Weight Stigma and Hypothalamic–Pituitary–Adrenocortical Axis Reactivity in Individuals Who Are Overweight

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Abstract

Background Stigmatized people exhibit blunted cortisol responses to many stressors.

Purpose To examine the cortisol responses of individuals who are overweight to a stigma-related stressor involving interviewing for a weight-discriminatory company.

Methods We recruited 170 men and women (mean age = 35.01) from towns located within about a 30-min drive of the study center. Weight was assessed using body mass index (BMI) and self-perceptions about being overweight. Participants were exposed to a laboratory stressor, modeled after the Trier Social Stress Test. In the stigmatizing condition, participants gave a supposedly videotaped speech about what makes them a good candidate for a job at a company that was described as having a weight-discriminatory health insurance benefit. Participants in the nonstigmatizing condition made a supposedly audiotaped speech for a company whose health insurance benefit was not described. Cortisol reactivity was then assessed.

Results Participants who rated themselves as overweight or who were overweight according to their BMI evidenced a blunted cortisol response in the weight-stigmatizing condition, whereas lean participants in the weight-stigmatizing condition showed the rise in cortisol levels that typically occurs following the Trier Social Stress Test.

Conclusions People who experience the chronic stress of being stigmatized due to their weight show blunted cortisol responses just as other chronically stressed people do.

Keywords Weight stigma • Social identity threat • HPA axis reactivity • Blunted cortisol

Introduction

Researchers interested in the obesity epidemic have identified chronic stress as a potential mechanism through which stigma and stigmatizing environments increase the risk for negative health outcomes [1]. Weight-stigma identity threat is a social evaluative threat that occurs in situations in which people who are overweight or obese believe that others may negatively evaluate them or treat them unfairly because of their weight [2]. Social evaluative threats, defined as a context in which the self can be judged negatively by others, can activate the hypothalamic–pituitary–adrenocortical (HPA) axis, which governs the secretion of cortisol, a stress hormone [2, 3]. Thus, one pathway in which weight-stigma may affect the physiological outcomes of individuals who are overweight is through changes in the HPA axis [4].

Specifically, there is growing evidence that people subjected to chronic stress exhibit a blunted cortisol response [5]. A typical cortisol response to a stressor is characterized by a sharp increase followed by a slow decline. In laboratory studies of social stressors, this typically occurs within 45 min from the onset of the stressor [3]. A blunted cortisol response is characterized by relatively small fluctuations in cortisol levels following a stressor [3, 6]. Perceived threat instigates the release of cortisol that readies the body for a fight-or-flight response. Cortisol levels then slowly decline to baseline. Chronic stress produces repeated activation of the fight-or-flight reaction. This can disrupt the neurobiological processes involving the regulation of cortisol releasing hormone receptors in the pituitary and glucocorticoid receptors in the hippocampus, which regulate the HPA axis response to a stressor [5].

Individuals who are objectively overweight (usually defined as body mass index [BMI] ≥ 25) are aware of the devaluation associated with this social identity even if

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they do not perceive that they are overweight [7]. People who perceive themselves as overweight also are at risk for weight-stigma identity threat because even if other people do not perceive them as having a higher body weight, they may fear negative reactions because they think they are overweight [8].

Results of one study showed that the cortisol levels of women who perceive themselves as overweight were led to believe that their size made them unsuitable for an in-person shopping task, which were higher than the cortisol levels of women who were led to believe that their arrival time made them unsuitable for the in-person shopping task [9]. This effect occurred because those in the control condition showed a diurnal decline from baseline to postmanipulation, whereas those in the stigmatizing condition maintained their prestressor cortisol levels. The experimental condition did not affect the cortisol levels of women who did not perceive themselves as overweight [9]. Another study found that women who watched a weight-stigmatizing video showed an attenuated diurnal cortisol decline over the course of the experiment compared with the diurnal cortisol declines of women who watched a nonstigmatizing video [10]. However, this effect occurred regardless of the women's BMI, suggesting that women in general, not just women who are overweight, experience stress in weight-stigmatizing situations. It also is important to note that neither study showed an increase in cortisol level from baseline to poststressor. Rather, they found that the weight-stigmatizing manipulation reduced the diurnal decline in cortisol levels that normally occurs as the day progresses [9, 10].

Numerous studies document that people who experience childhood victimization or racial discrimination have blunted cortisol responses to acute stressors [11, 12]. Also, compared with nonstigmatized people, their awakening levels of cortisol tend to be lower and decline more slowly throughout the day, producing a flatter diurnal pattern [11, 12]. Blunted cortisol responsivity is especially important to individuals who are overweight because cortisol plays an important role in the distribution of adipose tissue, which is implicated in diseases associated with obesity including cardiovascular disease and type 2 diabetes [4].

Blunted cortisol responses among stigmatized people have been observed in laboratory studies in which people are exposed to an acute social evaluative stressor, most commonly the Trier Stress Test, in which people give a brief speech in front of an impassive audience who supposedly is evaluating them while they are being video recorded for later analysis. For example, gay and lesbian college students from states with high levels of anti-gay policies and attitudes did not exhibit elevated cortisol levels following the Trier Stress Test, whereas those from states with more accepting attitudes and policies had increased cortisol levels [5].

Researchers have found that weight stigma is pervasive, occurring at rates comparable to gender and race-based mistreatment [13]. Therefore, individuals who are overweight are likely to be chronically stressed. This suggests that those who experience weight-based social identity threat may experience a blunted cortisol response.

The current study was a part of a larger study that addressed the cognitive, affective, physiological, and behavioral effects of weight stigma among men and women who are overweight. One previous study from this project theorized that physiological stress is one pathway by which weight-based social identity threat may lead to weight gain and poorer mental and physical health [2]. A major finding from this project is that self-evaluative weight-stigma threats evoke rejection expectations, reduced self-esteem, negative emotion, and stress among individuals who are overweight [14]. No published research from the larger project has examined HPA reactivity to weight-stigma identity threat.

Consistent with the main goals outlined in the research for the larger study, the goal of the present study was to examine the effect of a weight-stigmatizing social evaluative threat on HPA reactivity of men and women who are overweight in a simulated employment interview. Individuals who are overweight face chronic stigma in the workplace [15]. We hypothesized that an employment-related weight-stigmatizing situation (the independent variable) would result in blunted cortisol responses (dependent variable) among people who are objectively overweight and/or perceive themselves to be overweight (moderator variables). This study is the first to use an experimental design to examine how weight-stigma identity threat affects cortisol reactivity among people who are overweight and obese in an employment-related situation.

Methods

Participants

This study was funded by the National Heart, Lung, and Blood Institute (5R01HL112818-02, Brenda Major, principal investigator). Participants were recruited through postings on electronic bulletin boards (e.g., community e-newsletters) in towns located within about a 30-min drive of the study center—a social psychological laboratory located at the University of Vermont. The posting indicated that the purpose of the study was to examine people's emotional, cognitive, and physiological responses to employment settings. Interested individuals followed a link to a brief online eligibility survey. Those who indicated that they were 18–55 years old, spoke fluent English, and were not pregnant were invited to participate in the study.

Participants included 170 people (58 men, 103 women, 6 *trans*-sexual) and 3 people who did not indicate their gender. The *trans*-sexual participants and those who did not indicate their gender were omitted from the analysis so that we could use gender as a covariate. Participants were 19 to 55 years old ($M = 35.01$, $SD = 9.83$) with 91.9% identifying as White. Most participants were employed (88.2%) with a median household income between \$40,000 and \$60,000. The online eligibility survey asked participants to report their self-perceived weight (1 = *very underweight*, 4 = *average weight*, 7 = *overweight*; $M = 4.61$, $SD = 1.00$). At the conclusion of the study, participants were weighed and measured for height to calculate their BMI ($M = 27.36$, $SD = 6.39$). Participants were compensated \$70 for their time.

Procedure

One day prior to their scheduled laboratory visit, participants were emailed asking them to refrain from activities that could influence their cortisol on the day of the visit, including brushing their teeth or drinking caffeinated beverages within 4 hr of their scheduled time, and exercising at any point during that day. Participants were also provided with a web link to complete a battery of pre-experimental self-reported questionnaires that included measures of psychological well-being and demographics. Self-reported measures produced null effects and will not be described further. A complete list of measures is available from the first author.

Experimental sessions were conducted with individual participants between the hours of 2 and 7 PM, the approximate time span during which cortisol reaches its diurnal nadir. After giving informed consent, participants waited in a sitting area for 20 min to allow for cortisol levels to achieve a stable baseline. At the end of this waiting period, a saliva sample was collected to later be assessed for baseline cortisol level.

Participants then completed procedures that constituted the weight-stigma identity threat condition or the control condition. All participants viewed a slide show about a fictitious company that was ostensibly conducting this research. In the weight-stigma identity threat condition, the slide show stated that the company's health insurance policy set insurance premiums higher for people who are overweight because of the adverse effects of excess weight on overweight employee's productivity and professional appearance. The control version of the video stated that the company's policy was to encourage employees to become knowledgeable about personal finance and did not mention weight.

Participants then prepared for a simulated job interview for employment in this company in which they would give a 5-min speech (modeled after the Trier Social Stress

Test) about what makes them a good candidate for their ideal job. After 5 min elapsed, the experimenter collected their notes so that they made the speech from memory. After completing measures of their expectations about making the speech, they then gave the speech. Those in the weight-stigma identity threat condition made the speech facing a video camera and those in the control condition made the speech into a microphone. In addition, those in the weight-stigma identity threat condition were told that the company's hiring manager would see and evaluate a videotape of their speech, and those in the control condition were told that the company's hiring manager would evaluate them after listening to the audiotape of their speech [7].

Thus, weight-stigma identity threat was manipulated by informing participants that the company discriminates against people who are overweight, as well as by setting up a situation where they would believe that their appearance was seen by the evaluator. In the control condition, participants thought that the company manager would listen, but not see a recording of their speech, and the company he or she represented was not described as having weight-discriminatory policies [7]. In reality, the speeches were not evaluated or video recorded, but they were audio-recorded.

After the speech, participants provided a second saliva sample, which occurred 20 min after the onset of the stressor (the start of the slide show), a time during which cortisol levels typically peak after a stressful event. They also completed measures of postperformance affective responses and perceptions of the evaluator (available from the first author). Twenty minutes later, participants provided two recovery saliva samples spaced 20 min apart to assess cortisol levels during the period when cortisol levels typically begin to return to baseline following a stressor. Finally, participants were measured for BMI. After debriefing they were compensated.

The four saliva samples for cortisol assessment were obtained with cryovial tubes (Salimetrics) using the oral swab method. Participants chewed a salivette for about 30 s then placed it back into the cryovial tube. Saliva samples were stored immediately at -30°C until they were shipped to the Laboratory of Biological Health Psychology at Brandeis University (Waltham, MA, USA), where they were assayed for salivary free cortisol, using a chemiluminescence immunoassay (IBL-International, Toronto, Canada). Prior to analysis, salivettes were thawed and centrifuged at 2000 g and 4°C for 10 min. Intra- and inter-assay coefficients of variations were below 10%.

To examine cortisol reactivity, we used the four cortisol samples (baseline, peak, and two recovery samples) to compute the increase in area under the curve (AUCi [16]). AUCi represents the time-dependent change in cortisol relative to the baseline resting value [16].

Results

Bivariate Correlations

Table 1 shows that neither BMI nor self-perceived weight were correlated with baseline cortisol levels. Thus, there were no significant differences in pre-manipulation cortisol levels of individuals who were overweight/obese or lean. Table 1 also shows that self-perceived weight and BMI were substantially correlated. Gender was uncorrelated with BMI, but was positively correlated with self-perceived weight indicating that women (coded as 1) rated themselves as more overweight than did men (coded as 0). There were no significant correlations with experimental condition, indicating that the weight-stigma identity threat condition (coded as 1) and control condition (coded as 0) were similar in terms of participant gender, BMI, self-perceived weight, and baseline cortisol level. The nonsignificant correlation between condition and AUCi increase indicates that the experimental condition by itself did not produce increases in cortisol relative to the control condition. The number of males in the sample was not sufficient to examine gender differences. Consequently, we used gender as a covariate in data analyses.

Statistical Analyses of Main Hypotheses

We conducted moderation analyses using Hayes' PROCESS macro model 1 [17]. In one analysis, weight was represented by participant BMI, and in the other analysis weight was represented by self-perceived weight. For both analyses, condition was binary coded such that the control condition was coded 0 and the weight-stigma identity threat condition was coded 1. The outcome measure (AUCi) was the cumulative change in cortisol levels for the three poststress samples relative to the baseline cortisol level.

BMI as Moderator

The regression model was significant, $R^2 = .12$, $F(7, 137) = 2.57$, $p = .02$, $\eta^2 = .12$. Standardized regression coefficients (β s) reported below are effect size estimates. The effect of weight-stigma identity threat condition was significant, $\beta = 29.59$, $SE = 11.66$, $p = .01$. The effect of BMI was not significant, $\beta = 0.16$, $SE = 0.30$, $p = .58$. The predicted interaction between weight-stigma identity threat condition and BMI was significant, $\Delta R^2 = .04$, $F(1, 137) = 5.61$, $p = .02$, $\eta^2 = .04$. Simple slopes were calculated to decompose the interaction (see Fig. 1) with predicted values calculated for the 25th, 50th, and 75th percentiles for sample BMI. We used percentiles rather than plus or minus one standard deviation from the mean because the BMIs that correspond to these percentiles (21.09, 27.38, and 33.67, respectively) fell within the range of BMIs classified as normal weight, overweight, and obese [17].

Figure 1A shows that there was a significant positive slope for participants in the 25th percentile for BMI, $t(137) = 2.38$, $p = .02$, 95% CIs [1.51, 16.17], which indicated a significant rise in cortisol levels ($\beta = 8.84$) in the weight-stigma identity threat condition for participants with BMIs of 21.09 (25% percentile). There was no significant increase in cortisol levels for participants who were overweight (50th percentile), $t(137) = 1.00$, $p = .32$, 95% CIs [−2.60, 7.89], and obese (75th percentile), $t(137) = -.95$, $p = .34$, 95% CIs [−10.94, 3.84] (β s = 2.64 and −3.55).

Self-Perceived Weight as Moderator

A regression model in which self-perceived weight was substituted for BMI was significant, $R^2 = .12$, $F(7, 138) = 2.58$, $p = .02$, $\eta^2 = .12$. The effect of weight-stigma identity threat condition was significant, $\beta = 31.52$, $SE = 12.41$, $p = .01$. The effect of self-perceived weight was not significant, $\beta = 1.07$, $SE = 1.85$, $p = .56$. The interaction between weight threat condition

Table 1 Bivariate correlations between key variables

	BMI	Self-perceived weight	Weight-stigma condition	Baseline cortisol	AUCi	Exercise	Gender	<i>M</i>	<i>SD</i>
BMI	1	.78**	.05	−.06	−.15	−.03	−.03	27.36	6.39
Self-perceived Weight	.78**	1	.06	−.07	−.13	−.02	.16*	4.61	1.00
Weight-stigma condition	.05	.06	1	.10	.10	.01	.06		
Baseline cortisol	−.06	−.07	.10	1	−.42**	.06	−.16*	10.35	8.40
AUCi	−.15	−.13	.10	−.42**	1	−.14	−.03	−1.53	15.89
Exercise	−.03	−.02	.01	.06	−.03	1	−.05		
Gender	−.03	.16*	.06	−.16*	−.14	−.03	1		

AUCi increase in area under the curve; BMI body mass index.

* $p \leq .05$, ** $p \leq .01$.

Fig. 1. Effects of weight-stigma identity threat on cortisol change for participants at the 25th, 50th, and 75th percentiles for (A) sample body mass index (BMI) (upper panel) and (B) self-perceived overweight (lower panel).

and self-perceived weight was significant, $\Delta R^2 = .04$, $F(1, 138) = 5.71$, $p = .02$, $\eta^2 = .04$. To maintain consistency with the simple slopes analysis conducted for BMI, simple slopes were calculated for the 25th, 50th, and 75th percentiles for sample self-perceived weight. These percentiles correspond to values of 3.64, 4.64, and 5.63 on the 1–7 scale on which participants rated their weight.

Results revealed a significant positive slope for participants who perceived themselves a bit below average weight (25th percentile), $t(138) = 2.38$, $p = .02$, 95% CIs [1.48, 16.17], which indicated that they exhibited increased cortisol levels ($\beta = 8.83$) in the weight-stigmatizing condition. The slopes for participants who perceived themselves as a bit above the scale point designated as average weight (50th percentile), $t(138) = 1.00$, $p = .32$, 95% CIs [-2.57, 7.81] and those who perceived themselves as overweight (75th percentile), $t(138) = -.98$, $p = .33$, 95% CIs [-10.83, 3.67] were not significant, $\beta = 2.63$ and -3.58 , respectively. Thus, participants who rated themselves heavier than average weight demonstrated a blunted cortisol response (see Fig. 1B).

The bivariate correlations between covariates with baseline cortisol levels indicated that smoking was significantly correlated with baseline cortisol levels ($r = .196$,

$p = .015$). The 3.7% of participants who smoked had higher baseline cortisol levels than nonsmokers did (Table 1). Skipping a meal ($r = .091$, $p = .264$) and exercising ($r = .06$, $p = .463$) on the day of the study were not significantly correlated with baseline cortisol levels, indicating that the 30.2% of participants who skipped a meal and 28.5% who exercised on the day of the study did not have substantially higher cortisol levels than did other participants at baseline. For this reason, we redid the analyses using only gender (which was correlated with baseline cortisol levels) and smoking as covariates. Results were almost identical to the results described earlier.

Discussion

Results showed that men and women who are overweight or obese and were placed in a weight-stigmatizing employment situation evidenced a blunted cortisol response. We found that both BMI and self-perceived weight moderated the relationship between employment-based weight stigma and HPA reactivity, suggesting that both objective and perceived weight make people susceptible to weight-based identity threat, with associated irregular cortisol responses.

Prior research has found that either BMI or self-perceived weight moderated the effect of a weight-stigmatizing manipulation on cortisol reactivity [9, 10]. This may be because of the range of BMI characteristics of participants in the sample. One study that did not find a moderating effect of BMI examined undergraduate women about 19–20 years old, with average BMIs of just over 24 [9]. Thus, the range of BMIs was relatively small. Another study that found that BMI moderates the effects of weight stigma on cortisol reactivity sampled participants between 18 and 50 years old, half of whom were lean with BMIs ranging from 16.6 to 24.8, and the rest were overweight or obese with BMIs ranging from 25.1 to 60.2 [10]. Participants in the present study more closely resembled the latter study's participants, with an average age of 27 and an average BMI of 27.36. However, since only a handful of studies have examined cortisol reactivity to weight-stigma identity threat, replication is needed before definitive conclusions can be reached.

The blunted cortisol response we found among people who are overweight and obese to a weight-stigma identity threat is consistent with prior research showing that people who have experienced chronic stress, including stigma-related stress, have blunted cortisol responses to acute stressors [5, 11]. Although we did not measure whether participants had a history of weight stigmatization, a review of research on HPA reactivity to stress indicates that the likelihood of blunted cortisol responses increases when a person experiences chronic stressors, the stress is severe and persistent, and the stress results in feelings of shame [6]. Prior research has shown that weight stigma permeates most important life domains and affects interpersonal relationships with school mates, parents, and coworkers [13]. Thus, weight stigma is a pervasive and chronic stressor. Furthermore, because weight is seen as a controllable stigma, people often feel shame and guilt about being overweight or obese [4].

Consistent with previous research, our study showed that stigmatized and nonstigmatized people had different cortisol responses to a Trier-like stress experience [7, 5]. For lean participants, our adaptation of the Trier Social Stress Test induced increased cortisol levels. For participants who are overweight, the test induced blunted cortisol responses. Previous research on cortisol reactivity to weight-stigmatizing situations has not been interpreted as showing blunted cortisol response [9, 10]. However, as we pointed out earlier, these studies showed attenuated cortisol changes in the weight-stigmatizing conditions compared with the control conditions.

Future research is needed to sort out whether the blunted cortisol response is a physical effect of obesity, a reaction to repeated stress from stigma or other sources, or a combination of these factors. Prior research has shown that people who experience chronic discrimination (sexual minority college students from states with

discriminatory laws/policies toward sexual minorities) have blunted responses to stress, even when their stigmatized status has nothing to do with body size [5]. In that study, researchers used the Trier Social Stress Test where participants spoke to an impassive audience and there was not any explicit reference to participants' stigmatized identity. In other words, the main source of stress was from public speaking [5]. Even in that study, however, it is possible that stigma played some role. The sexual minority participants in that study may have assumed that the impassive audience made assumptions about their sexual orientation. Regardless of whether stigma was explicitly evoked by the situation used in this study, individuals who grew up in states with discriminatory laws and policies showed a blunted response to stress. This could indicate that stigmatized people generally have blunted responses to stress, not just to stigma-related stress.

The finding that lean participants in the present study showed an increase in cortisol levels relative to baseline suggests that the multipronged weight-stigmatizing situation we devised was indeed stressful to participants. The goal of the experimental manipulation was to induce stress levels that are high enough to induce a cortisol response. For this reason, we combined several stressful elements (the company discriminates, being videotaped, being evaluated, and having one's weight known) in the weight-stigma identity threat condition. It was not our purpose to try to determine which of these components was the most effective ingredient in inducing stress. The multiple potential sources of stress may explain why lean participants showed a heightened cortisol response and make it even more noteworthy that participants who are overweight or obese showed no response.

It also is consistent with the prior finding that thin women were stressed by the weight-stigmatizing video they viewed [10]. This suggests that people may be generally susceptible to a weight-stigmatizing situation [10]. One reason for this might be that idealized standards for body weight, muscularity, and physical fitness that saturate modern media threaten the body image of many people regardless of their weight [18]. Thus, many thin people may be self-conscious about their appearance (not necessarily their weight in particular). As a result, regardless of the expectation of weight discrimination, people may be self-conscious about their appearance for many reasons.

One limitation of the study is that many aspects of the laboratory situation differed in important ways from how the actual employment interview process unfolds. It should be noted, however, that even though participants had little at stake in this situation, because they knew they were not actually applying for a job, it was still stressful enough to produce elevated cortisol responses among lean participants. Moreover, in real life, companies often prescreen applicants by phone, and preliminary interviews do sometimes take place via

teleconferencing. Thus, in some respects, the situation we examine, although contrived, modeled procedures that someone seeking employment might undergo. Our participants also were mostly White. Minority group members face racial/ethnic stigma as well as weight stigma, suggesting that their cortisol responses might be different from those we found in this sample.

Finally, our research suggests that the workplace may be an important place to examine weight stigma and neuroendocrine functioning. Workplace stress resulting from weight-stigmatization may be one avenue through which the health of people who are overweight and obese may be further compromised. Future studies are needed to understand the ways in which coworkers, employers, and institutional policies may serve to buffer or exacerbate the negative psychological and physiological consequences of exposure to weight-stigma identity threat in the workplace.

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Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards Brenda Major and Carol T. Miller have received research grants from the National Institute of Health.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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