitivity, irrespective of body composition.

When addressing the second, exploratory research question, the findings surrounding weight-related pressure, body ideals, and rates of body dissatisfaction among racial/ethnic groups

were considered (Himmelstein et al., 2017). Given the well-documented prevalence of body dissatisfaction, anti-fat attitudes, and internalization of the thin ideal, we predicted that there would be a significant association between pressure to be thin and impaired insulin sensitivity among adolescents identifying as non-Hispanic (Grabe & Hyde, 2006). With similar rates of body dissatisfaction and cultural adherence to the thin ideal, it was anticipated that the association between pressure to be thin and reduced insulin sensitivity would also be significant among Hispanic participants (Grabe & Hyde, 2006). It is important to note that the second aim and corresponding hypotheses on race and ethnicity as a moderator were framed as exploratory. It was our hope that these findings would shed light on the potential role of pressure to be thin in insulin sensitivity and how this association might differ among racial and ethnic groups of adolescents to inform improved prevention and intervention efforts in adolescent girls at heightened risk for developing T2D.

Method

Participants

Participants within the study included girls that were participating in a larger study examining the effects of behavioral interventions for depressive symptoms on insulin sensitivity and T2D risk. Convenience sampling strategies were utilized to recruit participants from the Denver-metropolitan area through local community postings, direct mailings to area families with adolescent daughters, newspaper and radio advertisements, and notices on local school parent Listservs. Participants were also recruited through physician referrals from Children's Hospital Colorado patients who are identified as eligible based upon a review of the electronic medical record, which records the BMI of patients and documents their family history of T2D.

Inclusion criteria were: (i) female; (ii) age between 12 and 17 years; (iii) overweight or obesity, determined as a body mass index (BMI) greater than or equal to the 85th percentile for age and sex; (iv) moderate depressive symptoms, defined as a total score greater than 20 on the 20-item Center for Epidemiologic Studies-Depression Scale (CES-D; Radloff, 1977); (v) the ability to speak and comprehend spoken English to participate in group interventions; (vi) parent-reported T2D, prediabetes, or gestational diabetes in one or more first-or second-degree relatives; and (vii) good general health as determined from parent-reported medical history and physical examination performed by a physician. Exclusion criteria included: (i) pregnancy or breastfeeding; (ii) major medical issues, such as T2D (determined as a fasting glucose ≥ 126 mg/dL, 2-hour OGTT glucose > 200 mg/dL, or HbA1c ≥ 6.5); (iii) medication that could affect insulin resistance, body weight, or mood, such as antidepressants, stimulants, or insulin sensitizers; (iv) DSM-5 major psychiatric disorder that would impede compliance and necessitate

more intensive treatment; (v) active suicidal ideation or suicidal behavior, and (vi) current participation in weight loss or psychotherapy treatment programs.

Procedures

Following a brief phone screening, interested participants were screened for eligibility and completed baseline assessments at an outpatient research center. In the first screening laboratory visit, guardians provided active, written informed consent, and assent was obtained from adolescents. Researchers also reviewed the purpose of the study, testing procedures, and program components in detail with the participants and their parents/guardians. Adolescents and guardians were informed of the potential risks, benefits, and inconveniences of participating in the study, as well as their right to alternatives and withdrawal. After reviewing this information with the participants, adolescents' BMI indices and medical health histories were recorded. In the second screening visit, insulin sensitivity and body composition were measured, and participants also completed questionnaires.

Measures

Pressure to be thin. The Pressure to be Thin Subscale of the Pressure to be Physically Attractive Questionnaire (PPAQ-THIN; Shomaker & Furman, 2008) was used to measure perceived pressure to be thin. The PPAQ-THIN is designed to assess multiple reports of pressure to be thin and criticism regarding physical appearance in specific, interpersonal relationships and has demonstrated good internal reliability (Cronbach's $\alpha = .75$; Shomaker & Furman, 2009; Schvey et al., 2016). More specifically, the PPAQ-THIN assesses adolescents' perceptions of how frequently their mother figure, father figure, an opposite-sex friend, a same-sex friend, and romantic partner provide positive reinforcement of thinness. An example item is, "This person gives me compliments when it looks like I've lost weight." Within the subscale, there are

typically three items per relationship, such that the total number of items completed by participants varies depending on their interpersonal network. However, participants' reports of pressure to be thin were combined across all sources in the present study, so that each participant responded to a total of three items focused on reinforcements of thinness in all of their relationships. Items are rated on a 5-point Likert scale, ranging from 1 (*not at all*) to 5 (*almost always*), with higher scores representing greater perceived pressure to be thin.

Parents also completed a parallel version of the questionnaire at baseline. They reported the extent to which they pressured their teen to be thin. An example item is, "I give my son/daughter compliments when it looks like he/she has lost weight." This scale has demonstrated good internal reliability (Shomaker & Furman, 2009).

Perceived stress. The Perceived Stress Scale (PSS; Cohen 1994) was used to measure perceptions of stress (Cohen et al., 1983). More specifically, the PSS measures the extent to which individuals assess their lives as stressful by including ten items that focus on how unmanageable, unpredictable, and overwhelmed respondents viewed their lives throughout the past month. An example item is, "In the last month, how often have you felt that you were unable to control the important things in your life?", and items are rated using a Likert scale. The Likert scale ranges from 0 (*never*) to 4 (*very often*), with higher sums representing greater perceived stress. Initially designed for use in community samples with a minimum of junior high school education, the PSS contains items that are simple and easy to understand, and response alternatives are also straightforward. Ultimately, the questions in the scale are not specific to any subpopulation, which contributes to the global nature of the measure (Cohen et al., 1983; Cohen, 1994).

Insulin sensitivity and resistance. An oral glucose tolerance test (OGTT) was administered to adolescents to yield estimates of insulin sensitivity, as this test is well validated and less invasive than clamps. After a 10-hour overnight fast, participants received 1.75 g/kg of glucola, and blood was sampled using an intravenous line for insulin, glucose, and C-peptide at fasting, 10, 20, 30, 60, 90, and 120 minutes after glucola. Estimations for insulin sensitivity and resistance were calculated using the whole-body insulin sensitivity index (WBISI), which has excellent convergent validity with clamps in nondiabetic youth with obesity (Yeckel et al., 2004; Gungor et al., 2004).

Anthropometrics. Height was measured by stadiometer to the nearest millimeter in triplicate, and fasting weight was measured to the nearest 0.1 kilogram by calibrated digital scale. BMI (kg/m^2) was computed to estimate eligibility and was calculated as weight divided by the square of height. Additionally, body composition was measured using the Hologic QDR Discovery A (SN81337; Bedford, MA), the gold standard for assessing total fat and lean mass (Bauer et al., 2012).

Data Analytic Plan

Data Preparation

Data were examined for outliers, skewness, and kurtosis. All analyses were conducted using IBM SPSS Statistics for Windows version 26 (IBM Corp., Armonk, NY).

Statistical Analyses

Analyses proceeded from simple to more complex. Descriptive information was generated about the study sample demographics and key variables. An independent-sample t-test was used to describe differences in non-Hispanic and Hispanic participants in key variables. Pearson correlations were also conducted to examine associations between continuous variables. Analyses of covariance (ANCOVA) were performed to assess the associations of pressure to be thin and race/ethnicity and their interaction on insulin sensitivity/resistance, controlling for variables selected a priori that have been shown to be associated with insulin function in adolescents, including chronological age, pubertal stage, body fat mass, fat-free mass, and height (Travers et al., 1995). Separate models were evaluated for adolescent-reported pressure to be thin and parent-reported pressure to be thin.

Results

Preliminary Analyses

Descriptive information. A convenience sample of 92 adolescent girls was used to conduct the secondary data analysis for this master's thesis project. **Table 1** displays a summary of demographic, anthropometric, and psychological information for the sample. Average age was 14.95 ± 1.82 years, and mean BMI z-score was 1.88 ± 0.47 . The racial/ethnic composition of the sample was 46% Hispanic. The remainder of adolescents were non-Hispanic, comprised of 34% non-Hispanic White adolescents, 12% non-Hispanic Black, 3% American Indian/Alaska Native, 3% Asian, and 2% Native Hawaiian/Other Pacific Islander adolescent females.

Table 1

Demographic, anthropometric, and psychological characteristics

Variable	Mean	Standard Deviation	Range
Age, years	14.95	1.82	12-17
BMI ^a , kg/m ²	31.61	5.63	24-47
BMI, z score	1.88	0.47	1-3
BMI, percentile	95.68	3.74	85-100
Body fat, %	43.60	4.98	29-55
Lean mass, kg	43,468.89	9,281.26	5046-65,653
WBISI ^b	3.95	2.43	0.42-14.50
Height, cm	162.50	7.47	145-177
Depressive symptoms	29.16	6.36	10-54
Perceived stress	28.32	6.80	4-44
Pressure to be thin	2.39	1.00	1-5
Parent-report pressure to be thin	2.25	1.29	1-5
Variable	Percentage	n	
Race/ethnicity			
Non-Hispanic	54.1	40	
Hispanic	45.9	34	
Pubertal stage			
Tanner 2	2.6	2	
Tanner 3	1.3	1	
Tanner 4	6.6	5	
Tanner 5	89.5	68	

Note. ^a Body mass index, ^b Whole-body insulin sensitivity index

Bivariate associations. A series of independent-samples t-tests were conducted to assess for ethnicity-related simple differences between Non-Hispanic and Hispanic participants. Among adolescent participants, there were significant differences in height and fat percentage by ethnicity. Non-Hispanic adolescent females ($M = 165.46$, $SD = 6.69$) were significantly taller than Hispanic adolescent females ($M = 158.65$, $SD = 6.72$), $t(70) = -4.30$, $p < .001$, and body fat percentage was significantly higher in Hispanic adolescents ($M = 45.15$, $SD = 4.31$) compared to non-Hispanic adolescents ($M = 42.17$, $SD = 5.32$), $t(70) = 2.58$, $p = .01$. Additionally, there was a significant difference in parent-reported pressure to be thin such that parents of Hispanic adolescent females reported greater pressure toward their adolescent ($M = 2.75$, $SD = 1.33$) than parents of non-Hispanic adolescent females ($M = 1.97$, $SD = 1.22$), $t(68) = 2.58$, $p = .01$. Conversely, there was no statistically significant difference in insulin sensitivity between non-Hispanic ($M = 4.33$, $SD = 2.16$) and Hispanic ($M = 3.76$, $SD = 2.99$) participants, $t(69) = -.94$, $p = .40$. No other study variables differed by ethnicity.

Correlations among key study continuous variables are displayed in **Table 2**. As would be expected, there was a strong, positive correlation between body fat percentage and BMI z-score, $r(73) = .68$, $p < .001$. Also as expected, insulin sensitivity and BMI z-score were negatively correlated, such that the greater adolescent females' BMI z-score, the poorer their insulin sensitivity, $r(71) = -.45$, $p < .001$. There were no other significant associations among key study variables.

Table 2

Bivariate associations

Variable	1.	2.	3.	4.	5.	6.	7.
1. BMI ^a , z score	—						
2. Body fat, %	.68***	—					
3. Teen PPAQ ^b	.12	-.02	—				
4. Parent PPAQ ^c	.11	.17	.18	—			
5. PSS ^d	.07	-.03	-.15	-.20	—		
6. CESD ^e	.21	.12	-.13	-.11	.28*	—	
7. WBISI ^f	-.45***	-.26*	-.07	.09	-.10	.06	—

Note. * $p < .05$, *** $p < .001$; ^aBody mass index, ^bTeen-reported pressure to be thin on the Pressure to be Physically Attractive Questionnaire, ^cParent-reported pressure to be thin on the Pressure to be Physically Attractive Questionnaire; ^dTeen-reported perceived stress on the Perceived Stress Scale, ^eTeen-reported depressive symptoms on the Center for Epidemiologic Studies-Depression Scale, ^fWhole-body insulin sensitivity index.

Primary analyses. Analysis of covariance (ANCOVA) was conducted to determine if pressure to be thin was associated with insulin sensitivity and whether there were moderating differences between Hispanic and non-Hispanic ethnicity, after controlling for depressive symptoms, perceived stress, pubertal stage, body fat mass, fat-free mass, and height. Adolescent and parent-report of pressure to be thin were tested in separate ANCOVA models. There were no main or interactional effects by ethnicity of either adolescent-reported or parent-reported pressure to be thin on insulin sensitivity (all p -values $> .05$).

Lean mass was the only significant predictor of insulin sensitivity, such that greater lean mass related to higher (more positive valence) insulin sensitivity $F(1,57) = 5.38, p = .02$.

Discussion

The present study represents the first systematic investigation of pressure to be thin and insulin sensitivity at the intersection of ethnicity. Previous studies have emphasized the importance of examining potentially modifiable influences on insulin sensitivity in adolescence, given that the bulk of this research has focused on adult samples (Hannon et al., 2006; Pervanidou & Chrousos, 2012). Furthermore, Schvey and colleagues (2016) identified pressure to be thin as a salient psychosocial stressor in adolescence and found an inverse relationship between pressure to be thin and insulin sensitivity in a sample of adolescents, independent of body composition (Schvey et al., 2016). Thus, the objectives of the present study were to examine the association between pressure to be thin and insulin sensitivity and explore the extent to which racial/ethnic identity moderated this association in a sample of girls at-risk for developing T2D.

Contrary to the hypothesized association between pressure to be thin and insulin sensitivity, results indicated that this link was non-significant in the current sample. This result is inconsistent with previous findings that supported an inverse association between perceived pressure to be thin and insulin sensitivity (Schvey et al., 2016). However, it is important to note that sex moderated this relationship within Schvey and colleagues' (2016) study, such that the association between pressure to be thin and impaired insulin sensitivity was strongest among male participants (Schvey et al., 2016). This finding may provide insight into our non-significant association, given that the sample in the present study was composed of females. The sample's diabetes risk status is also important to note when considering why pressure to be thin was less salient for insulin sensitivity, as all participants had at least one family member with diabetes.

Future research is warranted to better understand the influence of pressure to be thin in families with histories of diabetes. Furthermore, adolescents' reports of pressure to be thin were combined across all sources, as the measure did not differentiate the participants' relationship types. In past studies, reports of pressure to be thin were separated by relationship type (Schvey et al., 2016; Suelter et al., 2018). The erroneous administration of the questionnaire may have influenced the association between pressure to be thin and insulin sensitivity in the present study. It is also possible that the study was underpowered and, thus, unable to detect a significant outcome. Vadillo and colleagues (2016) caution against over-interpreting null results, as null findings indicate that there is inadequate support for the experimental hypothesis but provide no information regarding the amount of support for the null hypothesis. Ultimately, replication studies with larger sample sizes are warranted to better understand the association between pressure to be thin and insulin sensitivity.

Additionally, future research is needed to understand the role of thin-ideal internalization in the association between perceived pressure to be thin and insulin sensitivity (Thompson & Stice, 2001). Thin-ideal internalization is defined as the extent to which one adopts socially determined ideals of attractiveness and participates in behaviors intended to improve their likelihood of achieving those ideals (Thompson et al., 1999). This internalization has been linked with increased use of social networking sites, body dissatisfaction, disordered eating, and negative affect (Mingoia et al., 2017; Stice, 2001). Research suggests that individuals are more likely to experience thin-ideal internalization if significant or respected others express approval of the thin-ideal through comments or actions (Kandel, 1980). This social reinforcement of thinness, which aligns with our definition of pressure to be thin, appears to play an important role in the transmission of thin-ideal internalization. However, additional research is needed to better

understand the salience of thin-ideal internalization for insulin sensitivity and T2D risk (Thompson & Stice, 2001).

Likewise, our findings did not support the moderation hypothesis, as the link between perceived pressure to be thin and insulin sensitivity was not moderated by racial/ethnic identity. There are some potential explanations for this finding. Previous research suggests that non-White adolescents may value a curvy body ideal more than the dominant thin ideal. Unlike the ultrathin silhouette that is often idolized by White girls and women, the curvy body ideal is characterized by large breasts and hips, a thin waist, and a large behind (de Casanova, 2004; Goodman, 2002). Winter and colleagues (2019) found that women of color place great value on non-body size and shape characteristics, such as facial features and hair, indicating that these physical characteristics may be equally important to assess for as body shape and size. It has also been suggested that women of color may have a greater appreciation for style and movement over body size (de Casanova, 2004). However, these characteristics are seldom included in body image assessments and research, despite discussions of their significance in previous work (Byrd & Solomon, 2005). These findings demonstrate the importance of contextualizing individuals' body image development, as the thin ideal does not fully capture the embodied experiences of girls and women of color.

Given that the association between pressure to the thin and insulin sensitivity was non-significant for all racial and ethnic groups in the present study, it is also important to consider different factors influencing the salience of pressure to be thin in individuals' lives. According to Aniulis and colleagues (2021), social media usage, as well as exposure to images of ideal bodies, has been associated with greater body dissatisfaction, disordered eating, and adoption of the thin ideal. The body positivity movement, with roots in feminist ideology, advocates for the

celebration of diverse body types and denounces the idea of a dominant body ideal (Cwynar-Horta, 2016). This movement is gaining popularity in Western culture and on social media (Aniulis et al., 2021). Findings from a study conducted by Aniulis and colleagues (2021) indicate that ideal body perceptions are influenced by the presentation of more diverse body types, however, these perceptions appear to shift around societal standards. These results suggest that body ideals are adaptable and influenced by body types that one is exposed to. Thus, exposure to different bodies on social media may play an important role in cultivating healthy body ideals and fostering greater body acceptance among individuals.

Results from this investigation also revealed significant differences in parent-reported pressure to be thin, with parents of Hispanic adolescent females reporting greater pressure toward their adolescent than parents of non-Hispanic females. Although this was not a primary finding, it is still interesting to consider in light of some suggestion of greater “body policing” and weight management practices in Hispanic/Latina families compared to families of other races and ethnicities (Winter et al., 2019). Body policing is defined as the practice of monitoring one’s appearance through statements and behaviors suggesting that their body does not conform to social norms or ideals (Schooler & Lowry, 2012). According to Winter and colleagues (2019), these experiences have been connected to acculturative stress regarding conflicting media depictions of the ideal body in the United States (Goodman, 2002; Schooler & Lowry, 2012). A previous study examining this phenomenon found that greater acculturation into mainstream American culture was linked with thinner body ideals among Hispanic/Latina women (Cachelin et al., 2006). Altogether, increased weight management practices have been shown to heighten the likelihood of eating pathology and depression for Hispanic/Latina women and may be important to consider when examining T2D risk in Hispanic girls (Kronenfeld et al., 2010;

Schooler & Lowry, 2012; Wildes et al., 2001). These findings highlight the significance of attending to individuals' overlapping social identities, as socioeconomic status, gender, generation status, level of acculturation, and country of origin may contribute to widely different experiences with body image. Future studies must examine the ways in which these factors influence body image development in diverse communities.

Considerations and Future Directions

The current data add to the growing body of literature surrounding the role of cultural influences in beauty standards and how the internalization of these ideals may impact several aspects of health. Strengths of this study include the use of objective BMI and anthropometric measurements, multiple informant reports, and the inclusion of a relatively racially/ethnically diverse sample of adolescents. However, the present study has several notable limitations. First, the cross-sectional nature of the data limits our ability to make any causal interpretations. Thus, longitudinal studies are needed to clarify the psychological factors that are predictive of metabolic dysfunction in adolescents. Additionally, pressure to be thin and perceived stress were measured via self- or parent-report, which introduces the potential for reporting bias. Furthermore, adolescents' reports of pressure to be thin were combined across all sources, making it difficult to identify sources that were particularly salient. Future studies may benefit from using alternative methodologies to assess pressure to be thin, such as recorded conversations between parent-adolescent dyads or ecological momentary assessments (Suelter et al., 2018). Third variable explanations cannot be dismissed either, as potential confounding factors, including daily diet, past dieting attempts, loss of control eating, parent weight, and socioeconomic status, were not included in the current analysis plan. Future studies examining the influence of psychosocial factors on insulin sensitivity will benefit from exploring body

image development in diverse samples, with a specific focus on media consumption, acculturation status, and thin-ideal internalization.

It is evident that there are multiple developmental and societal costs associated with heightened insulin resistance during adolescence. Among youth with increased risk for developing early-onset T2D, this period is critical for determining the course of health-related outcomes. Given that the majority of youth-onset T2D incidence occurs in marginalized racial and ethnic groups, it is imperative to further understand the psychological constructs that predict insulin sensitivity in diverse populations, as pressure to be thin may not be as relevant to these groups. Longitudinal studies will help illuminate the underlying mechanisms involved in the association between social-psychological stressors and worsening health outcomes in diverse samples. Ultimately, these findings will be helpful in guiding the development of culturally informed prevention and intervention efforts targeting T2D risk and promoting resilient body image perceptions.

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