THE MODERATING EFFECT OF PERCEIVED PEER INCLUSION ON INTERNALIZED WEIGHT STIGMA AND PHYSIOLOGICAL AROUSAL IN ADOLESCENTS

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ABSTRACT

THE MODERATING EFFECT OF PERCEIVED PEER INCLUSION ON INTERNALIZED WEIGHT STIGMA AND PHYSIOLOGICAL AROUSAL IN ADOLESCENTS

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While existing research has largely concentrated on clinical populations, this study examined the experiences of weight stigma in a typical adolescent sample. We hypothesized that adolescents with higher internalized weight stigma will show increased sympathetic nervous system reactivity and decreased parasympathetic regulation during a peer-to-peer discussion task. Additionally, peer inclusion will moderate the effect of weight stigma on physiological responses, with low peer inclusion intensifying the effects of internalized weight stigma. The study involved 31 adolescents from a magnet school in North Carolina who completed self-report questionnaires to assess internalized weight stigma and peer inclusion. The heart rate variability (HRV) of participants was used to measure sympathetic and parasympathetic activity in terms of modal amplitude and RR intervals. Peer inclusion was found to significantly moderate the relationship between internalized weight stigma and sympathetic reactivity when discussing past experiences of weight bullying/stigmatization. Specifically, adolescents who endorsed high levels of internalized weight stigma and low peer inclusion exhibited heightened sympathetic reactivity in response to the peer discussion task. The findings of this study support the idea that peer inclusion plays a major role in the development of physiological reactivity in response to weight related stressors.

Introduction

Over the last 50 years American society has declared a "war on obesity", which has supported a weight-centered health paradigm that being fat is unhealthy and bad (O'Hara & Gregg, 2006). As a result of this societal paradigm, weight stigma, defined as an individual's social devaluation due to their perceived weight (Tomiyama et al., 2018), is considered acceptable and commonplace. Despite the normalcy produced by these societal weight related initiatives, weight stigma has a negative impact on psychological and physiological well-being regardless of age; however, the experience of weight stigma during the adolescent period of development (Riumallo & Durnin, 1988) might have particularly significant ramifications. The current study explores weight stigma in adolescence and examines the associations with physiological reactivity and regulation and peer relationships.

Research on adolescent weight stigma has primarily focused on clinical populations, whether it be participants experiencing disordered eating or those participating in clinically driven weight loss programs. This has left a void in examining the outcomes of adolescents experiencing weight stigma, especially those who do not appear to have higher weight. Many adolescents are believed to be exposed to significant levels of weight discrimination, commonly seen in the form of fat bullying or fat shaming (Monaghan, 2014). Recent research has demonstrated an increased prevalence of weight stigma over time, which has increased by 66% since the 1990's (Puhl & Heuer, 2010). Moreover, research in adult samples indicate that weight stigma impacts psychological and physiological outcomes (Putra et al., 2023). This study intends to bridge the gap in the literature regarding the impact of weight stigma on adolescents through the measurement of physiological arousal that is present during a peer-to-peer discussion about their experiences with weight stigma.

The current study sets forth to interpret the impact of internalized weight stigma on physiological reactivity in a general adolescent population and how perceived peer inclusion might moderate this relation, independent of weight status. Considering that many youth experience weight stigma during adolescence, yet not all youth develop negative outcomes as a result of this exposure, it would suggest that peer inclusion may play a role in altering the impact of weight stigma. Thus, only those adolescents who experience internalized weight-stigma and have low peer inclusion might experience increased physiological reactivity. This relationship may be associated with the increased relevance of peer support as youth age and develop better socioemotional regulation.

Weight Stigma

Weight stigma is defined as an individual's social devaluation due to their perceived excess body weight leading to prejudice and discrimination (Fulton et al., 2024). Weight stigma can be experienced by anyone regardless of their actual weight status, although it is experienced more frequently by individuals who are fat (Puhl et al., 2020). Weight stigma can be experienced externally from other individuals with whom the person interacts with, such as family members, peers, educators, health care providers, and even total strangers (Magson & Rapee, 2022). External weight stigma can be experienced as many different types of negative behaviors, such as bullying, exclusion, and differential treatment (Lewis et al., 2011). External weight stigma can also become internalized by the individual and be experienced as self-hatred, body dissatisfaction, and social vigilance (Lucibello et al., 2021; Wetzel & Himmelstein, 2023). Both externalized and internalized weight stigma might link to various negative outcomes; however, internalized weight stigma might be particularly relevant to physiological outcomes in response to stress.

Weight stigma may be a result of health concerns, originating from the idea that weight status is controllable by the individual, known as a weight-centered health paradigm (O'Hara & Gregg, 2006). Individuals might feel justified to devalue others because of their weight, due to the belief that being fat is "unhealthy" due to being linked to a variety of negative physiological health outcomes (e.g. increased risk of Type II Diabetes; Hossain et al., 2007). Additionally, some people think that fat shaming an individual might motivate the individual to lose weight. Unfortunately, this inaccurate assumption that weight stigmatization as a means of weight control and weight-centered health often results in more negative outcomes for individuals who are fat (Flint & Reale, 2018). Indeed, individuals who have been exposed to weight stigma are likely to have an increased drive to eat unhealthy foods, partake in emotional or "comfort" eating, and subsequent weight gain (Wellman et al., 2018). A secondary study was conducted by Wellman et al., (2018) to evaluate the relationship between weight stigma and weight gain within college students over a 10-week longitudinal study. The study results demonstrated that participants who experienced weight stigma were more likely to gain an average of 2.5 lbs. over the 10-week period than those who did not experience weight stigma. In addition to gaining weight, weight stigmatized individuals are also likely to have other negative physiological outcomes.

In addition, weight gain as a result of weight stigma, through emotional or comfort eating, has the potential risk of further damaging an individual's overall health due to the perpetual nature of weight stigma. Weight stigma and weight gain can result in increased barriers for obtaining health care due to fears of being weighed and receiving unsolicited weight loss advice (Puhl & Heuer, 2010). Other research has found other significant long-term implications of weight stigma on an individual's physiological functioning. Adults living with higher weight

or obesity participating in two experimental studies who were exposed to the external weight-stigma condition, such as exposure to weight stigma scenarios or videos, sustained higher levels of cortisol reactivity than the non-weight stigma sample (Wu & Berry, 2018).

Internalized weight stigma also has implications for physiological outcomes. Pearl and colleagues (2017) examined the association between internalized weight stigma and metabolic syndrome, which is a cluster of risk factors for physiological impairments, such as Type II diabetes. They found that for individuals who had higher internalized weight stigma they had an increased likelihood of meeting criteria for metabolic syndrome regardless of their weight status (Pearl et al., 2017). This would suggest that although weight status does predict metabolic syndrome, internalized weight stigma is also predictive of meeting criteria for physiological disorders, such as metabolic syndrome, higher blood pressure, and risk of stroke for individuals, independent of weight status. The link between weight stigma and physiological health outcomes might suggest that individuals who have experienced internalized weight stigma have higher physiological reactivity to the stress caused by internalized weight stigma.

Weight Stigma as a Predictor of Physiological Responses

Physiological reactivity and regulation are the processes that take place automatically in response to stressful situations. This immediate response to stressor is recognized as the "fight-or-flight" physiological reactivity response in which our sympathetic nervous system is activated to protect us from these potential dangers (McCorry, 2007). Simultaneously, our parasympathetic nervous system "rest and digest" physiological regulation response is deactivated (or experiences withdrawal) to also allow us to respond to the stressful or challenging situation (Porges, 1997). Although physiological responses to stress pose significant benefits in the face of danger, chronic dysfunctional physiological stress responses are linked to disease and illness. In extreme cases,

the degree of dysfunctional arousal an individual can develop general adaptation syndrome which may result in both physical and mental health conditions (McCarty, 2016). Despite physiological stress being most associated with being faced with physical danger, the body often perceives psychological stressors in a similar manner resulting in the activation of the sympathetic nervous system and deactivation of the parasympathetic nervous system. Due to the body's inability to differentiate between physical danger and mental stressors (Carter & Ray, 2009) it is important to identify predictors of physiological reactivity and regulation which may go unrecognized. Indeed, the presence of stress produced by experiences of weights stigma may be one of these predictors of physiological reactivity and regulation.

Some research has examined the relation between physiological reactivity and weight stigma. One study by Sutin et al. (2014) examined inflammatory biomarkers, C-reactive protein levels, in a sample of higher weight individuals (Sutin et al., 2014). They found that participants who experienced increased externalized weight stigma were more likely to have increased levels of C-reactive protein. These findings suggest that individuals who are fat have increased inflammatory biomarkers as a stress response to weight stigma.

Another study examined C-reactive protein levels of children and its association with parental weight perceptions. Results found that children who were perceived by their parents as "overweight" have increased inflammation (C-reactive protein) regardless of actual weight status (based on body mass index percentile cut-offs recommended by the Center for Disease Control) (Sutin et al., 2017). This might suggest that these individuals experienced weight stigma, which predicted higher physiological reactivity. They also ran additional analyses with a subsample of children who were categorized as "obese" based on recommended body mass index percentile cut-offs and found similar results: children who were categorized as "obese" or "overweight" but

were perceived by parents as being "the right weight" had lower C-reactive protein levels than those perceived by parents as being "overweight." Thus, these findings suggest that weight stigma reflected by negative perceptions of weight status represents a unique risk for physiological responses.

Another index of physiological reactivity and regulation that might be related to internalized weight stigma is heart rate variability (HRV). HRV is influenced by increased reactivity of the sympathetic nervous system to an acute stressor as part of the "fight or flight" response (low frequency HRV) and regulation of the parasympathetic nervous system to an acute stressor as part of the "rest and digest" response (high frequency HRV, Berger et al., 1989). During challenges or acute stressors, the body will increase sympathetic nervous system activity in coordination with decreases in parasympathetic nervous system activity to allow the individual to utilize physiological resources and respond to the challenge/stressor (Scott-Solomon et al., 2021). When the challenge or stressor is removed, the individual increases parasympathetic nervous system activity and decreases sympathetic nervous system activity to return the body to rest. It is also important to acknowledge that when utilizing positive and/or calming stimuli individuals often appear to have an increase in their high frequency HRV, which is associated with reduced stress, happiness, and "rest and digest" autonomic processes (Raz & Lahad, 2022).

Regardless of whether the challenging situation is psychological or physical, the autonomic response to stimuli triggers these acute physiological processes (Chu et al., 2022). As such, stressor paradigms have been designed to elicit the concurrent autonomic response of an individual without the need for imminent physical/psychological harm to assess these physiological responses. Many studies have utilized public speaking tasks (e.g. Trier Social Stress Test; Kirschbaum & Hellhammer, 1993) to increase physiological reactivity and regulation

of these participants. In addition to these social-evaluation stress tasks, researchers more recently used a parent-adolescent discussion task to also elicit increased autonomic arousal responses (Thomas et al., 2019). However, for adolescents these tasks might not be an appropriate stressor stimulus (Gunnar et al., 2009). Rather, peer discussion tasks might elicit even more autonomic arousal and be more appropriate to gauge parasympathetic and sympathetic nervous system responses to stress and their relations to weight stigma due to the increasing importance of peers during adolescence (Lam et al., 2014). Specifically, HRV has been linked to simulated peer exclusion tasks (Gunnar et al., 2009) and social communication in adolescents (Quintana et al., 2012) and might also be linked to peer discussion tasks that center on weight stigma or peer exclusion/conflict topics.

Adolescents who have increased internalized weight stigma might be particularly sensitive to peer discussion tasks and experience increased physiological reactivity (low frequency HRV) and decreased physiological regulation (high frequency HRV). Theoretically this link could be explained by weight stigmatized adolescents expecting more negative treatment from their peers because of their weight and more sensitivity to peer conflict/exclusion and peer weight stigma. This peer discussion on weight stigma might represent an increased stressor to adolescents who have already experienced increased externalized weight stigma and internalized this weight stigma. A study that focused primarily on peer-related stress and peer rejection in association between disordered eating, binge eating, and internalized weight/shape concerns found that sensitivity to rejection was directly associated with increased internalized weight stigma (Schell & Racine, 2023). Weight stigma is also associated with increased vigilance/sensitivity for future stigma (Wetzel & Himmelstein, 2023). Furthermore, this increase in sensitivity to weight stigma is believed to alter an individual's response to peer-to-peer stress

tasks, especially if discussing topics such as experienced weight stigma and/or peer disagreements. Ehrlich and colleagues (2015) found that individuals with high rejection sensitivity are likely more vigilant to recognize social cues linked to peer rejection and had elevated arousal in response to facial stimuli. Thus, it is possible that an individual who has increased levels of internalized weight stigma might experience more physiological arousal as a result of a peer-to-peer discussion activity. Moreover, this effect might be particularly pronounced if they have also experienced less peer inclusion.

The Moderating Role of Peer Inclusion

Adolescents who experience increased internalized weight stigma could have increased sensitivity to their peers, thus might be more sensitive to lower levels of peer inclusion. Subsequently, the experience of decreased peer inclusion may increase the impact of internalized weight stigma on physiological reactivity and dysregulation to stress. Moreover, studies have found that obesity in adolescents is associated with lower levels of peer inclusion, harassment, and bullying (Haqq et al., 2021). These findings could suggest that individuals with increased internalized weight stigma are more likely to have increased physiological reactivity and decreased physiological regulation to peer-to-peer stressors.

Peer inclusion is defined as being accepted and better liked by your peers. Youth with increased peer inclusion have more positive school and clinical outcomes. In addition, previous research findings that increased peer inclusion is associated with improved overall health outcomes among individuals aged 15 to 74 (Majeed & Liaqat, 2019). Additional research found that high levels of perceived social support were associated with high levels of mental well-being and low frequency of emotional symptoms, such as sadness (Petersen et al., 2023). Research also shows that positive peer relationships and peer attachment are associated with positive

psychological wellbeing (Portt et al., 2020). The psychological benefits include an increase in self-esteem, increased levels of empathy, and resilience (Tang et al., 2022). Resiliency in adolescents is associated with a better ability to manage both physical as well as psychological functioning when faced with stressful situations. This association between resiliency and physical health provides insight into the links between higher levels of peer acceptance and inclusion and high levels of autonomic regulation. Furthermore, the resiliency stimulated by peer inclusion might directly link to protection from physiological responses to peer-to-peer stressors. Thus, peer inclusion may protect adolescents from the negative consequences of internalized weight stigma and decrease physiological reactivity and increase physiological regulation to peer-to-peer stressors.

Present Study

The current study examined the association between weight stigma and physiological reactivity to an acute peer-to-peer stress task as moderated by peer inclusion in a sample of early adolescents while controlling for gender and current grade level. I hypothesized that adolescents who have increased internalized weight stigma will have increased sympathetic nervous system reactivity and decreased parasympathetic nervous system regulation during a peer-to-peer discussion task. Peer inclusion will have a moderating effect on the associated physiological responses predicted by internalized weight stigma, such that adolescents who have low levels of peer inclusion will have increased physiological reactivity and decreased physiological regulation to increased internalized weight stigma. Additionally, adolescents who have high peer inclusion will have decreased physiological reactivity and increased physiological regulation to increased internalized weight stigma. Due to the potential physiological differences between

genders and age-groups (Balhara et al., 2011), these variables will be utilized as covariates when examining the moderating effects of peer inclusion on physiological reactivity and regulation.

Method

Measures

Weight stigma. The Weight Bias Internalization Scale (WBIS-M; Pearl & Puhl, 2014) was used to assess internalized weight stigma. The WBIS-M is a 10 item self-report measure utilizing a seven-point Likert scale ranging from *strongly disagree* through *strongly agree*. Specific questions include: "I am less attractive than most other people because of my weight," "I hate myself for being overweight," and "Because I'm overweight, I don't feel like my true self." Higher mean scores indicate greater internalized weight stigma. This measure is recognized as being psychometrically valid within this sample ($\alpha = .85$) as a univariate measure in adolescents ($\alpha = .92$, Roberto et al., 2012) and has appropriate predictive value for outcomes such as body dissatisfaction, drive for thinness, and binge eating (Pearl & Puhl, 2014).

Peer inclusion. Items based on the Interpersonal Relations scale from the Behavior Assessment System for Children, Third Edition (BASC-3; Reynolds & Kamphaus 2015) were used to assess the participants' beliefs on how their peers perceive them. Participants provided ratings of how often they experience or feel specific interpersonal attributes on a four-point Likert scale listed as *never, sometimes, often,* and *almost always.* This study utilized the following three items ($\alpha = .81$): "I get along well with others," "I am liked by others," and "People think I am fun to be with." A mean score was created, with higher mean scores indicating more peer inclusion.

Sympathetic Nervous System Reactivity and Parasympathetic Nervous System Regulation. To index sympathetic nervous system reactivity, heart rate variability (HRV) was assessed via an electrocardiogram monitoring of participants' heart rate and heart rhythm was monitored. These participants were monitored at baseline and then again during the peer discussion task in order to obtain measurements at rest and during acute stress (*Electrocardiogram (Ecg or Ekg) - Mayo Clinic*, 2022). HRV is defined as the fluctuation in time intervals between adjacent heart beats (Shaffer & Ginsberg, 2017). HRV was measured based on the power of the HRV frequency band with low frequency HRV used as an index of sympathetic nervous system reactivity. Whereas the power of the HRV frequency band with high frequency HRV was used as an index of parasympathetic nervous system reactivity (Sieciński et al., 2020).

Following data collection participant raw heart rate data was transformed using Kubios HRV software into the square root of the mean of the squares of the successive differences between adjacent NN intervals (RMSSD; parasympathetic regulation assessed by calculating the high frequency band power) and Baevsky Stress Index (Baevsky, 2008; sympathetic activation assessed by calculating the low frequency band power) values. Followed by each participant's aggregated HRV results being partitioned into baseline and talking segments of the peer-to-peer discussion task. Each participant's low frequency HRV values (Baevsky Stress Index), at baseline were aggregated and subtracted from their aggregated low frequency HRV values (Baeysky Stress Index) during the talking segment of the peer-to-peer interaction task. More positive scores in low frequency HRV changes indicate more reactivity during task. In addition, each participant's high frequency HRV index values (RMSSD) at baseline were aggregated and subtracted from their aggregated high frequency HRV index values (RMSSD) during the talking

segment of the peer-to-peer discussion task. More negative scores in high frequency HRV changes indicate more regulation during task (adequately withdrawing sympathetic nervous system to effectively respond to the challenge).

Demographics. Participants' parents were asked to answer a demographic questionnaire to ascertain the gender identity, racial identity, education level, family income of the parents as well as the participant's age, height, weight, gender identity, and racial identity. In addition to a parent questionnaire, the participants were asked to provide their current grade level, gender, and date of birth.

Participants and Procedure

The research team recruited adolescents between the ages of 11 and 15 from the Catamount School at Western Carolina University. Parents of these adolescents provided consent for their adolescents to participate and were asked to provide demographic information for themselves and their adolescent. These participants were recruited with recruitment flyers and consent forms sent home with the students from the Catamount School Administration. In addition to parental consent, the participants were given the opportunity to provide assent after being provided with details as to what their participation entailed. To determine the required sample size for adequate statistical power, an a priori power analysis was conducted using G*Power version 3.1.9.7. However, due to the limited research being conducted on non-clinical adolescents and the moderating effect of peer inclusion on arousal, multiple power analyses were run to determine sample size requirements. When power analysis was conducted for a medium effect size ($F^2 = .15$) and an alpha of .05, results showed that a total sample of 68 participants were required to achieve the minimum acceptable power level.

The goal was to achieve over 30 adolescent participants who varied in their experiences of weight stigma and weight status. This goal of over 30 participants is based on the limited sample population present within the Catamount school while meeting the sample size requirements for adequate statistical analyses. The final sample included 31 participants (sample descriptives Table 1). The participants were offered snacks, fidget toys, and 10 minutes of playing games on an iPad for their participation.

The data collection process took place at the Catamount School as part of a larger study from April 15th, 2024, through November 13th, 2024. Following the completion of questionnaires and computer based executive functioning tasks with electroencephalogram measurement, participants were administered an electrocardiogram to measure heart rate and heart rate variability while they were engaged in a peer-to-peer discussion task. The peer-to-peer discussion task was a novel task which was developed to increase physiological arousal based on adult-adolescents conflict discussion tasks (Gunnar et al., 2009). To eliminate the need for confederates, the participants were paired with a gender-matched peer with whom they shared a class with and provided a weight stigma prompt. The primary prompt provided was: "Talk about a time you were bullied or teased by your classmates/peers about your weight. Discuss what you thought about, how you felt, what you did in this situation." Participants were also granted permission to abstain from participation or to select an alternate topic (e.g., "Describe a conflict you have recently had with a peer"). Participants wore a Polar H10 heart rate sensor to measure heart rate and HRV. Trained experimenters demonstrated and instructed sensor band placement, so that the sensor band was snug, and the primary sensor was placed on the epigastric region of their abdomen. One participant declined to wear the heart rate monitor during the conversation portion of the study but completed the questionnaires. Each participant was equipped with the

heart rate sensor for 60 seconds for a baseline measure of HRV followed by either 180 seconds of discussing their personal experience or listening to their peer before switching roles of discussant and listener.

To minimize the production of missing or confounded data each participant's ECG data was collected in its entirety during a single session. However, participants were allowed to complete questionnaires on multiple days to eliminate time constraint related response patterns and potential missing data due to participant absenteeism (Kang, 2013).

Due to the potential bias that can result from missing data (Dettori et al., 2018), imputation was utilized to determine adequate replacement values for the five participants with missing heart rate variability values. Specifically, three participants were imputed due to their small abdominal circumference not allowing for an adequate fitting of the heart rate sensor. One participant refused to participate in the peer-discussion portion of the task. One other participant's heart rate data was corrected by the Kubios HRV software, using a cubic spline interpolation (Lipponen & Tarvainen, 2019), due to technological malfunctions resulting in significant artifacts present within the sample. Due to the limited number of parent demographic questionnaires that were completed (n = 5), participant height, weight, and family income were not measured.

Results

Descriptive statistics of the self-reported characteristics for the 31 participants are included in Table 1. The covariates and focal variables were then analyzed through a correlation matrix to assess for any bivariate associations between these variables (see Table 2) to test the first hypothesis that internalized weight stigma would be significantly and positively correlated with heightened physiological reactivity and significantly and negatively correlated with

decreased physiological regulation. However, internalized weight stigma was not significantly correlated with heightened physiological reactivity or decreased physiological regulation. Peer inclusion was also not significantly related to physiological reactivity, suggesting that peer inclusion was not associated with physiological reactivity during the peer discussion task; however, this may be influenced by the limited power of this study.

Additional focal analyses were then conducted to examine the moderating effects of perceived peer inclusion in a multiple linear regression despite the lack of variable correlation due to previous research revealing the presence of the relationship. Further analysis of these variables is considered appropriate given the support from previous research and the potential for this study's limited power being a factor in the correlational properties of the focal variables. These analyses were ran using SPSS 29.0 through model 1 PROCESS macro; this was deemed most appropriate due to the limited ability for a standard linear regression equation to appropriately predict the moderating effect of designated variables upon the independent variable(s). Indeed, the PROCESS model evaluated the proportion of variance in physiological arousal (y) uniquely attributable to peer inclusion's (w) moderating effects on weight stigma (x) (Hayes, 2017). The PROCESS model tests the interaction term of the mean centered values of weight stigma with peer inclusion. This increased sensitivity for variable interaction allows for a more accurate analysis of these variables.

Results of the multiple linear regression examining the effect of weight stigma on physiological reactivity, with peer inclusion as a moderator, were significant ($F(6, 24) = 6.51$, $p < .01$) (see Table 3). Gender (boy = 1, girl = 0) and grade were included as covariates in the model. The mean centered interaction term between peer inclusion and internalized weight stigma was significant ($\beta = .32$, $p < .05$) and predicted an $\Delta R^2 = .09$, suggesting that the

relationship between internalized weight stigma and physiological reactivity is significantly moderated by peer inclusion. Probing the simple slopes effects demonstrates this relationship is only significant at low levels of peer inclusion (β = -.93, p = .03), such that, for adolescents who have low peer inclusion, as internalized weight stigma increased there was significant increases in sympathetic reactivity (see Figure 1). Additionally, the regression model revealed a main effect of gender on sympathetic reactivity (β = .33, p < .05). This finding suggests that boys are more likely to have increased physiological reactivity to a peer-to-peer discussion task.

A second moderated linear regression was conducted to examine the effect internalized weight stigma on physiological parasympathetic regulation with peer inclusion as a moderator (see Table 4). Gender and grade were included as covariates in the model. The overall model yielded statistically significant results, $F(6, 24) = 21.39$, $p < .001$, $R^2 = .82$ The mean centered interaction term between peer inclusion and weight based internalized stigma was not significant (β = -.16, p = .11), suggesting that the relationship between weight based internalized stigma and physiological parasympathetic regulation is not significantly moderated by peer inclusion. The regression model revealed a significant main effect of gender on parasympathetic regulation (β = -.19, p = .04). This finding suggests that boys had poorer parasympathetic regulation during the peer-to-peer discussion task.

Discussion

The present study investigated weight based internalized stigma as a predictor of physiological regulation and the moderating effects of peer inclusion, in a sample of adolescents. Additionally, this study utilized a novel peer-to-peer discussion task to elicit increased physiological responses when discussing experiences of weight stigma.

The first hypothesis that adolescents who have increased internalized weight stigma will have increased sympathetic nervous system reactivity and decreased parasympathetic nervous system regulation during a peer-to-peer discussion task was not supported. Although the results of this study suggest that there is no significant relation between internalized weight stigma and physiological reactivity or regulation; this is likely attributed to the limited number of participants and limited experiences of weight-based bullying within this sample population. Although not a specific hypothesis, results showed a significant relation between physiological arousal and peer inclusion, such that youth who had more peer inclusion had decreased physiological reactivity to the peer-to-peer discussion task. This fits with previous literature (Butterfield et al., 2021; Cuadrado et al., 2021) and suggests that adolescents who have increased peer inclusion are not as stressed by peer-to-peer tasks because they know they are supported by their peers. Although previous research utilized peer rejection tasks (Gunnar et al. 2009), the recollection of previous negative experiences also yielded a similar significant relationship between stress response and peer inclusion when participants discussed their experiences with peers.

Additional results demonstrated that the relation between internalized weight stigma and physiological regulation was moderated by peer inclusion. Specifically, only for those adolescents who had high levels of peer inclusion, increased internalized weight stigma predicted increased physiological regulation. Indeed, this association between internalized weight stigma, low peer inclusion, and heightened sympathetic reactivity is likely a representation of how our experiences and cognitions directly influence autonomic responses to stressors. For example, when an adolescent internalizes negative beliefs about themselves and perceives decreased peer inclusion, they might be more sensitive to negative peer responses and have more sympathetic

reactivity than adolescents who feel more included by their peers. Despite the significant findings for physiological reactivity, the lack of significance for peer inclusion moderating parasympathetic regulation is likely attributable to the important role of age and gender on physiological functioning. Previous research has found that there is a negative relationship between age and parasympathetic regulation which suggests that adolescents are likely to exhibit high levels of regulation following exposure to stress (Abhishekh et al., 2013). Additionally, previous studies found that girls have greater vagal tone than boys, which also plays a role in the overall sample's limited dysregulation during the discussion task (Venkata Pothineni et al., 2016). This highlights the complexity of the relationship and suggests that other factors may also play a major role in physiological responses in adolescence.

Lastly, a significant effect of gender was revealed, demonstrating that boys had more physiological reactivity and poorer physiological regulation to peer-to-peer discussions. Although this was not specifically hypothesized, gender differences should be considered in future research when examining these variables. Future studies may benefit from a larger sample of adolescents in order to analyze these focal variables with separate analyses for each gender. Indeed, the mechanisms of the relationship between these focal variables may operate differently for boys and girls. Research has suggested that girls more often experience increased internalization of negative beliefs than boys (Gutman & Codiroli McMaster, 2020). Additionally, the influence of culturally accepted body standards present in adolescence are believed to be imposed more heavily onto girls than boys. Thus, girls might be more sensitive to internalized weight stigma and experience increased physiological reactivity and decreased regulation compared to boys.

Limitations

Due to this study focusing on adolescents in a magnet school, the sample may have limited internal and external validity. The positive student environment that is present within the Catamount School posed a potential barrier for negative experiences of peer exclusion, weight stigma by peers, and general conflicts amongst peers. Most of the participants discussed events at other schools and seemed relatively positive in the relationships they had with their current peers. Specifically, several students had a difficult time thinking of any negative peer experiences to discuss and conversations were somewhat limited. One student stated, "I used to get bullied at my old school but not here." Another student shared a similar sentiment and stated that "The girls at my last school were really mean to each other." This might have decreased the physiological stress response during these discussions. This is believed to be due to the increased levels of cohesion present within smaller groups as opposed to large groups (Carron & Spink, 1995) that would be increasingly present within more traditional school settings. This might have limited the physiological reactivity within the peer-to-peer discussion task.

The small sample size (n = 31) posed a risk to non-significant findings based on the a priori power analysis findings. Along with a limited sample size, this study was conducted within a single town with limited diversity. According to the 2021 census data, the location of the school (Sylva, NC.) has a 72.7% white (non-Hispanic) population which is 13.3% greater than the estimated national census date of 59.4% white (non-Hispanic). This discrepancy reveals the potential for reduced generalizability of our sample as compared to the United States of America as a whole (Bureau, n.d.; *Sylva, NC | Data USA*, n.d.). Moreover, the restricted demographic diversity within Sylva, NC was likely further exacerbated by the selective nature of magnet

programs. Along with the limited demographic variability within this sample, the catamount school's philosophy on promoting caring, collaboration, and a socially just environment.

Additionally, the inability to obtain parent reported height and weight did not allow for the assessment of how these focal variables might be affected by weight status. Although previous research suggests that weight stigma might be affected by weight status, research also suggests that weight stigma predicts negative outcomes regardless of weight status (Pearl et al., 2017). However, I could not test that directly due to not receiving useable measures of weight status. Additionally, due to physiological functioning being related to genetics (Karoly et al., 2012), the lack of parental engagement did not allow for race to be utilized as a covariate.

Conclusion

In closing, this study endeavored to advance our understanding of internalized weight stigma's relation to adolescents' physiological arousal to an acute peer-to-peer stressor. Additionally, this study sought to better understand the link between perceived peer inclusion and physiological regulation. The significant interaction between low levels of peer inclusion and high levels of weight stigma on physiological reactivity suggests that further studies are warranted. Future studies would likely benefit from utilizing a more generalizable population, access to a more robust sample of adolescents, and the comparison to a non-peer stress task. Results from this study and the possible future studies have important implications in increasing our understanding as to why not all adolescents that internalize their experiences of weight stigma exhibit poor physiological regulation.

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Table 1.

Descriptive Statistics of Participant Characteristics

Characteristics	*n*	%
Gender		
Girl	13	41.9
Boy	18	58.1
Current Grade		
6th	6	19.4
7th	16	51.6
8th	9	29

Notes. N = 31.

Table 2.

Correlations for Study Variables

Variable	Mean	SD	1	2	3	4	5	6	7	8
1. SNS reactivity	0.56	2.66	-	-.50**	.65**	-.35	-.06	-.06	.45*	.11
2. PNS regulation	23.07	44.01		-	-.64**	.88**	-.19	-.04	-.17	-.27
3. Baseline SNS	8.48	4.09			-	-.77**	.11	.12	.23	.15
4. Baseline PNS	99.07	72.47				-	-.18	-.17	-.01	-.21
5. Weight Stigma	3.33	1.06					-	.01	-.03	-.08
6. Peer Inclusion	1.81	0.85						-	-.04	-.14
7. Gender	-	-							-	-.17
8. Grade	7.10	.70								-

Notes. *p < .05. **p < .01. N = 31, SNS = Sympathetic Nervous System (aggregate RMSSD), PNS = Parasympathetic Nervous System (aggregate Stress Index). Gender is coded as Boy = 1, Girl = 0.

Table 3

Regression Predicting Sympathetic Nervous System Reactivity from Internalized Weight Stigma and Peer Inclusion.

Predictor	R^2	ΔR^2	β (SE)
Step 1	.52	.52**	
Gender			.33* (.74)
Grade			.08 (.52)
Baseline SNS			.56** (.09)
Step 2	.55	.03**	
Peer Inclusion			-.12 (.44)
Weight Stigma			-.11 (.34)
Step 3	.64	.09**	
Weight Stigma x Peer Inclusion			.32* (.36)

Notes: *$p < .05$. **$p < .01$, $N = 31$

Table 4

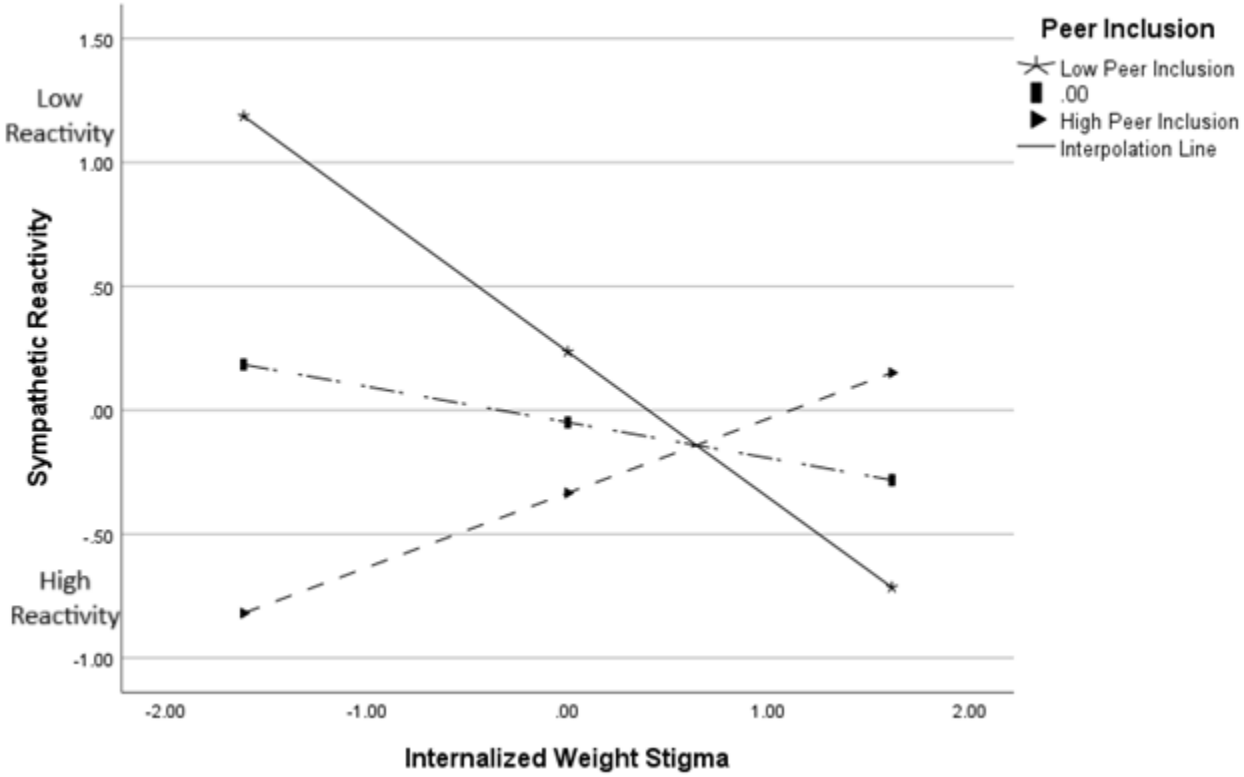
Regression Predicting Parasympathetic Nervous System Regulation from Internalized Weight Stigma and Peer Inclusion.

Predictor	R^2	ΔR^2	β (SE)
Step 1	.82	.82**	
Gender			-.19* (7.33)
Grade			-.12 (5.37)
Baseline PNS			.85** (.05)
Step 2	.83	.01	
Peer Inclusion			.09 (4.50)
Weight Stigma			-.04 (3.57)
Step 3	.85	.02	
Weight Stigma x Peer Inclusion			-.16 (4.01)

Notes: *$p < .05$. **$p < .01$, $N = 31$

Figure 1.

The Moderating Effect of Peer Inclusion on Weight Stigma onto Sympathetic Reactivity



Note. Weight stigma predicted sympathetic reactivity at low levels of peer inclusion (B = -.93, p = .03) but not at high levels of peer inclusion (B = .58, p = .23).

Appendices

Weight Bias Internalization Scale Modified (WBIS-M; Pearl & Puhl, 2014**)**

Please answer the following questions using this scale:

1	2	3	4	5	6	7
Strongly disagree	**Disagree**	**Slightly disagree**	**Neutral**	**Slightly agree**	**Agree**	**Strongly agree**

_____1. I am less attractive than most other people because of my weight.
_____2. I feel anxious about being overweight because of what people might think of me.
_____3. I wish I could drastically change my weight.
_____4. Whenever I think a lot about being overweight, I feel depressed.
_____5. I hate myself for being overweight.
_____6. My weight is a major way that I judge my value as a person.
_____7. I don't feel that I deserve to have a really fulfilling social life, as long as I'm overweight.
_____8. I am OK being the weight that I am.
_____9. Because I'm overweight, I don't feel like my true self.
_____10. Because of my weight, I don't understand how anyone attractive would want to date me.

Peer Relationship Questionnaire

Answer the following questions from 0 = never to 3 = almost always

0	1	2	3
Never	**Sometimes**	**Often**	**Almost Always**

1. I get along well with others,
2. I am liked by others
3. People think I am fun to be with