

MINORITY STRESS AND EATING BEHAVIOR AMONG OVERWEIGHT AND OBESE
SEXUAL MINORITY WOMEN: AN ECOLOGICAL MOMENTARY ASSESSMENT STUDY

By

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ABSTRACT OF THE DISSERTATION

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Background: Sexual minority women are nearly three times more likely to be overweight or obese than their heterosexual counterparts, yet little research has investigated *why* or *how* sexual minority status confers risk for obesity in women (Boehmer, Bowen & Bauer, 2007). The current study examined the relevance of one factor, minority stress, as a mechanism for weight disparity in this group. Sexual minority women belong to multiple socially stigmatized groups: being non-heterosexual, being female, and for 60% of this group, being overweight. This “triple oppression” exposes sexual minority women to unique and chronic minority stressors, including repeated experiences of external stigmatization (i.e., being treated unfairly or differently) and internal stigmatization (i.e., internalized shame and hostility) (Meyer, 2003). Social rejection is stressful, causing chronic elevations in stress and negative emotion that some sexual minority women may try to regulate by overeating and/or binge eating. Over time, these behaviors may promote weight gain and risk for obesity, resulting in a positive feedback loop of stigmatization, stress, overeating, and weight gain.

Methods: To test this proposed theoretical model, the current study used Ecological Momentary Assessment (EMA) methods to examine whether lifetime and acute minority stress increased risk for elevated levels of stress, negative emotion, overeating, and binge eating in sexual minority women. 55 overweight or obese (BMI>25) sexual minority (e.g., lesbian, bisexual, queer, pansexual) women were recruited from the local community to complete baseline assessments of eating behavior and minority stress related to sexual orientation, weight,

and gender. For the following five days, participants used a smartphone application to report experiences of perceived stigmatization, overeating, binge eating, stress, and negative emotion five times daily.

Results: Study findings reveal promising support for the proposed model. As expected, women who reported greater lifetime heterosexist, gender-based, and weight-based stigma reported higher baseline levels of stress, depression, disordered eating symptoms, and binge eating symptoms, and greater daily stress and negative emotion during the EMA period. Stigma events reported during the EMA period were associated with greater concurrent negative emotion and overeating at the same signal, and being stigmatized on any given day was associated with more stress, negative emotion, overeating, and binge eating on that day.

Conclusions: The current study provides preliminary support for minority stress as a potential mechanism of the obesity disparity among sexual minority women. Given the paucity of research in this area and this study's small and preliminary nature, findings justify future research studies to unpack the relevance and significance of minority stress as a risk factor for obesity among sexual minority women using longer monitoring periods and larger, more diverse samples. This research will be essential for developing effective, informed, and tailored interventions to reduce obesity, to increase knowledge and resources for coping, and to improve health among sexual minority women.

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I. Introduction

Obesity among Sexual Minority Women

Obesity, defined as having a Body Mass Index (BMI) of 30 or more, is a serious public health concern. The majority of U.S. adults (69%) are currently overweight or obese (CDC, 2012; Flegal et al., 2010), and obesity confers risk for life-threatening diseases like cancer (Mokdad et al., 2003), chronic conditions like heart disease and type 2 diabetes (Guh et al., 2009), psychological disorders like depression (Strine et al., 2008), and early mortality (Peeters et al., 2003). While BMI alone is a crude measure of health, as it accounts only for height and weight rather than diet or physical activity [equation: $(\text{weight} / \text{height}) \times 703$], BMI becomes a progressively strong predictor of negative health outcomes as it increases. This is notable because, within the past decade, the incidence of severe obesity ($\text{BMI} \geq 35$) has risen rapidly. Since 2007, there has been a 50% rise in individuals with a BMI over 40 (about 100 pounds overweight) and a 75% rise in those with a BMI of 50+, rendering BMI an imperfect yet relevant marker of health risk (Sojcher, Fogerite & Perlman, 2012; Sturm, 2007). Further, because body mass is modifiable, treating obesity is an ideal target for improving population health.

While obesity is prevalent among many sub-groups, little research has investigated the disproportionate incidence of obesity in one group in particular: sexual minority women, or women who identify their sexual orientation as non-heterosexual (e.g., gay/lesbian, bisexual, pansexual, queer). In fact, a growing body of research documents higher obesity rates among sexual minority compared to heterosexual women (see Eliason et al., 2015 for a review; Bowen, Balsam, & Ender, 2008; Conron, Mimiaga, & Landers, 2010; Smith, Markovic, Danielson, Matthews, Youk, & Talbott, 2010; Thayer, 2010; Ward, Dahlhamer, Galinsky, & Joestl, 2014).

Though precise rates vary across studies, one nationwide probability-sample study found that adult lesbians were nearly three times more likely to be overweight (odds ratio [OR] = 2.69) and obese (OR = 2.47) than their heterosexual counterparts (Boehmer, Bowen & Bauer, 2007). These findings align with epidemiological work, which demonstrates that 32% of lesbian women and 27% of bisexual women are obese, compared to 24% of heterosexual women (Fredriksen-Goldsen, Kim & Barkan, 2012).

The weight disparity among sexual minority women is also documented by longitudinal data. Over a 16 year period, compared to heterosexual women, sexual minority women were nearly twice as likely to have weight gain trajectories that were moderate (lesbian OR = 1.3, bisexual OR = 1.6) or rapid (L OR=1.8, B OR=1.6) (Jun, Corliss, Nichols, Pazaris, Spiegelman & Austin, 2012). And while BMI alone does not signify poor health, this weight disparity is notable because obesity increases risk for conditions like cardiovascular disease and cancer, two diseases that are also disproportionately prevalent among sexual minority women (Brandenburg, Matthews, Johnson & Hughes, 2007; Fredriksen-Goldsen, Kim, Barkan, Muraco & Hoy-Ellis, 2013).

Testing a Theoretical Framework for the Weight Disparity among Sexual Minority Women

Despite the distinct prevalence of obesity among sexual minority women, little research has investigated *why* or *how* sexual minority status confers risk for obesity in women, and no theoretical framework exists to explain this disparity. The current study aimed to fill this gap by testing a novel theoretical model to explain the weight disparity among sexual minority women (Eliason et al., 2015; Thayer, 2010).

The model proposed here tests whether one factor, minority stress, contributes to higher risk for obesity among sexual minority women. Sexual minority women are members of multiple minority groups, including being female, being non-heterosexual, and for 60% of sexual minority women, being overweight. They therefore face a “triple oppression,” as they are exposed to discrimination and prejudice associated with multiple stigmatized identities (Boemer, Bowen & Bauer, 2007). These unique and chronic stressors are called minority stressors (Meyer, 2003). The model proposed in this study suggests that these minority stressors may generate significant stress and negative emotion among sexual minority women, and in an effort to reduce distress, women may be more likely to use overeating and binge eating as coping strategies. Over time, binge eating and overeating may promote weight gain and risk for obesity, resulting in a positive feedback loop of stigmatization, stress, negative emotion, overeating, and weight gain among sexual minority women. This model is tested in the current study and outlined in greater detail below.

The current study also advances the field by filling methodological gaps in the literature, which to date has only examined the weight disparity among sexual minority women using population-based and cross-sectional data. The present study used both cross-sectional methods and ecological momentary assessment (EMA), a data collection strategy wherein participants complete self-report assessments of emotions and behaviors multiple times daily as they go about their daily lives. A mixed methods approach was advantageous in this study because it allowed us to test how women’s lifetime and acute experiences of minority stress impacted their stress, negative emotion, and eating behavior both on average and throughout the day, providing data with greater ecological and temporal validity than cross-sectional methods alone.

Minority Stress among Sexual Minority Women

One potential mechanism linking sexual minority status and obesity is minority stress. According to the *Minority Stress Model*, minority stress describes a set of unique stressors, including discrimination and harassment, that are faced by members of minority groups (Meyer, 2003). The impact of these stressors accumulate over time, contributing to disproportionate rates of mental and physical health problems among minority group members (Meyer, 2003). Sexual minority women are a multiply marginalized population, holding membership in at least two socially stigmatized groups: being non-heterosexual and female. Stigma refers to the social devaluation of a particular group, wherein individuals are perceived as different or inferior by others because they belong to a group that is associated with negative stereotypes (Goffman, 1963; Hatzenbuehler, 2009). Heterosexist stigmatization against sexual minority individuals, for example, is based on beliefs that a heterosexual sexual orientation is the “correct,” moral, or normal orientation (Szymanski, 2006).

According to the *Minority Stress Model*, membership in even one stigmatized group exposes sexual minority individuals to two types of distinct and chronic stressors: distal and proximal (Meyer, 2003). Distal stressors describe events that subject stigmatized individuals to unfair treatment based on a stigmatized identity, and include instances of prejudice, discrimination, harassment, social rejection, and ostracism. Both acutely and over time, this unfair treatment is stressful, requiring stigmatized individuals to continuously recruit resources to cope with and adapt to a threatening social environment (Hatzenbuehler, 2009). Distal stressors are remarkably prevalent among sexual minority adults, as 56% have been verbally harassed, 43% have been followed, 39% have been threatened, and 28% have been physically assaulted (Katz-Wise & Hyde, 2012).

Over time, chronic exposure to distal stress cultivates the internalization of stigmatized ideals, or “self-stigmatization,” called proximal minority stress. Given multiple experiences of unfair treatment, stigmatized individuals may internalize shame or hostility about their identity, and in an attempt to reduce this negative emotion and stress, may conceal, minimize or deny the identity (Meyer, 2003). For example, sexual minority adults may minimize contact with sexual minority peers or organizations to reduce being labeled and ridiculed as part of this group, or they may not disclose their sexual orientation to friends or coworkers to prevent discrimination. While these strategies may minimize discrimination in the short-term, they require hyper-vigilance to one’s own and to others’ social behavior, and repeated denial and active concealment of one’s own identity (Pachankis, 2007). Over time, this results in chronic experiences of stress and negative emotion, suppression of thoughts and desires, low self-esteem and social isolation (Hatzenbuehler, 2009). Given this intersection of distal and proximal minority stressors, it is perhaps unsurprising that sexual minority women report greater perceived stress on average than heterosexual women (McElroy, Wintemberg, Cronk & Everett, 2016).

The Role of Weight-Based Stigmatization

While minority stressors related to sexual orientation and gender identity may confer risk for the development of obesity in sexual minority women, being overweight is also a stigmatized identity, and 60% of sexual minority women are currently overweight or obese (Boemer, Bowen & Bauer, 2007). Therefore, the majority of sexual minority women experience a “triple oppression” through exposure to minority stressors associated with sexual orientation, gender, and weight. For example, fatness is associated with negative stereotypes such as being lazy, asexual, worthless and unattractive (Crandall, 1994; Puhl & Heuer, 2009). Whereas one’s sexual

orientation is concealable and somewhat pre-determined, one's weight is publicly evident and assumed to be within a person's power to control, making it particularly shameful and difficult to hide (Puhl & Heuer, 2009). Weight-based stigmatization is also pervasive among healthcare providers, employers, peers, and overweight individuals themselves (Puhl & Heuer, 2010; Rudman, Feinberg & Fairchild, 2002). To date, no studies have examined the intersecting effects of sexual orientation, gender and weight-based minority stress on the progression of obesity in sexual minority women once they are overweight.

Though prevalent, experiencing weight stigma has a host of negative effects that, ironically, increase risk for weight gain in overweight and obese individuals. For example, weight-based stigmatization has been linked to heightened physiological stress (Major et al., 2012), higher calorie intake (Major, Hunger, Bunyan & Miller, 2014), binge eating (Carels et al., 2010), poor body image (Myers & Rosen, 1999), and exercise and healthcare avoidance (Drury, Aramburu, Louis, 2002; Vartanian & Novak, 2011). Taken together, this evidence suggests that the added stress of weight-based stigma may further increase risk for weight gain in sexual minority women, contributing to the maintenance and/or exacerbation of obesity in this group. A similar cycle has been identified by the Cyclic Obesity/Weight-Based Stigma (COBWEBS) model of obesity in adults, but has not been applied to sexual minority women, who experience stigma associated with multiple identities (Tomiya, 2014).

Stress, Negative Emotion, and Eating Behavior among Sexual Minority Women

Higher rates of social and self-stigmatization and the subsequent stress and negative emotion suggest that sexual minority women may have more stress to regulate, and one strategy for coping with stress is eating. A large body of research demonstrates that stress, defined here as

environmental conditions that disrupt an individual's homeostasis and necessitate adaptive resources, is a predictor for increased food intake (Hatzenbuehler, 2009; Tomiyama et al., 2011). For example, stress has been shown to precede episodes of "comfort" eating (i.e., eating foods high in sweetness, fat, calories and convenience) in normal eaters and binge eating (i.e., discrete periods of eating unusually large amounts of food while feeling out of control) in individuals with clinical eating disorders (Goldfield, Adamo, Rutherford & Legg, 2008; Stone & Brownell, 1994).

Minority stress, in particular, may be likely to prompt dysregulated eating, as stressors that threaten one's self-image, such as stigmatization, are a unique and potent predictor of binge eating. For example, the stress caused by social rejection, but not physical pain, has been linked to elevated propensity for palatable food intake (Heatherton, Herman & Polivy, 1991; Wallis & Hetherington, 2009). Engaging in eating behaviors like binge eating when stressed, according to growing empirical research, may function to provide immediate relief from stress and negative emotion (Heatherton & Baumeister, 1991) and over time may dampen the body's biological reactivity to stress, reinforcing the behavior (Pecoraro, Reyes, Gomez, Bhargava, & Dallman, 2004).

Given that stress is a common precipitant of obesogenic eating behaviors which, in turn, may function to regulate stress and negative emotion, it is unsurprising that chronically stressed sexual minority women have higher rates of disordered eating behaviors. For example, sexual minority women have a greater prevalence of binge eating (Austin, Ziyadeh, Corliss, Haines, Rockett, Wypij, & Field, 2009), as well as fasting, vomiting, and using laxatives and smoking to reduce appetite (Polimeni, 2009), compared to their heterosexual counterparts (see Bankoff & Pantalone, 2014 for a full review). The connection between minority stress and disordered eating

behaviors in sexual minority women is supported more directly by recent research, with one study demonstrating that sexual minority women with higher levels of proximal stress, including sexual orientation concealment, internalized homophobia and stigma consciousness (i.e., awareness of negative stereotypes about sexual minority individuals), reported more binge eating behaviors (Mason & Lewis, 2015). Among sexual minority adolescent women, earlier awareness of a non-heterosexual orientation and more bullying victimization have been associated with more emotional and disinhibited eating (Katz-Wise, Scherer, Calzo, Sarda, Jackson, Haines & Austin, 2015).

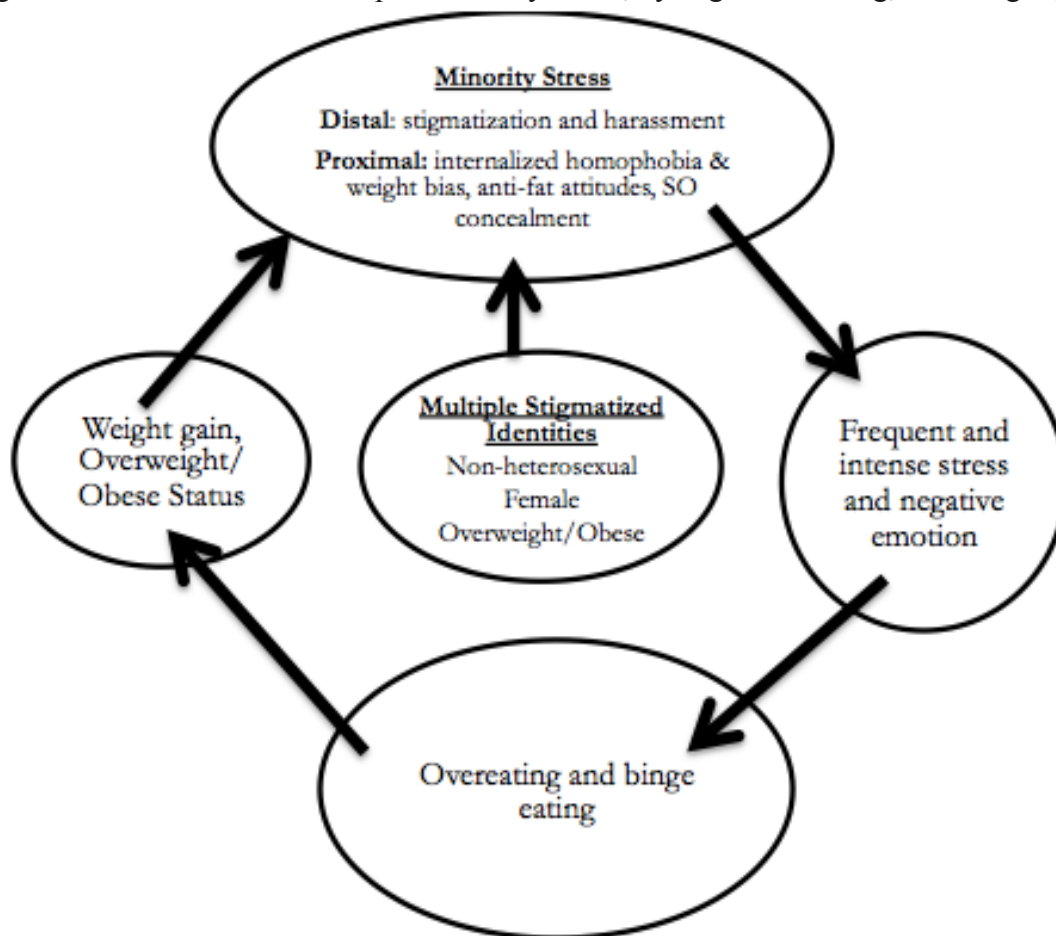
Taken together, these findings suggest that sexual minority women may experience chronic minority stressors that promote using overeating and binge eating to regulate stress and negative emotion. This pattern may contribute to weight gain among sexual minority women over time, as comfort eating and binge eating are uniquely associated with weight gain (Greeno & Wing, 1994; Korkeila, Kaprio, Rissanen, Koshenvuo, & Sörensen, 1998). This connection is supported by recent evidence linking minority stress with weight gain, as lesbians who report experiencing heterosexist discrimination are more than twice as likely to fall into the overweight (OR = 2.55) or obese (OR = 2.49) than normal weight categories (Mereish, 2014). Collectively, this evidence suggests that minority stress and dysregulated eating may be potential pathways to becoming overweight in sexual minority women.

The Current Study

Collectively, the evidence reviewed here converges such that we can propose a potential model for understanding how sexual minority status confers risk for obesity in sexual minority women. This model suggests that possessing multiple stigmatized identities exposes sexual

minority women to unique and chronic stressors. This “triple oppression” promotes engagement in maladaptive regulation strategies like binge eating and overeating, leading to weight gain and risk for obesity in a positive feedback loop of stigmatization, stress, overeating, and weight gain (see Figure 1 for a visual depiction of this positive feedback loop). Given the paucity of research investigating weight disparities among sexual minority adults, research is needed to understand whether minority stress is a causal contributor to obesity risk among sexual minority women.

Figure 1. Positive feedback loop of minority stress, dysregulated eating, and weight gain



The current study tested a piece of the proposed model by examining whether minority stress increases risk for overeating and binge eating in sexual minority women who are overweight or obese. To explore this question, this study used Ecological Momentary Assessment (EMA) methods, a data collection strategy wherein participants complete self-report assessments of emotions and behaviors multiple times daily as they go about their daily lives. In this study, 55 overweight and obese sexual minority women completed baseline assessments of eating behavior and distal and proximal minority stress related to sexual orientation and weight. For the following five days, participants used a smartphone application to report experiences of perceived stigmatization, food intake, stress, and negative emotion five times daily. These data allowed us to clarify the relation between both lifetime and acute experiences of distal and proximal minority stress and obesogenic eating behavior.

This study used multiple measures of minority stress. Baseline measures of minority stress included standard distal stressors (e.g., discrimination) and proximal stressors (e.g., internalized weight bias and homophobia) related to sexual orientation, weight, and gender, and are outlined in Table 6. EMA assessments of minority stress in this study measured experiences of perceived stigmatization, or the belief that one is being perceived differently or treated differently based on sexual orientation or weight, for example. This study measured stigmatization because it relies on *subjective* experience and, therefore, encompasses a broader array of stressors than outright discrimination, which measures *objective* unfair treatment (Hatzenbuehler, 2009; Myers & Rosen, 1991). For example, an obese person being glared at while buying ice cream qualifies as stigmatization, but not discrimination. Momentary stigmatization was assessed in this study to obtain a comprehensive measure of minority stress.

The Rationale for Ecological Momentary Assessment

To assess the relation between minority stress and obesogenic eating behavior, an EMA data collection strategy is particularly indicated. For example, accurate recollection of stigmatization, food intake, stress and emotion fades over time, resulting in retrospective biases that can lead to inaccurate participant reports (Stone, Schwartz, Shiffman, Marco, Hickcox & Cruise, 1998). EMA also provides information on how *fluctuations* in, for example, stress impact eating throughout the day, compared to cross-sectional data that only allows us to examine the impact of stress on average. By collecting both baseline and EMA data, this study can clarify how both lifetime exposure to distal minority stress (e.g., accumulated lifetime experiences of stigma) and acute exposure (e.g., daily exposure to stigma) impact eating throughout the day. These methods allowed us to determine, with greater ecological and temporal validity than cross-sectional methods alone, whether minority stress increases risk for binge eating and overeating among sexual minority women.

Specific Aims

This was the first EMA study to examine the effects of heterosexist, gender-based, and weight-based minority stressors on eating behavior among overweight and obese sexual minority women. To improve our knowledge of the relation between lifetime and daily stigmatization and obesogenic eating behaviors, this study tested three aims.

Aim 1a: The first study aim examined the impact of baseline minority stress on overall stress, negative emotion, and obesogenic eating behavior among sexual minority women in two ways. First, we examined whether greater lifetime exposure to minority stress was associated with greater baseline perceived stress, baseline depression symptoms, baseline disordered eating,

and baseline binge eating symptoms. Hypothesis 1a: We expected that sexual minority women who reported greater lifetime distal minority stress at baseline (e.g., more lifetime experiences of heterosexist, weight-based, and gender-based stigmatization) and greater proximal minority stress at baseline (e.g., more self-reported internalized heterosexism, sexual orientation concealment, anti-fat attitudes, internalized weight bias, and internalized misogyny) would report greater levels of perceived stress, depression symptoms, disordered eating, and binge eating at baseline.

Aim 1b: To build on the cross-sectional associations examined in Aim 1a, the first study aim also explored whether greater lifetime and recent exposure to minority stress reported at baseline was associated with more daily stress, negative emotion, overeating, and binge eating during the five day EMA period. Hypothesis 1b: We expected that sexual minority women who reported greater lifetime distal minority stress at baseline (e.g., more lifetime experiences of heterosexist, weight-based, and gender-based stigmatization) and greater proximal minority stress at baseline (e.g., more self-reported internalized heterosexism, sexual orientation concealment, anti-fat attitudes, internalized weight bias, and internalized misogyny) would report more total episodes of overeating and binge-eating over the course of the five day EMA period.

Aim 2: The second study aim was to test whether experiencing minority stress (e.g., stigmatization) at any random prompt during the EMA period increased immediate risk for stress, negative emotion, overeating, and binge eating at the same prompt. This was tested by examining concurrent associations between stigmatization, stress, negative emotion, and eating behaviors reported at the same prompt. Hypothesis 2: We expected that experiencing stigmatization at one prompt was associated with more concurrent stress, negative emotion and engagement in overeating and binge eating.

Aim 3: The third study aim was to test whether experiencing minority stress (e.g., stigmatization) at any prompt during the EMA period increased future risk for stress, negative emotion, overeating, and binge eating at the subsequent prompt. This was tested by examining the prospective associations between stigmatization at one random prompt and stress, negative emotion and eating behaviors at the next prompt. Hypothesis 3: We expected that sexual minority women who experience stigmatization at one prompt reported greater future stress, negative emotion, and engagement in overeating and binge eating at the next prompt.

Finally, we examined concurrent associations between stigma, stress, negative emotion, overeating, and binge eating at the day level, hypothesizing that sexual minority women who experience stigma on any given day will experience higher average stress and negative emotion on that day and more overeating and binge eating events, compared to days when they do not experience stigma.

II. Method

Participants

Participants were 55 adult women (age range: 18-60 years, $M=25.00$, $SD=9.27$) from the local community. To be included in the study, participants had to be female, aged 18 or older, who self-identified as non-heterosexual. In the current study, 61.8% of participants identified as bisexual or pansexual, 32.7% identified as lesbian/homosexual, and 5.5% identified as queer. The majority of participants were in a committed relationship (58.2%), and of these, most identified their partner as female (62.5%).

To be included in the study, participants were required to have a BMI equal to or greater than 25 at the time of the baseline visit. Participants were also required to own a smartphone and

to speak fluent English. Participants were excluded from this study if they reported current symptoms of psychosis or a history of schizophrenia, a psychotic disorder, or a developmental disorder, as these conditions could interfere with accurate reporting of real-time experiences. Participants were also excluded if they were currently pregnant, had a current serious medical condition (e.g., cancer), or had a history of weight loss surgery (e.g., lap band, gastric bypass), as these factors could systematically alter participant experiences of hunger and satiety. A consort diagram outlining the flow of participants through the study and the breakdown of reasons for participant exclusion is included in Figure 6.

Within this sample, BMI ranged from 25.1 to 45.0 ($M=32.42$, $SD=4.94$), with 36.4% of participants qualifying as overweight ($25 < \text{BMI} < 30$), 29.1% qualifying as obese ($30 < \text{BMI} < 35$), and 34.5% qualifying as very obese ($\text{BMI} = 35+$). In terms of race/ethnicity, 54.5% of the sample ($N = 30$) was White, 14.5% was Multiracial ($N = 8$), 12.7% was Asian ($N = 7$), 9.1% was Hispanic ($N = 5$), 7.3% was African American/Black ($N = 4$), 1.8% was Native American ($N = 1$). The majority of the sample (92.7%) had at least some college education and household income ranged from under \$9,999 (9.1%) to \$100,000 or more (20.0%).

Procedures

Recruitment

The majority of participants were recruited from online advertisements on Facebook (43.3%) or from flyers posted in the local community and Rutgers campus locations (21.8%). Participants were also recruited from the General Psychology subject pool (8.4%), word of mouth (7.0%), the Rutgers Faculty/Staff Bulletin (5.9%), Craigslist (4.4%), and other online

advertisements (2.4%), Targeted recruitment efforts included sending study flyers to local LGBTQ groups and organizations for dissemination to group members.

Advertisements referred participants to either complete an anonymous online survey that assessed inclusion and exclusion criteria, or to email a research assistant to receive the survey link. Potentially eligible individuals were contacted by a research assistant to receive brief information about the study, and interested individuals were invited to attend a 65-minute in-person baseline visit at one of two locations on the university campus.

Baseline Visit

During the baseline visit, a research assistant outlined study procedures and obtained written informed consent. To confirm that participants met inclusion criteria, research assistants calculated BMI by measuring participants' height and weight using an advanced digital scale and stadiometer, and individuals who did not have a BMI of 25 or more were not invited to complete the study ($n = 1$). Next, participants used a laptop to complete measures of demographic variables (e.g., age, racial background), sexual orientation, distal and proximal minority stressors, and eating behaviors using Qualtrics Online Survey software (Qualtrics, 2016).

Following survey completion, participants used their personal smartphone to download the LifeData smartphone application (LifeData, LLC; <https://www.lifedatacorp.com>), the HIPAA-compliant EMA platform used to administer EMA measures in this study. Research assistants gave participants a detailed handout that outlined EMA procedures, reviewed the handout with them, and the participant practiced completing prompts during the visit. The handout outlined when to complete prompted and self-initiated sessions, reviewed the four categories of questions (e.g., current emotions, current stress, eating behavior, and stigma), and

provided definitions and examples for terms used in the app (e.g., stigma). For example, the handout defined stigmatization as, “times when you felt like you were perceived differently, treated differently, or singled out by others or the environment because of your sexual orientation, weight, gender, or another part of your identity.” Participants were encouraged to report any situations where they felt stigmatized, even if it was ambiguous or subtle. To increase compliance with the EMA protocol, research assistants emphasized the importance of accurate and timely data entry.

Participants received \$15 for completing the baseline visit, and Rutgers student participants were given the option to receive 2 research participation units (RPU) as an alternative. Two student participants chose this option.

EMA Assessment Protocol

Participants used the Lifedata smartphone application to complete prompted assessments of experiences of stigma, eating behaviors, and state stress and negative emotion five times daily for five days, a monitoring period that is standard across EMA studies on stigma and eating behavior (Vartarian & Shaprow, 2008). Participants were prompted to complete entries five times randomly between 9:00AM through 9:30PM, with prompts occurring no less than 120 minutes apart. To ensure EMA compliance, a research assistant monitored EMA data completion for each participant at the end of each monitoring day. Participants who failed to answer one or more Lifedata prompts, and had one or more days of the study remaining, were e-mailed the following morning to remind them about the importance of answering all prompts. No participant was e-mailed more than one reminder. Lifedata prompts not answered within 120

minutes of receipt counted as missing data, a standard time window for determining missing data in the field.

Prompts were delivered to participants' smartphones via an on-screen notification from the LifeData system (LifeData, LLC; 2016). LifeData hosted both a web-based platform and a smartphone application that were linked by a wireless internet connection. LifeData's web-based platform was used by the study PI to design this study's momentary surveys and to monitor prompt completion in real-time. LifeData's smartphone application was downloaded and used by participants to complete notification-initiated and self-initiated study prompts. The LifeData app was available for free download, was designed specifically for EMA research, ran on Android and iOS mobile devices, and used HIPAA compliant encryption procedures during data transmission. During the initial baseline visit, a research assistant assisted participants in downloading and using the LifeData application on their smartphones. Participants were oriented to the time-limited nature of notification-initiated prompts, which expired 120 minutes after receipt. The study PI was available via email and phone throughout the study to answer participant questions.

After completing the five day EMA procedures, participants received an email from study staff containing a link to a brief, five minute survey containing 10 questions that assessed their experience in the study using open-ended, free-response questions. After completing this short survey, participants received an additional \$30 electronically. Participants who chose to receive RPU's were compensated with four additional RPU's. Due to an increase in funding in the final month of data collection, a small minority of participants ($n = 6$) were compensated \$90 total, receiving \$30 after the baseline visit and \$60 after the full study.

Baseline Measures

This study used electronic surveys to assess a number of constructs during the baseline visit, including standard demographics and the measures outlined below. See Table 6 for a summary of baseline measures.

BMI. Objective weight and height were measured at baseline using an advanced digital scale and stadiometer, and were used to calculate participants' current BMI.

Sexual orientation. Sexual orientation is a complex construct that encompasses sexual attraction, behavior, and self-identification (Sell, 1996). In order to be consistent with the majority of research in this area, this study determined sexual minority status based on self-identification as non-heterosexual (e.g., lesbian, bisexual, pansexual, or queer) (Eliason et al., 2015).

Depression. This study measured depressive symptoms occurring in the past 2 weeks using the Patient Health Questionnaire-9 (PHQ-9; Kroenke, Spitzer & Williams, 2001). This measure was used as a dependent variable to test Aim 1a, and as a covariate when testing Aims 2 and 3. This scale is a well-validated 10-item measure that assesses the frequency of depressive symptoms on a scale from 0 (not at all) to 3 (nearly every day). In the current study, we obtained excellent reliability with a coefficient alpha of 0.93.

Perceived Stress. This study measured overall perceived stress with the 10-item Perceived Stress Scale (PSS; Cohen, Kamarck & Mermelstein, 1983). This measure was used in the current study as a dependent variable to test Aim 1a, and as a covariate when testing Aims 2 and 3. The PSS is designed to assess the frequency of general stressful experiences over the past month on a scale from 0 (never) to 4 (very often). The scale is widely used for measuring chronic stress and includes items such as, "In the past month, how often have you felt unable to control

the important things in your life?” In the current study, we obtained excellent reliability with a coefficient alpha of 0.90.

Social Support. This study used an adapted version of the Social Support Behaviors Scale (SSB; Vaux, Riedel, & Stewart, 1987) to measure participants’ perceived levels of social support. This measure was used as a covariate in Aim 2 of this study. The adapted version of the measure (Doty, Willoughby, Lindahl, & Malik, 2010) was shortened from the original version to reduce assessment burden on participants, and the version used in this study included 16 items that assessed emotional support and guidance related to 1) general problems (SSB-G) and 2) problems related to sexuality (SSB-S). Participants completed 16 questions about general problems and the same 16 questions about sexuality-related problems on a Likert scale ranging from 1 to 5, with higher scores indicating more support. This measure has demonstrated excellent internal consistency and validity across multiple studies of sexual minority adults (Doty et al., 2010; Vaux et al., 1987). In the current study, we obtained excellent reliability for social support related to general problems ($\alpha = 0.98$) and sexuality-related problems ($\alpha = 0.98$).

Measures of Distal Minority Stress

Lifetime and recent heterosexual discrimination. To measure lifetime experiences of heterosexual harassment and discrimination, a distal sexual minority stressor, this study used the Heterosexual Harassment, Rejection and Discrimination Scale (HHRDS; Szymanski, 2006). This 14-item self-report measure used three subscales to measure lifetime and recent (past year) experiences of 1) harassment and rejection, 2) work/school discrimination and, 3) other discrimination based on sexual orientation on a scale from 1 (never) to 6 (almost all of the time). A sample question from the 7-item harassment and rejection subscale ($\alpha = 0.89$) is “how many

times have you been verbally insulted because of your sexual orientation,” a question from the 4-item workplace and discrimination subscale ($\alpha = 0.84$) is, “How many times have you been treated unfairly by your employer, boss, or supervisors because of your sexual orientation,” and a question from the 3-item other discrimination subscale ($\alpha = 0.78$) is, “how many times have you been treated unfairly by strangers because of your sexual orientation.” The HHRDS has been used in recent studies examining minority stress and eating patterns among sexual minority women (Bankoff, Marks, Swenson & Pantalone, 2016; Mason & Lewis, 2015). We obtained good reliability for several of these subscales in our study, with acceptable coefficient alphas for measures of harassment and rejection at lifetime ($\alpha = 0.80$) and past year ($\alpha = 0.70$), work/school discrimination at lifetime ($\alpha = 0.79$) and past year ($\alpha = 0.56$), and other discrimination at lifetime ($\alpha = 0.67$) and past year ($\alpha = 0.58$). For several of these scales, including recent work/school discrimination and lifetime and recent other discrimination, lower coefficient alphas reflect women’s more heterogeneous experiences of discrimination at work, school, and across “other” sources.

Lifetime and recent weight-based stigmatization. To measure lifetime experiences of weight-based stigmatization, a distal weight-based minority stressor, this study used the Stigmatizing Situations Inventory (SSI; Myers & Rosen, 1999). This 50-item measure asked participants to report the frequency of lifetime experiences of weight-based stigmatization across a range of settings on a scale from 0 (never) to 9 (daily). Sample items included, “Having people assume you have emotional problems because you are overweight” and “Being started at in public.” The scale has been used extensively to measure stigmatization in overweight and obese populations (Puhl & Brownell, 2006; Seacat, Dougal & Roy, 2014).

This measure contains a global overall score and 11 smaller factors. We obtained good reliability for both the global factor ($\alpha = 0.93$) and the subscales, which assess lifetime experiences of weight-based stigma from specific groups of people, including 1) children ($\alpha = 0.70$), 2) doctors ($\alpha = 0.79$), 3) family members ($\alpha = 0.64$), 4) others ($\alpha = 0.75$), lifetime weight-based stigma in certain environments, such as 5) in the workplace ($\alpha = 0.41$) or 6) by encountering physical barriers in the environment ($\alpha = 0.64$), and lifetime experiences of weight-based stigma in different forms, such as being 7) physically attacked (one item), 8) stared at ($\alpha = 0.71$), 9) excluded ($\alpha = 0.45$), and 10) having others make negative assumptions about you ($\alpha = 0.84$) or 11) be embarrassed by you ($\alpha = 0.50$). For several of these scales, low coefficient alphas may reflect women's disparate experiences of weight-based stigma in the workplace, as well as in social situations, like being excluded or embarrassed.

Lifetime and recent gender-based stigmatization. To measure lifetime and past year experiences of gender-based stigmatization, this study used the Schedule of Sexist Events (SSE; Klonoff, 1995). This measure used 40 items to measure the frequency of both lifetime (20 items) and past year experiences (20 items) of sexist stigmatization across a range of settings on a scale from 1 (never) to almost all of the time (70+% of the time). Scale questions captured four factors, measuring degrading sexist events, workplace discrimination, and sexism in distant and close relationships (Klonoff, 1995). Sample items included, "How many times have you been made fun of, picked on, pushed, shoved, hit, or threatened with harm because you are a woman?" and "How many times have you been treated unfairly by your employer, boss, or supervisors because you are a woman?" In the current study, reliability was excellent for both the lifetime factor ($\alpha = 0.93$) and the past year factor ($\alpha = 0.92$). The scale has been used extensively to

measure sexist stigmatization in adult women in general and sexual minority women in particular (Szymanski, 2005).

Measures of Proximal Minority Stress

Explicit internalized homophobia. To measure internalized homophobia, a proximal sexual minority stressor, this study used an 8-item subscale of the Lesbian Internalized Homophobia Scale (LIHS; Szymanski & Chung, 2001). The “Personal feelings about being a lesbian” subscale assessed participants’ attitudes toward their own sexual orientation and demonstrated good reliability in the current study ($\alpha = 0.72$). The original scale used lesbian-specific language, which was amended in this study to refer to sexual orientation more broadly. A sample item included, “I am proud of my sexual orientation.” This measure was appropriate because it was created and validated for use with sexual minority women, and was used in recent studies examining minority stress and eating patterns among sexual minority women (Bankoff et al., 2016).

Sexual orientation concealment. To measure social concealment of sexual orientation, an additional index of proximal sexual minority stress, this study used the 5-item Sexual Orientation Concealment assessment (Meyer, Rossano, Ellis & Bradford, 2002). This scale assessed participants’ disclosure of their sexual orientation across a range of social settings (e.g., work, friends, family, healthcare providers) on a scale from 1 (out to all) to 4 (out to none), with higher scores representing greater concealment. This scale has been used in previous research examining sexual minority stress among sexual minority women (Lehavot & Simoni, 2011), and reliability for the scale in this study was good ($\alpha = 0.72$).

Anti-fat attitudes. This study measured anti-fat attitudes, a proximal weight-based minority stressor, with the 13-item Anti-fat Attitudes Questionnaire (AFA; Crandall, 1994). This scale measured three components of anti-fat attitudes on a scale from 0 (very strongly disagree) to 9 (very strongly agree). The 7-item Dislike subscale assessed negative attitudes toward obese individuals and included items such as, “Fat people make me feel somewhat uncomfortable.” The 3-item Willpower subscale assessed beliefs about the controllability of body mass, and includes items such as, “Fat people tend to be fat pretty much through their own fault.” While these subscales measured beliefs about fatness in relation to other people, the 3-item Fear of Fat subscale assessed beliefs about fatness in relation to the self, and included items such as, “I feel disgusted with myself when I gain weight.” This measure has been used extensively in research investigating weight-based stigmatization (Myers & Rosen, 1999; Puhl & Brownell, 2006). Reliability in this study was excellent for subscales assessing dislike ($\alpha = 0.85$) and far of fat ($\alpha = 0.86$) and was good for the willpower subscale ($\alpha = 0.77$).

Internalized weight bias. To measure internalized weight bias, an additional index of proximal weight-based minority stress, this study used the 11-item Weight Bias Internalization Scale (WBIS; Durso & Latner, 2008). This scale was developed for use with overweight and obese individuals specifically, and assessed the extent to which participants applied negative beliefs about obese persons to themselves on a 7-item scale ranging from strongly disagree to strongly agree. This scale demonstrated excellent reliability ($\alpha = 0.90$) and included items such as, “I don’t feel that I deserve to have a really fulfilling social life, as long as I’m overweight” and “I hate myself for being overweight.”

Internalized gender bias. Proximal gender-based minority stress was assessed by measuring internalized misogyny using the 17-item Internalized Misogyny Scale (IMS; Piggott,

2004). Participants rated their current internalized sexist beliefs on a 7-item scale ranging from strongly disagree to strongly agree. Sample items included, “Women seek to gain power by getting control over men” and “Women are too easily offended”. This scale was validated for use with both sexual minority and heterosexual women, and contains three subscales that assess distrust of women, gender bias toward men, and devaluing women (Szymanski, Gupta, Carr, & Stewart, 2009). In the current study, this scale demonstrated excellent reliability ($\alpha = 0.88$).

Measures of Eating Behaviors

To assess baseline eating attitudes and behaviors, this study assessed the constructs outlined below. Though this study did not recruit individuals with eating disorders specifically, we recruited overweight and obese women, a population with high rates of disordered eating behaviors (Thomas, Doshi, Crosby & Lowe, 2011).

Disordered eating behaviors and attitudes. This study used the 28-item Eating Disorder Examination-Questionnaire (EDE-Q; Fairburn & Beglin, 1994) to assess the frequency of objective binge eating episodes and compensatory behaviors (e.g., vomiting, laxative use, compulsive exercise) occurring in the past month on a scale from 0 (no days) to 6 (every day). The current study used this measure as a dependent variable in Aim 1a and as a covariate in Aims 2 and 3. The measure also contains four subscales that measure eating restraint (5 items) and eating concerns (5 items), shape concerns (8 items), and weight concerns (5 items). The EDE-Q global scale was used in this study to control for the effects of eating restraints and concerns, and the scale demonstrated excellent reliability, with a coefficient alpha of 0.92.

Binge eating severity. This study used the 16-item Binge Eating Scale (BES; Gormally, Black, Daston & Rardin, 1982) to assess the severity of subjective binge eating episodes and

symptoms. The BES was used in this study as a dependent variable in Aim 1a and as a covariate in Aims 2 and 3. This scale was used in the current study to control for baseline differences in binge eating symptoms, and it demonstrated excellent reliability ($\alpha = 0.90$). This measure was designed for use with an overweight and obese population. It does not use a consistent scale, with each question including unique options. A sample item includes, “I can usually stop eating when I decide I’ve had enough; sometimes I feel an urge to eat that I cannot control; I often feel impulses to eat so strong that I cannot win, but sometimes I can control myself; I feel totally unable to control my impulses to eat.” This scale has been used to assess binge eating severity in previous studies examining eating behavior among sexual minority women (Bankoff et al., 2015).

EMA Protocol Momentary Measures

Prompted assessments of stigmatization, eating, stress, and negative emotion were reported five times daily for the five day EMA period using the LifeData app. Prompts assessed the information outlined below and summarized in Table 7. Participants who did not experience stigma or eat since the last signal completed brief assessments of current stress and negative emotion only.

Participants were also asked to self-initiate entries of eating events that occurred after the final prompt of the day. Research demonstrates that overeating and binge eating episodes occur more frequently during evening hours (Schreiber-Gregory, Lavender, Engel, Wonderlich, Crosby, Peterson, & Mitchell, 2013), so self-initiating prompts to document evening eating was important to reduce the likelihood that recall bias interfered with study data, which could occur if participants waited until the next morning prompt to report evening eating events.

EMA Measures of Stigmatization

This study assessed perceived stigmatization, a measure of minority stress, which was defined here as, “any instance where you feel you are being perceived differently or treated differently because of your sexual orientation, weight, gender, or another aspect of your identity” (Myers & Rosen, 1991; Vartarian et al., 2014). While few studies have examined momentary experiences of stigmatization, our measurement strategy used 6 items and was adapted from and consistent with those that exist (Vartarian et al., 2014, Vartarian, 2015). Our assessments were also derived from previous research investigating lifetime and state experiences of discrimination and conflict (Borrell, Muntaner, Gil-González, Artazcoz, Rodríguez-Sanz, Rohlfs & Álvarez-Dardet, 2010; Krieger et al., 2005; Ong, Fuller-Rowell & Burrow, 2009; Schoenthaler, Schwartz, Cassells, Tobin & Brondolo, 2010).

Stigma occurrence. Participants were asked whether (yes/no) they have experienced stigmatization since the last signal by asking, “Since the last signal, have you experienced stigmatization (e.g., felt you were perceived differently or treated differently because of your sexual orientation, weight or gender?)”

Stigma frequency and form. Participants who reported stigmatization were asked how many distinct events occurred since the last signal and reported the type(s) of stigma they experienced using a checklist of stigmatizing events that read, “Based on your [sexual orientation, weight, gender], you were: a) treated with less courtesy and respect than others, b) made fun of, teased or called derogatory names, c) glared at or singled out, d) treated unfairly or prevented from doing something, e) been made to feel inferior, f) excluded, g) been harassed or threatened, h) been judged or criticized, i) had others make unfair assumptions about you, j)

could not fit in a seat or find clothes, k) unrelated problems were blamed on your sexual orientation or weight, m) family/friends were ashamed of you, n) other (please explain).”

Reason for stigmatization. Because sexual minority women have multiple stigmatized identities, participants provided a perceived reason for the stigmatization, or the identity to which they attributed the stigma (e.g., were you stigmatized because of your weight, sexual orientation, gender, race, age, social class, religion). This allowed us to identify stigma that is related to weight, sexual orientation and gender, though in our final analyses, we did not parse these out.

Perceived stigma intensity. Participants rated the intensity/severity of the stigmatization on a scale from 1 (mild) to 10 (very intense).

Reactivity to stigmatization. Participants rated their affective response to the event using a 5-point scale (1 = this event made me feel good, 2 = It did not bother me, 3 = It bothered me slightly, 4 = It upset me, 5 = This event upset me extremely) that is consistent with previous research investigating reactivity to discrimination (Huynh, 2012).

EMA Measures of Eating Behaviors

This study assessed eating behavior, specifically overeating and binge eating, at each prompt using 13 items. Prompts assessed current hunger and the presence of food intake since the last signal. Participants who consumed food were asked to report details about the content, volume, timing, and location of food intake, as well as perceptions of lack of control while eating. Specific eating items are listed in Table 7, and were derived from momentary measures of eating behavior used in a variety of EMA studies that have been conducted in obese and non-obese populations (Engel et al., 2016; Goldschmidt, Crosby, Cao, Engel, Durkin, Beach, & Peterson, 2014; Thomas et al., 2011; Tomiyama, in press).

Overeating was defined by an episode of eating wherein the participant ate “more than usual” or at an “unusual time for me” when they were not “making up for a missed meal or snack.” This measure of overeating was used in a recent EMA study of obesogenic eating behavior in women (Thomas et al., 2011). Binge eating was defined as eating “what most people would regard as an unusually large amount of food (given the circumstances)” and feeling “out of control” while eating, items from a standard measure binge eating (EDE-Q; Fairburn & Beglin, 1994) that have been used in EMA studies of eating behavior in obese individuals (Berg, Peterson, Crosby, Cao, Crow, Engel, & Wonderlich, 2014).

Participants were also instructed during the baseline visit to self-initiate EMA entries of food intake that occurred after the last prompt of the day. These self-initiated responses prompted participants to answer the 13 momentary questions that assess eating and the 10 questions that assessed stress and negative emotion.

EMA Measures of Stress and Negative Emotion

All random and self-initiated prompts assessed state stress and negative emotion using 10 items. To assess state stress, participants completed the short, 4-item version of the PSS (Cohen, Kamarck & Mermelstein, 1983). This 4-item measure has been widely used to measure state stress in EMA studies (Carney, Armeli, Tennen, Affleck & O’Neil, 2000). A sample item included, “Since the last prompt, how often have you felt difficulties were piling up so high that you could not overcome them.” Items were rated on a scale from 0 (never) to 4 (very often), and a total state stress score was computed for each prompt by summing the 4 items (range: 0 to 16). The measure achieved good reliability in this study ($\alpha = 0.82$).

Participants also reported current levels of seven negative emotions (sadness, loneliness,

anxiety, embarrassment/shame, anger, guilt, and disgust) on a Likert scale (0 = not at all, 5 = extremely). A total state negative emotion score was computed at each prompt by summing the seven negative items (range: 0 to 35), and reliability was excellent ($\alpha = 0.87$). These assessments have been used by previous EMA studies of the emotional experiences associated with dysregulated behaviors (Selby, Kranzler, Panza & Fehling, 2015), eating behaviors (Engel, Kahler, Lystad, Crosby, Simonich, Wonderlich, & Mitchell, 2009; Goldschmidt et al., 2014; Thomas et al., 2011; Tomiyama, Mann & Comer, 2009) and weight-based stigmatization (Tomiyama et al., in press).

III. Data Analytic Strategy

Descriptive statistics. The study PI used SPSS Version 24.0. to conduct data analysis. Baseline data was examined by computing descriptive data and bivariate correlations between key variables of BMI, sexual orientation, distal minority stress, proximal minority stress, and eating attitudes and behaviors. Momentary data was examined in aggregate form to understand the frequency and intensity of experiences of stigmatization during the sampling period. Individual sum scores for both negative emotion (7 items) and stress (4 items) were computed for each random signal, and the frequency of overeating and binge eating episodes were calculated based on the criteria outlined in the Measures section of this paper. All variables were examined for outliers and random variance.

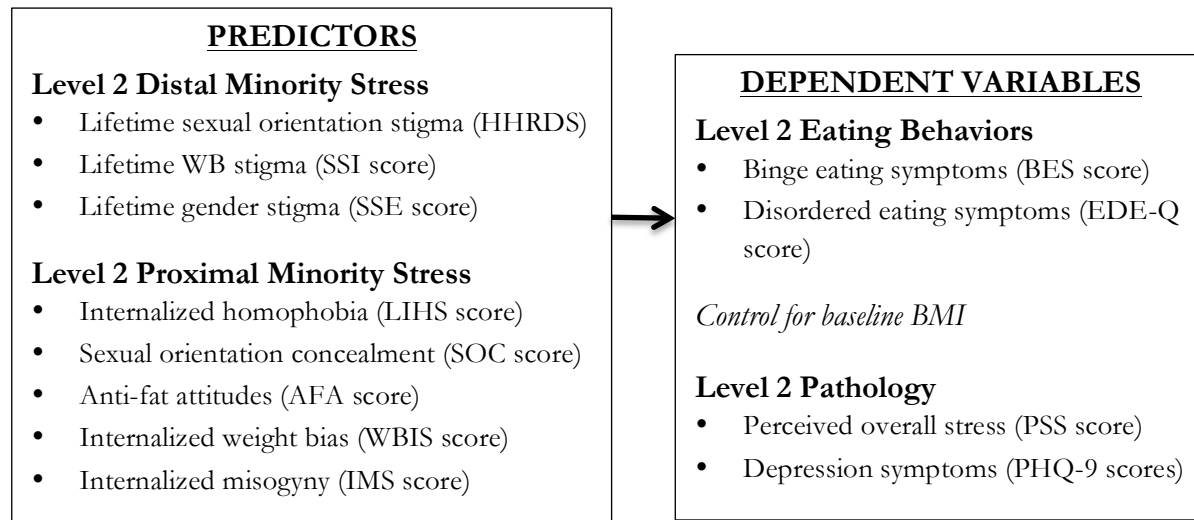
General analysis plan. For analyses of baseline predictors on baseline outcomes, linear regression was used. For within-person analyses during EMA, because EMA data violate the assumption of independence of observations, this study utilized generalized and linear mixed modeling to account for the multiple observations for each participant. These data have a two-

level structure, including both baseline measures and momentary measures, and contain multiple assessments within each participant (five daily signals). Level 1 describes within-person variation (e.g., daily experiences of stigmatization, eating episodes, stress and negative emotion occurring during the five day study period) and Level 2 describes between-person variation (e.g., lifetime distal minority stress, proximal minority stress, baseline disordered eating, BMI, sexual orientation, baseline stress, and depression). All mixed models included a random intercept, and all predictor variables were examined as fixed effects.

Aim 1a

To examine the hypothesis that baseline minority stress was associated with greater perceived stress and symptoms of depression, disordered eating, and binge eating at baseline, linear regressions were used to determine whether the baseline Level 2 variables of distal stress (lifetime weight-based, heterosexist, and gender-based stigma) and proximal stress (anti-fat attitudes, sexual orientation concealment, and internalized weight-bias, homophobia, and misogyny) were associated with more baseline Level 2 perceived stress, depression symptoms, disordered eating, and binge eating. Linear regression was an appropriate statistical test because all covariates, independent variables, and dependent variables were normally distributed and measured on continuous scales. After examining main effects, BMI was added as a covariate into the model to control for the effect of body weight on baseline overeating and binge eating. See Figure 2 below for a visual depiction of the data analysis plan for Aim 1a.

Figure 2. Visual data analysis plan for Aim 1a
(level 1 = within person variable, level 2 = between person variable)

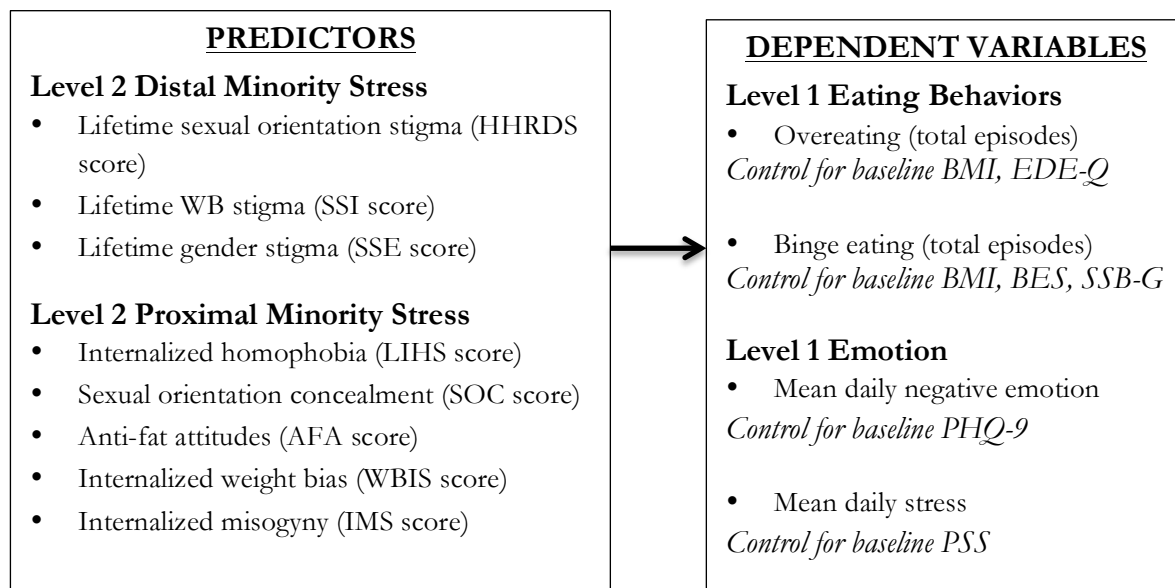


Aim 1b

To examine the hypothesis that baseline minority stressors were associated with more daily stress, negative emotion, overeating and binge eating, this study used generalized and linear mixed models to determine whether the fixed Level 2 variables of distal stress (lifetime weight-based, heterosexist, and gender-based stigma) and proximal stress (anti-fat attitudes, sexual orientation concealment, and internalized weight-bias, homophobia, and misogyny) predicted more daily Level 1 mean stress, mean negative emotion, and total overeating and binge eating episodes. Given that two of the dependent variables were count variables, describing the total number of overeating and binge eating episodes that occurred per participant during the EMA period, the data were non-normally distributed and demonstrated a systematic pattern of skewness. This was accounted for by using a Poisson distribution with a log link function, a distribution that is typically used when testing count variables.

After examining main effects, analyses also controlled for several covariates. Models predicting average EMA negative emotion controlled for baseline depression using PHQ-9 scores. Models predicting average EMA stress controlled for baseline perceived stress using baseline scores on the PSS. Models predicting overeating controlled for the effects of weight using baseline BMI, as well as baseline disordered eating using scores on the EDE-Q. Models predicting binge eating controlled for the effects of baseline BMI, binge eating symptoms on the BES at baseline, and given strong bivariate correlations between general social support and EMA binge eating, analyses also controlled for social support using scores on the SSB-G. All together, this allowed us to determine the extent to which lifetime distal and proximal minority stress contributed to daily stress, negative emotion, overeating, and binge eating above and beyond baseline depression, perceived stress, weight, disordered eating, binge eating, and social support. See Figure 3 below for a visual depiction of the data analysis plan for Aim 1b.

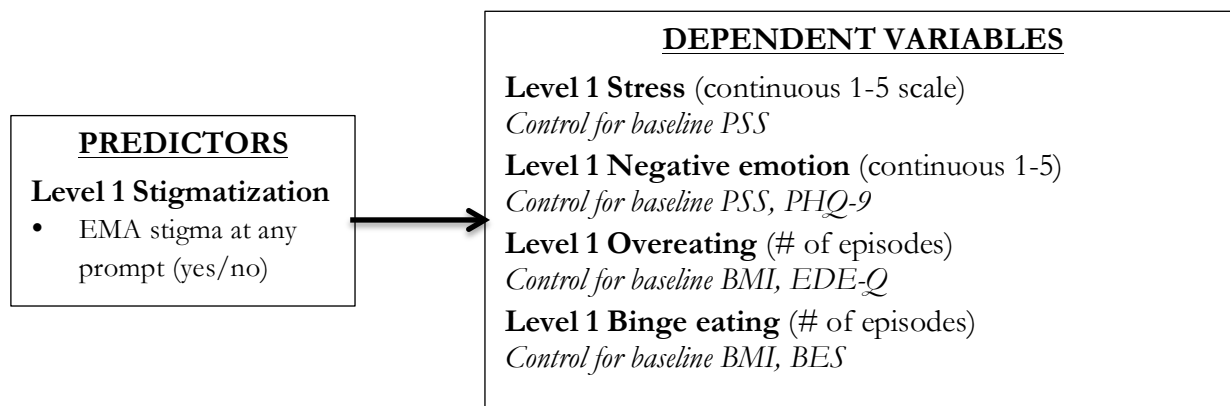
Figure 3. Visual data analysis plan for Aim 1b
(level 1 = within person variable, level 2 = between person variable)



Aim 2

To examine whether momentary experiences of stigma were associated with concurrent elevations in stress, negative emotion, binge eating, and overeating, this study used generalized mixed models with a Poisson distribution and log link function to determine whether reports of stigma (yes/no) (Level 1) at one signal were associated with concurrent levels of stress, negative emotion, overeating and binge eating (Level 1) at the same signal. After examining main effects, covariates were added, including BMI, baseline levels of stress, depression, and disordered eating. See Figure 4 below for a visual depiction of the data analysis plan for Aim 2.

Figure 4. Data analysis plan for Aim 2: concurrent associations

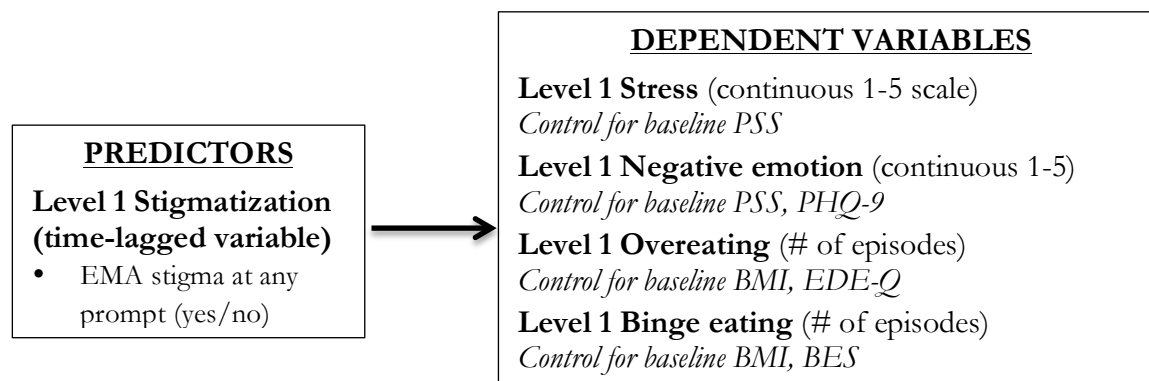


Aim 3

To examine whether momentary experiences of stigmatization heightened risk for future stress, negative emotion, overeating, and binge eating, this study used time-lagged analyses to determine whether reports of stigma (Level 1) at one signal predicted stress, negative emotion, overeating and binge eating (Level 1) at the next signal. Participants reported the frequency of experiences of stigma, stress, negative emotion, and eating behaviors at each assessment point, and these reports were used to create time-lagged variables. Next, we created lag variables by

taking the score for stigma occurrence (yes/no) for every participant at each signal and shifting the data to the next signal time point. This allowed us to analyze the hypothesis that stigma occurrence at one time point predicted stress, negative emotion, overeating, and binge eating at the subsequent time point. Reports of eating behaviors at the first prompt of each day, which had no preceding report of stigma, were not included when creating lag variables. After examining main effects, we additionally controlled for baseline BMI, overall stress, disordered eating, and depression. This allowed us to determine the extent to which stigmatization contributed to future risk for stress, negative emotion, overeating and binge eating, above and beyond covariates. See Figure 5 for a visual depiction of the data analysis plan for Aim 3.

Figure 5. Data analysis plan for Aim 3: prospective associations



Finally, we examined all effects at the day level to test whether experiencing stigma during the day, versus not experiencing stigma, heightened risk for experiencing greater stress, negative emotion, overeating, and binge eating on that day. To do this, a variable was created to reflect whether stigma had been reported per participant at any of the five signals throughout the day (yes/no). Next, average scores of stress and negative emotion per participant per day were

computed for each of the monitoring period's five days. Daily totals of overeating episodes and binge eating episodes were computed per participant per day. Using these variables, generalized mixed models with a Poisson distribution and log link were used to determine whether greater daily stigma (Level 1) predicted greater average stress, average negative emotion, and total overeating episodes and binge eating episodes (Level 1) on that day.

Power

Given the nature of EMA data, which comprise multiple within-person assessments, these data were robust to small sample sizes for examining within-subjects effects, which Aims 2 and 3 were primarily composed of. However, the proposed sample size had low power for detecting between-subjects effects (e.g., differences in Level 2 baseline measures), which influenced results for Aim 1. Given the novel and exploratory nature of the study, however, all analyses were exploratory and aimed to establish preliminary effect sizes.

Results

Descriptive Statistics

Baseline Descriptive Data

55 overweight or obese sexual minority women completed the baseline visit. The majority of participants (92.7%) perceived their overall stress level, as measured by the PSS, to be moderate or high ($M = 24.83$, $SD = 7.07$, range: 0-38). Participants also reported high average social support ($M=59.71$, $SD=15.11$, scale: 16-80, range: 24-80), with general perceived support and sexuality-specific support levels ($M=56.70$, $SD=14.76$, range: 16-80) being comparable.

Despite fairly high levels of social support reported by the sample, the majority of participants (80%) reported having received therapy for mental health problems during their lifetime, most frequently for depressed mood (69.1%), general anxiety (50.9%), suicidal thoughts or self-harm (27.3%), eating disorders (10.9%), or weight loss or quitting smoking (9.1%). In terms of current psychopathology symptoms, the majority of participants reported no significant binge-eating symptoms (61.8%), though a significant subset reported moderate (18.2%) or severe (20%) symptoms (range: 0-37, $M=16.65$, $SD=9.32$). We also measured depressive symptoms, with average scores falling in the moderate range ($M = 11.98$, $SD = 7.03$), and the majority of participants reporting either moderate (20%) or severe (36.4%) symptoms.

Momentary Descriptive Data

One hundred percent of women who completed the baseline visit also completed the five day EMA portion of the study, and no adverse events were reported during the study. The majority of participants (85%) completed at least 80% of notification-initiated prompts during the study period, meeting minimum criteria for good compliance with EMA procedures. Out of 1,387 notification-initiated prompts delivered throughout the five day period, participants responded to 1,253 prompts (90.3%) and completed 1229 prompts (88.6%). Participants completed 32 self-initiated prompts to report any eating episodes that occurred after the last prompt of the day.

Throughout the five day period, participants reported no stigma at the majority of notification-initiated prompts (93.9%). Stigma was reported at 97 sessions (6.1%), with participants reporting 180 total episodes of stigma (range 0-25, $M = 4.52$, $SD = 5.19$). Most participants ($N = 41$, 74.5%,) reported at least one stigma episode during the study (range: 0-11).

Participants reported 2.76 episodes of stigma per day, on average ($SD = 2.97$). Though lesbian women reported significantly more episodes of stigma ($M = 6.0$, $SD = 5.9$) than bisexual ($M = 3.9$, $SD = 5.4$) and queer ($M = 4.0$, $SD = 3.6$) women ($F(2, 53) = 3.3$, $p < .05$, $\eta_p^2 = 0.12$), when the number of episodes at each prompt was taken into account, no significant differences emerged.

Participants experienced stigma in a variety of forms, including being made to feel inferior ($N = 17$; 17.5% of episodes), being glared at or singled out ($N = 13$; 13.4%), overhearing disparaging comments ($N = 12$, 12.4%), being judged or criticized ($N = 10$, 10.3%), and others making unfair assumptions about them ($N = 10$, 10.3%). Participants most commonly believed that they were stigmatized because of their sexual orientation ($N = 50$, 45.6% of episodes), their gender ($N = 50$, 43.2%), their weight ($N = 30$, 28.3%), and their age ($N = 23$, 18.4%). Stigma elicited a negative reaction from most participants, with the majority reporting that it upset them either slightly (36.49%), moderately (35.14%), or extremely (22.97%). Most stigmatizing events occurred at work (31%), in a public setting (27%), and at home (19%), and on average, participants rated stigmatizing events as moderate in intensity ($M = 4.13$, $SD = 2.28$, scale: 0-10).

Participants also monitored their eating behaviors during the study, and could report up to 3 discrete eating events at each prompt. Participants reported 700 total eating events ($M=12.56$, $SD=2.88$) at 55.3% of notification-initiated prompts. Overeating was reported at 188 prompts (26.8% of eating episodes), with 236 total episodes of overeating reported ($M=4.29$, $SD=3.40$). The majority of participants (82.9%) reported at least one overeating episode during the study (range: 0-14). Binge eating was reported at 58 prompts (8.2% of eating episodes), with 60 total

binge eating episodes reported ($M=1.07$, $SD=1.79$). Forty four percent of participants reported at least one binge episode during the study (range: 0-9).

In addition to stigma and eating behavior, participants monitored state stress and negative emotion levels during the EMA period. On average, participants reported moderate momentary stress ($M = 7.03$, $SD = 3.57$, scale: 0-16) and momentary negative emotion ($M = 12.18$, $SD = 5.35$, scale: 0-35). Means, standard deviations, and bivariate correlations for baseline and momentary variables are presented in Table 3.

Aim 1a:

Baseline Minority Stress and Baseline Stress, Negative Emotion, and Eating Behavior

The model proposed in this study suggests that minority stress leads to chronically heightened stress and negative emotion among sexual minority women, two variables that heighten risk for overeating and binge eating in this group. To test this model, the current study first examined whether baseline minority stress impacted overall stress, negative emotion, and obesogenic eating behavior among sexual minority women in two ways: by testing cross-sectional associations between these variables, then testing associations between baseline minority stress and EMA measures of stress, negative emotion, overeating, and binge eating.

First, we examined cross-sectional associations, testing the relation between baseline minority stress and baseline perceived stress, depression symptoms, disordered eating, and binge eating symptoms. To do this, linear regressions were used to determine whether the baseline Level 2 variables of distal stress (lifetime weight-based, heterosexist, and gender-based discrimination) and proximal stress (anti-fat attitudes, sexual orientation concealment, and internalized weight-bias, homophobia, and misogyny) were associated with more baseline Level

2 perceived stress, depression symptoms, disordered eating and binge eating symptoms. After examining main effects, BMI was included as a covariate into to control for the effect of body weight on baseline overeating and binge eating.

Baseline Distal Minority Stress and Baseline Stress and Depression

To test the proposed model of minority stress as a mechanism for obesity in sexual minority women, we first examined whether baseline distal stressors, including lifetime and recent experiences of heterosexual, weight-based, and gender-based stigma, were cross-sectionally associated with baseline perceived overall stress and depression symptoms. Main effects demonstrated that, as expected, greater lifetime heterosexual stigma was associated with greater baseline stress ($b = 0.52$, $SE = 0.15$, $\beta = 0.42$, $p < .01$, $R^2 = 0.16$) and greater baseline depression symptoms ($b = 0.37$, $SE = 0.16$, $\beta = 0.30$, $p < .05$, $R^2 = 0.04$). Participants who reported higher recent heterosexual stigma were more likely to report higher baseline stress ($b = 0.55$, $SE = 0.27$, $\beta = 0.26$, $p < .05$, $R^2 = 0.06$), but not higher baseline depression symptoms ($p > 0.05$).

Expected effects also emerged for lifetime weight-based and gender-based stigma. Participants who reported higher lifetime weight stigma were more likely to report greater baseline stress ($b = 4.79$, $SE = 1.39$, $\beta = 0.46$, $p < .01$, $R^2 = 0.15$) and greater baseline depression symptoms ($b = 6.53$, $SE = 1.23$, $\beta = 0.63$, $p < .001$, $R^2 = 0.33$), effects that remained significant even after controlling for baseline BMI. With respect to gender-based stigma, greater lifetime stigma related to being a woman was associated with higher baseline stress ($b = 0.19$, $SE = 0.05$, $\beta = 0.44$, $p < .01$, $R^2 = 0.18$) and depression symptoms ($b = 0.14$, $SE = 0.05$, $\beta = 0.34$, $p < .01$,

$R^2 = 0.10$). Recent gender stigma was only linked with higher baseline stress ($b = 0.19$, $SE = 0.05$, $\beta = 0.45$, $p < .001$, $R^2 = 0.19$).

Baseline Proximal Minority Stress and Baseline Stress and Depression

According to the proposed model, higher levels of proximal minority stress, or “self-stigma,” will likely be associated with more stress and depression at baseline. However, contrary to expectations, when we examined participant reports of proximal minority stress related to sexual orientation at baseline, including internalized homophobia and sexual orientation concealment, neither were associated with baseline depression or stress. These contrary results also extended to gender-based proximal stress, as participant levels of internalized misogyny were not related to their levels of baseline stress or depression.

In contrast, results for weight-based “self-stigma” aligned more with the proposed model. Women who reported greater internalized weight bias at baseline also reported higher baseline stress ($b = 0.28$, $SE = 0.17$, $\beta = 0.55$, $p < .001$, $R^2 = 0.25$) and depression symptoms ($b = 0.31$, $SE = 0.06$, $\beta = 0.62$, $p < .001$, $R^2 = 0.32$). Similarly, women with a greater fear of becoming fat displayed more baseline stress ($b = 1.52$, $SE = 0.50$, $\beta = 0.40$, $p < .05$, $R^2 = 0.12$) and greater baseline depression symptoms ($b = 1.55$, $SE = 0.50$, $\beta = 0.39$, $p < .01$, $R^2 = 0.13$). Notably, these effects remained consistent after controlling for baseline BMI. A full breakdown of main effects for Aim 1a analyses examining the relation between distal and proximal minority stress and baseline stress and depression symptoms are included below in Table 1.

Table 1. Main effects for Aim 1a: Linear regressions of baseline distal and proximal minority stress and baseline perceived stress and depressive symptoms

	Baseline Overall Stress			Baseline Depression Symptoms		
<i>Distal Minority Stressors</i>	<i>b</i>	<i>SE</i>	<i>R</i> ²	<i>b</i>	<i>SE</i>	<i>R</i> ²
Lifetime heterosexist stigma - Total	0.52**	0.15	0.16	0.37*	0.16	0.04
Lifetime heterosexist stigma – Work/School	0.55*	0.27	0.06	0.22	0.27	-0.01
Recent heterosexist stigma - Total	0.42*	0.21	0.05	0.22	0.22	0.001
Recent heterosexist stigma – Work/School	0.67	0.42	0.27	-0.16	0.43	-0.02
Lifetime weight stigma	4.79**	1.39	0.15	6.53***	1.23	0.33
Lifetime gender stigma	0.19**	0.05	0.18	0.14**	0.05	0.10
Recent gender stigma	0.19***	0.05	0.19	0.09	0.06	0.02
<i>Proximal Minority Stressors</i>	<i>b</i>	<i>SE</i>	<i>R</i> ²	<i>b</i>	<i>SE</i>	<i>R</i> ²
Internalized homophobia	0.04	0.16	0.00	0.17	0.15	0.004
Sexual orientation concealment	0.56	1.43	-0.02	1.09	1.41	-0.01
Internalized weight bias	0.28***	0.17	0.25	0.31***	0.06	0.32
Anti-fat attitudes – fear of fat	1.52*	0.50	0.12	1.55**	0.50	0.13
Anti-fat attitudes – willpower	0.67	0.56	-0.01	0.96	0.54	0.03
Internalized misogyny	-0.02	0.07	-0.02	0.05	0.07	-0.01

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Baseline Distal Minority Stress and Baseline Disordered Eating and Binge Eating

To test the proposed model of minority stress as a mechanism for obesity in sexual minority women, we also examined whether baseline distal stressors, including lifetime and

recent experiences of heterosexist, weight-based, and gender-based stigma, were cross-sectionally associated with baseline disordered eating and binge eating symptoms. Main effects demonstrated that women who reported more frequent experiences of heterosexist harassment and rejection within the past year ($M = 10.54$, $SD = 4.31$) also reported higher levels of baseline binge eating ($M = 16.64$, $SD = 9.24$; $b = 0.69$, $SE = 0.28$, $\beta = 0.32$, $p = 0.015$, $R^2 = 0.09$) and disordered eating symptoms ($M = 2.78$, $SD = 1.14$; $b = 0.07$, $SE = 0.35$, $\beta = 0.27$, $p = 0.04$, $R^2 = 0.06$). In contrast, participants' experiences of lifetime heterosexist stigma were not significantly associated with either baseline binge eating or disordered eating. These results were consistent after controlling for the effects of baseline BMI on baseline disordered eating and binge eating.

In line with the model proposed in this study, there was a strong relation between weight-based stigma, disordered eating, and binge eating symptoms at baseline. Women who reported more frequent experiences of global lifetime weight-based stigma ($M = 1.08$, $SD = 0.67$) also displayed higher levels of baseline binge eating ($b = 7.3$, $SE = 1.76$, $\beta = 0.53$, $p < .01$, $R^2 = 0.22$) and greater baseline disordered eating symptoms ($b = 0.73$, $SE = 0.22$, $\beta = 0.43$, $p < 0.01$, $R^2 = 0.19$). Greater levels of nearly every facet of weight-based stigma was significantly associated with higher baseline binge eating and disordered eating symptoms, and these results were consistent after controlling for the effects of baseline BMI on baseline disordered eating and binge eating.

Data on participants' experiences of gender-based stigma also largely supported the proposed model. Women who, at baseline, described more frequent experiences of gender-based stigma during their lifetime ($M = 61.20$, $SD = 16.64$) also described higher levels of binge eating ($b = 0.16$, $SE = 0.07$, $\beta = 0.29$, $p = 0.03$, $R^2 = 0.06$) and disordered eating symptoms ($b = 0.02$, $SE = 0.01$, $\beta = 0.35$, $p = 0.01$, $R^2 = 0.11$). However, women's recent experiences of gender-

based stigma within the past year ($M = 50.04$, $SD = 16.65$) were not significantly associated with baseline binge eating or disordered eating. All results held when we added BMI into the model to control for the effects of body weight on baseline disordered eating and binge eating.

Baseline Proximal Minority Stress and Baseline Disordered Eating and Binge Eating

To test the proposed model, we also examined whether baseline proximal stressors, including sexual orientation concealment, internalized homophobia, internalized weight bias, anti-fat attitudes, and internalized misogyny, were cross-sectionally associated with baseline disordered eating and binge eating symptoms. In contrast to study hypotheses, main effects demonstrated that participants' levels of sexual orientation-based proximal stress, including internalized homophobia and sexual orientation concealment, were not associated with their baseline symptoms of disordered eating ($p > 0.05$) or binge eating ($p > 0.05$). These findings remained consistent when BMI was added into the model.

In contrast, findings regarding weight-based proximal stress were consistent with study hypotheses. Women who reported more internalized weight bias ($M = 47.43$, $SD = 14.03$) had higher levels of baseline symptoms of binge eating ($b = 0.44$, $SE = 0.073$, $\beta = 0.67$, $p < 0.001$, $R^2 = 0.39$) and disordered eating ($b = 0.06$, $SE = 0.007$, $\beta = 0.78$, $p < 0.001$, $R^2 = 0.59$). Further, participants who endorsed more intense fears of becoming fat at baseline ($M = 7.24$, $SD = 1.78$) reported significantly higher levels of baseline binge eating ($b = 2.4$, $SE = 0.64$, $\beta = 0.46$, $p = 0.001$, $R^2 = 0.18$) and disordered eating ($b = 0.43$, $SE = 0.062$, $\beta = 0.68$, $p < 0.001$, $R^2 = 0.50$). Finally, higher levels of another facet of anti-fat attitudes, the belief that being overweight is a failure of willpower ($M = 4.80$, $SD = 1.77$), were associated with greater disordered eating symptoms at baseline ($b = 0.24$, $SE = 0.083$, $\beta = 0.37$, $p = 0.006$, $R^2 = 0.16$), but not with baseline binge eating symptoms ($p > 0.05$). All results held when BMI was added into the model.

The last component of the hypothesis examined gender-based proximal minority stress. As expected, main effects demonstrated that greater internalized misogyny ($M = 35.98$, $SD = 12.95$) was associated with significantly more baseline disordered eating ($b = 0.03$, $SE = 0.011$, $\beta = 0.30$, $p = 0.02$, $R^2 = 0.08$). And, while the relationship did not reach significance, internalized misogyny and binge eating symptoms trended toward significance in the expected direction, with greater self-stigma being linked with greater eating pathology ($b = 0.17$, $SE = 0.09$, $\beta = 0.24$, $p = 0.078$, $R^2 = 0.04$). These findings did not change when BMI was added into the model as a covariate.

A full breakdown of main effects for Aim 1a analyses examining the relation between distal and proximal minority stress and baseline disordered eating and binge eating symptoms are included below in Table 2.

Table 2. Main effects for Aim 1a: Linear regressions of baseline distal and proximal minority stress and baseline disordered eating and binge eating

<i>Distal Minority Stressors</i>	Baseline Disordered Eating			Baseline Binge Eating		
	<i>b</i>	<i>SE</i>	<i>R</i> ²	<i>b</i>	<i>SE</i>	<i>R</i> ²
Lifetime heterosexist stigma - Total	0.04	0.03	0.03	0.30	0.22	0.02
Lifetime heterosexist stigma – Work/School	0.06	0.05	0.01	0.10	0.37	-0.02
Recent heterosexist stigma - Total	0.07*	0.35	0.06	0.69*	0.28	0.09
Recent heterosexist stigma – Work/School	0.02	0.07	-0.02	0.08	0.57	-0.02
Lifetime weight stigma	0.73***	0.22	0.19	7.3***	1.76	0.22
Lifetime gender stigma	0.02**	0.01	0.11	0.16*	0.07	0.06
Recent gender stigma	0.02	0.01	0.03	0.12	0.07	0.03

	Baseline Disordered Eating			Baseline Binge Eating		
<i>Proximal Minority Stressors</i>	<i>b</i>	<i>SE</i>	<i>R</i> ²	<i>b</i>	<i>SE</i>	<i>R</i> ²
Internalized homophobia	0.04	0.03	0.02	0.14	0.20	-0.01
Sexual orientation concealment	0.038	0.23	0.03	2.49	1.85	0.02
Internalized weight bias	0.06***	0.06	0.50	0.44***	0.07	0.39
Anti-fat attitudes – fear of fat	2.4**	0.08	0.16	0.43***	0.64	0.18
Anti-fat attitudes – willpower	0.24*	0.08	0.06	1.13	0.69	0.03
Internalized misogyny	0.03*	0.11	0.08	0.17	0.09	0.04

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Aim 1b:

While the majority of baseline measures of distal and proximal minority stress significantly predicted greater baseline stress, depression, disordered eating, and binge eating, the cross-sectional nature of the data make it impossible to draw any conclusions about causality or directionality. To build on limitations of these cross-sectional analyses, the current study tested the proposed model by conducting a “micro-longitudinal” analysis by examining whether women’s reports of minority stress at baseline predicted their levels of stress, negative emotion, overeating, and binge eating during the five day EMA period, as the proposed model would expect.

To do this, variables were computed to reflect average stress and negative emotion per participant per day, as well as the total number of overeating and binge eating episodes that each participant engaged in during the EMA period. Next, we used generalized mixed models with Poisson distributions and a log link function to determine whether the fixed Level 2 variables of distal stress (lifetime weight-based, heterosexist, and gender-based discrimination) and proximal

stress (anti-fat attitudes, sexual orientation concealment, and internalized weight-bias, homophobia, and misogyny) predicted more Level 1 daily average stress and negative emotion, and more Level 1 total overeating and binge eating throughout the EMA period.

After examining main effects, analyses also controlled for several key covariates. When examining effects related to daily stress, we controlled for baseline global stress using scores on the PSS. Models predicting daily average negative emotion controlled for baseline depression using PHQ-9 scores. When examining effects related to EMA overeating, we controlled for baseline weight using BMI, and for baseline disordered eating using scores on the EDE-Q. Finally, models predicting binge eating during the EMA period controlled for baseline BMI, baseline binge-eating symptoms using the BES, and given strong bivariate correlations between EMA binge eating and social support, we control for general social support using SSB-G scores.

Baseline Minority Stress and Daily Mean Stress and Negative Emotion

First, we tested whether greater lifetime and recent exposure to minority stress was associated with more average daily stress and negative emotion reported during the EMA period. Findings aligned both with the proposed model and the *Minority Stress Model*, as women who endorsed greater global lifetime heterosexist stigma also endorsed higher daily mean stress ($b = 0.02$, $SE = 0.01$, $Wald = 9.61$, $p < .01$, $RR = 1.02$) and negative emotion ($b = 0.03$, $SE = 0.01$, $Wald = 8.12$, $p < .01$, $RR = 1.03$) during the monitoring period. Similarly, those who reported more lifetime heterosexist harassment at work reported higher daily average stress ($b = 0.05$, $SE = 0.01$, $Wald = 26.3$, $p < .001$, $RR = 1.06$) and negative emotion ($b = 0.05$, $SE = 0.01$, $Wald = 14.32$, $p < .001$, $RR = 1.05$). Finally, consistent with both models, women's reports of heterosexist stigma within the past year predicted higher average daily stress ($b = 0.02$, $SE =$

0.01, $Wald = 5.93$, $p < .05$, $RR = 1.02$) and negative emotion ($b = 0.03$, $SE = 0.02$, $Wald = 4.06$, $p < .05$, $RR = 1.03$). These findings held even when controlling for the impact of baseline stress on daily stress, and baseline depression on daily negative emotion.

Women's reports of gender-based distal stress also aligned with study expectations. Greater lifetime gender stigma at baseline significantly predicted higher daily mean stress ($b = 0.01$, $SE = 0.00$, $Wald = 9.55$, $p < .01$, $RR = 1.01$) and negative emotion ($b = 0.01$, $SE = 0.001$, $Wald = 5.25$, $p < .05$, $RR = 1.01$). This was also largely true with respect to women's reports of gender-based stigma accruing over the past year, with those reporting greater recent stigma displaying higher daily mean stress ($b = 0.01$, $SE = 0.00$, $Wald = 8.12$, $p < .01$, $RR = 1.01$), but not higher daily negative emotion ($p > 0.05$).

However, in contrast to study hypotheses, generalized mixed models revealed that participants' levels of weight-based proximal stress, including internalized weight bias and anti-fat attitudes, were not associated with their levels of daily stress ($p > 0.05$) or negative emotion ($p > 0.05$) during the monitoring period. All findings remained consistent when controlling for the effect of baseline stress on daily stress and for baseline depression on daily negative emotion.

Baseline Proximal Minority Stress and Daily Mean Stress and Negative Emotion

To test the proposed model, we also examined whether baseline proximal stressors, including sexual orientation concealment, internalized homophobia, internalized weight bias, anti-fat attitudes, and internalized misogyny, predicted participants' daily average stress and negative emotion during the five day EMA period, as the proposed model would expect. In line, at least partially, with study hypotheses, generalized mixed models revealed that greater sexual orientation concealment at baseline predicted higher daily mean negative emotion ($b = 0.27$, SE

= 0.07, $Wald = 15.5$, $p < .001$, $RR = 1.31$), but not daily stress ($p > 0.05$). In contrast to expectations, women's baseline levels of internalized homophobia did not predict their daily reports of stress ($p > 0.05$) or negative emotion ($p > 0.05$) during the study. These unexpected null results were also true with respect to gender-based minority stress, as reports of internalized misogyny at baseline were not related to levels of daily stress or negative emotion.

Findings regarding weight-based “self-stigma” were more in alignment with the proposed model. For example, women who reported more internalized weight bias at baseline displayed greater daily mean stress ($b = 0.01$, $SE = 0.00$, $Wald = 3.56$, $p < .05$, $RR = 1.01$). Participant reports of fear of fat also predicted higher daily stress ($b = 0.07$, $SE = 0.03$, $Wald = 3.56$, $p < .05$, $RR = 1.07$), as did baseline beliefs about the controllability of obesity ($b = 0.06$, $SE = 0.02$, $Wald = 5.92$, $p < .01$, $RR = 1.06$). However, in contrast to what we would expect, baseline reports of internalized weight bias and anti-fat attitudes did not predict mean daily negative emotion during the EMA period.

A full breakdown of main effects for Aim 1b analyses examining baseline distal and proximal minority stress as a predictor of EMA daily mean stress and negative emotion are included below in Table 3.

Table 3. Main effects for Aim 1b: Generalized linear mixed models of baseline distal and proximal minority stress predicting EMA daily mean stress and negative emotion

	EMA Daily Mean Stress				EMA Daily Mean Negative Emotion			
<i>Distal Minority Stressors</i>	<i>b</i>	<i>SE</i>	<i>Wald</i>	<i>RR</i>	<i>b</i>	<i>SE</i>	<i>Wald</i>	<i>RR</i>
Lifetime heterosexist stigma - Total	0.02	0.01	9.61**	1.02	0.03	0.01	8.12**	1.03
Lifetime heterosexist stigma – Work/School	0.05	0.01	26.3***	1.06	0.05	0.01	14.32***	1.05
Recent heterosexist stigma - Total	0.02	0.01	5.93*	1.02	0.03	0.02	4.06*	1.03
Recent heterosexist stigma – Work/School	0.03	0.02	1.65	1.03	0.05	0.02	7.00**	1.05
Lifetime weight stigma	0.13	0.08	2.67	1.14	-0.22	0.12	3.09	0.80
Lifetime gender stigma	0.01	0.00	9.55**	1.01	0.01	0.00	5.25*	1.01
Recent gender stigma	0.01	0.00	8.12**	1.01	0.01	0.01	2.31	1.01
<i>Proximal Minority Stressors</i>	<i>b</i>	<i>SE</i>	<i>Wald</i>	<i>RR</i>	<i>b</i>	<i>SE</i>	<i>Wald</i>	<i>RR</i>
Internalized homophobia	0.01	0.01	3.41	1.01	0.01	0.01	0.47	0.99
Sexual orientation concealment	0.09	0.10	0.67	1.09	0.27	0.07	15.5***	1.31
Internalized weight bias	0.01	0.00	3.56*	1.01	0.00	0.01	0.00	0.95
Anti-fat attitudes – fear of fat	0.07	0.03	5.12*	1.07	0.03	0.04	0.36	1.03
Anti-fat attitudes – willpower	0.06	0.02	5.92**	1.06	0.06	0.04	2.70	1.07
Internalized misogyny	0.00	0.00	0.29	1.00	-0.00	0.00	0.48	1.00

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Baseline Minority Stress and Daily Eating Behavior

To test the second piece of our proposed model, that minority stress increases risk for overeating and binge eating in sexual minority women, we examined whether baseline minority stress predicted greater total overeating and binge eating during the monitoring period.

Baseline Minority Stress and Total Daily Overeating

First, we examined the relation between baseline minority stress and total overeating during the EMA period. With respect to participant reports of distal minority stress at baseline, findings did not support the study model, with main effects revealing that lifetime and past year heterosexist stigma did not significantly predict total overeating during the EMA period. However, when we controlled for the anticipated effects of baseline BMI and disordered eating symptoms on total overeating, one expected effect emerged. Women who reported more lifetime heterosexist stigma in school and/or the workplace at baseline engaged in more overeating during the EMA period ($b = 0.58$, $SE = 0.028$, $Wald = 4.25$, $p = 0.039$, $RR = 1.06$). However, no other measures of distal stress based on sexual orientation predicted engagement in overeating.

Minimal support for model hypotheses also emerged with respect to weight-based distal stress, as main effects revealed no significant relationships between baseline reports of lifetime weight-based stigma and total overeating during the EMA period. Though one significant trend emerged, showing that women who reported more lifetime weight-based stigma at work engaged in more overeating during the monitoring period ($b = 0.124$, $SE = 0.07$, $Wald = 3.15$, $p = 0.076$, $RR = 1.13$), when baseline BMI and eating disorder symptoms were added into the model the significance of this trend decreased ($p = 0.173$).

Further, though significant findings emerged regarding gender-based distal stress, these effects occurred in the opposite direction as the current study model would expect. Participants who reported more experiences of gender-based stigma in the past year experienced, in contrast to the mechanisms proposed in the study model, *fewer* episodes of overeating during the EMA period ($b = -0.01$, $SE = 0.005$, $Wald = 4.93$, $p = 0.026$, $RR = 0.99$). All effects remained consistent after controlling for the effects of baseline BMI and eating disorder symptoms.

The proposed model was also not supported when examining baseline proximal minority stress as a predictor of overeating during the EMA period. Even when adding key covariates into the model, baseline scores of internalized homophobia, sexual orientation concealment, internalized weight bias, anti-fat attitudes, and internalized misogyny failed to predict daily overeating.

Given these unexpected findings, several analyses were performed to increase our understanding of these results. According to the proposed model, women who have experienced greater lifetime minority stress may not be more likely to overeat during a five day period if they have not experienced stressful stigma events during that time. The current study tested this hypothesis by examining whether baseline minority stress interacted with total EMA stigma events to predict EMA overeating behavior, and analyses largely supported model hypotheses.

First, all baseline distal minority stressors interacted with the number of EMA stigma events to predict greater EMA overeating. For example, women who reported higher baseline levels of recent gender-based stigma *and* who experienced more stigma events during the EMA period, as the proposed model would expect, engaged in more EMA overeating episodes ($b = 0.002$, $SE = 0.0005$, $Wald = 12.26$, $p < 0.01$, $RR = 1.00$). Greater stigma during the EMA period also interacted with other baseline distal minority stressors to predict more EMA overeating events, including baseline lifetime gender-based stigma ($b = 0.001$, $SE = 0.0003$, $Wald = 17.9$, $p < 0.01$, $RR = 1.00$), lifetime heterosexist stigma ($b = 0.004$, $SE = 0.001$, $Wald = 10.24$, $p = 0.01$, $RR = 1.00$), recent heterosexist stigma ($b = 0.01$, $SE = 0.002$, $Wald = 5.6$, $p = 0.02$, $RR = 1.01$), and lifetime weight stigma ($b = 0.003$, $SE = 0.012$, $Wald = 7.09$, $p = 0.01$, $RR = 1.00$). Results were less compelling for proximal minority stressors, as only women with greater internalized

homophobia who experienced more stigma events during the EMA period engaged in more overeating ($b = 0.004$, $SE = 0.015$, $Wald = 8.30$, $p < 0.01$, $RR = 1.00$).

Baseline Minority Stress and Total Daily Binge Eating

Next, we examined the relation between baseline minority stress and total binge eating during the EMA period. Participant reports of distal minority stress at baseline revealed that, much like outcomes related to overeating, participant reports of lifetime and past year heterosexual stigma did not predict binge eating during the EMA period. Further, though significant findings emerged when we controlled for baseline measures of body weight, binge eating symptoms, and general social support, all effects occurred in the opposite direction as the current study model would expect. For example, participants who reported more lifetime heterosexual stigma engaged in *less* binge eating during the EMA period ($b = -0.06$, $SE = 0.031$, $Wald = 4.24$, $p = 0.039$, $RR = 0.88$), an effect that was also observed for women who reported greater recent heterosexual stigma within the past year ($b = -0.08$, $SE = 0.036$, $Wald = 4.38$, $p = 0.036$, $RR = 0.93$).

Findings related to weight-based distal stress also failed to support the proposed model, as main effects revealed no significant relationships between baseline lifetime weight stigma and binge eating during the EMA period. One significant trend emerged that aligned with the study model, as women with more experiences of others making negative weight-based assumptions about them engaged in more binge eating during the monitoring period ($b = 0.20$, $SE = 0.110$, $Wald = 3.29$, $p = 0.07$, $RR = 1.22$). And, while this trend strengthened favorably when we added BMI into the model ($p = .052$), its significance decreased when we controlled for differences in baseline binge eating symptoms and general social support ($p = 0.72$). Results further

contradicted the proposed model when covariates, including baseline body weight, binge eating symptoms, and social support, were added into the model. For example, participants who reported more lifetime weight-based stigma from doctors reported fewer daily binge episodes ($b = -0.43$, $SE = 0.198$, $Wald = 4.71$, $p = 0.03$, $RR = 0.65$), as did women with more lifetime experiences of being stared at because of their weight ($b = -0.483$, $SE = 0.161$, $Wald = 9.01$, $p = 0.003$, $RR = 0.62$).

Findings regarding gender-based stigma also contradicted the proposed model, as women who reported more lifetime gender-based stigma endorsed less binge eating during the EMA period ($b = -0.02$, $SE = 0.010$, $Wald = 4.77$, $p = 0.029$, $RR = 0.978$). This result extended to more recent experiences, as higher levels of gender-based stigma in the past year predicted fewer episodes of binge eating during the EMA period ($b = 0.03$, $SE = 0.009$, $Wald = 10.7$, $p = 0.001$, $RR = 0.972$).

Also in contrast to study hypotheses, no measure of proximal minority stress significantly predicted engagement in binge eating during the EMA period. Even when adding key covariates into the model, baseline scores of internalized homophobia, sexual orientation concealment, internalized weight bias, anti-fat attitudes, and internalized misogyny failed to predict daily binge eating.

Given these unexpected findings, several analyses were performed to increase our understanding of these results. According to the proposed model, women who have experienced greater lifetime minority stress may not be more likely to binge eat during a five day period if they have not experienced stressful stigma events during that time. The current study tested this hypothesis by examining whether baseline minority stress interacted with total EMA stigma events to predict EMA binge eating behavior. Analyses only mildly supported this hypotheses, as

only lifetime heterosexist stigma interacted with the number of EMA stigma events to predict greater EMA binge eating. For example, women who reported greater lifetime heterosexist stigma at baseline *and* who experienced more stigma events during the EMA period, as the proposed model would expect, reported greater EMA binge eating episodes ($b = 0.009$, $SE = 0.003$, $Wald = 8.05$, $p = 0.005$, $RR = 1.01$). However, the total number of stigma events did not interact with any other baseline distal stressors to predict greater binge eating. It is possible that our ability to detect significant interactions is undermined by low power, as participants in the current study only reported 60 total binge episodes, in contrast to 260 overeating episodes, diminishing our power to detect significant interaction effects.

Unlike baseline variables of minority stress, two key covariates predicted EMA binge eating in expected directions. Participants who reported higher binge eating symptomology at baseline reported more binge eating episodes during the EMA period ($b = 0.058$, $SE = 0.0169$, $Wald = 11.69$, $p = 0.001$, $RR = 1.059$). And, emerging as a potential protective factor, higher general social support at baseline predicted less binge eating during the EMA period ($b = -0.027$, $SE = 0.010$, $Wald = 6.45$, $p = 0.01$, $RR = 0.974$).

A full breakdown of main effects for Aim 1b analyses examining baseline distal and proximal minority stress as a predictor of EMA overeating and binge eating are included below in Table 4.

Table 4. Main effects for Aim 1b: Generalized linear mixed models of baseline distal and proximal minority stress predicting EMA overeating and binge eating

	EMA Overeating				EMA Binge Eating			
<i>Distal Minority Stressors</i>	<i>b</i>	<i>SE</i>	<i>Wald</i>	<i>RR</i>	<i>b</i>	<i>SE</i>	<i>Wald</i>	<i>RR</i>
Lifetime heterosexual stigma - Total	0.01	0.02	0.23	1.01	-0.06	0.03	4.24*	0.88
Lifetime heterosexual stigma – Work/School	0.58	0.03	4.25*	1.06	0.05	0.08	0.36	1.05
Recent heterosexual stigma - Total	-0.02	0.02	1.20	0.98	-0.08	0.04	4.38*	0.93
Recent heterosexual stigma – Work/School	0.01	0.03	0.23	1.01	-0.14	0.06	5.25*	0.87
Lifetime weight stigma	0.12	0.07	3.15	1.13	-0.506	0.31	2.75	0.60
Lifetime gender stigma	-0.01	0.01	1.09	1.00	-0.02	0.01	4.77*	0.98
Recent gender stigma	-0.01	0.005	4.93*	0.99	-0.03	0.01	10.7***	0.97
<i>Proximal Minority Stressors</i>	<i>b</i>	<i>SE</i>	<i>Wald</i>	<i>RR</i>	<i>b</i>	<i>SE</i>	<i>Wald</i>	<i>RR</i>
Internalized homophobia	0.00	0.01	0.001	1.00	0.03	0.02	1.81	1.03
Sexual orientation concealment	0.17	0.16	1.12	1.18	0.52	0.39	1.72	1.67
Internalized weight bias	0.003	0.01	0.26	1.00	0.02	0.12	1.51	1.02
Anti-fat attitudes – fear of fat	0.004	0.06	0.01	1.01	0.09	0.14	0.44	1.10
Anti-fat attitudes – willpower	0.05	0.07	0.45	1.05	0.09	0.16	0.34	1.10
Internalized misogyny	0.003	0.01	0.12	1.00	0.01	0.01	0.28	1.01

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

Aim 2:

The second study aim tested the proposed model that minority stress leads to heightened stress and negative emotion among sexual minority women by examining associations between discrete stigma events throughout the day and concurrent levels of stress, negative emotion,

binge eating, and overeating occurring at the same time or signal. To do this, generalized mixed models with a Poisson distribution and a log link function were used to examine whether experiences of stigmatization at one signal (yes/no) (Level 1) were associated with concurrent elevations in stress, negative emotion, binge eating and overeating at the same signal.

Concurrent Stigma, Negative Emotion, and Stress

To test the proposed model, we first examined concurrent relationships between prompt-level reports of stigma, negative emotion, and stress. The structure of these data, which were nested within individuals, was merited by significant ICCs for state stress ($ICC = 0.65$) and negative emotion ($ICC = 0.57$), indicating that 65% of the variance in state stress and 57% of the variance in negative emotion was between persons, with the remainder being within-person variation.

Main effects revealed moderate support for the proposed model, with women who reported experiencing stigma since the last signal also reporting greater concurrent levels of total negative emotion ($b = 0.05$, $SE = 0.02$, $t(1,236) = 2.61$, $p = 0.009$, $RR = 1.05$). They did not, however, report greater levels of concurrent stress ($p > 0.05$). These effects remained consistent when we controlled for the respective effects of baseline perceived stress and baseline depression symptoms. As expected, greater levels of one covariate, baseline perceived stress, predicted higher levels of negative emotion at any random prompt ($b = 0.02$, $SE = 0.006$, $t(1,212) = 3.30$, $p = .001$, $RR = 1.02$), though it unexpectedly did not predict levels of state stress ($p > 0.05$).

Concurrent Stigma, Overeating, and Binge Eating

To test the proposed model, we next examined concurrent relationships between prompt-

level reports of stigma, overeating, and binge eating. Main effects revealed moderate support for the proposed model, as women who experienced stigma at one signal reported greater engagement in concurrent overeating at the same signal ($b = 0.302$, $SE = 0.139$, $t(1,236) = 2.18$, $p = .029$, $RR = 0.74$). However, contrary to expectations, there was no significant relation between concurrent stigma and binge eating behavior. These findings did not change when baseline BMI, binge eating, and disordered eating were included as key covariates.

Finally, because the proposed model suggests that heightened negative emotion and stress may be a mechanism through which minority stress leads to overeating and binge eating, we also examined stress and negative emotion as predictors of concurrent overeating and binge eating using generalized mixed models with a Poisson distribution and log link function. Main effects supported the proposed model, as higher negative emotion at any signal was associated with greater overeating ($b = 0.06$, $SE = 0.02$, $t(1,282) = 3.37$, $p = .001$, $RR = 0.94$) and greater binge eating ($b = 0.13$, $SE = 0.03$, $t(1,282) = 4.66$, $p = .000$, $RR = 0.88$). Results for state stress provided more mild support for the model, as higher levels of state stress at any prompt was associated with more binge eating behaviors ($b = 0.13$, $SE = 0.05$, $t(1,276) = 2.75$, $p = .006$, $RR = 0.88$) but not more overeating ($p > 0.05$).

Aim 3:

Finally, our third aim tested the proposed model by examining whether experiencing stigma at one signal predicted higher levels of state stress, negative emotion, overeating, and binge eating at the subsequent signal. To do this, we created a lag variable for experiencing stigma (lag stigma), wherein reports of stigma at one signal were shifted to the subsequent signal time point. We used generalized linear mixed modeling with a Poisson distribution and a log link

function to examine whether experiencing stigma (yes/no) at one signal was associated with subsequent elevations in stress, negative emotion, binge eating and overeating at the next signal.

Stigma and Future Negative Emotion, Stress, Overeating, and Binge Eating

Main effects did not support the proposed model, as experiencing stigma did not significantly predict negative emotion or state stress at the subsequent prompt, even when baseline perceived stress and depression symptoms were included as covariates. Similar null results emerged when the relation between stigma and future eating behavior was examined, as stigma did not significantly predict overeating or binge eating at the subsequent prompt. These findings did not change when we controlled for BMI and baseline measures of binge eating behaviors, disordered eating, perceived stress, and depression symptoms.

Given these unexpected findings, we also tested the alternative hypothesis that overeating or binge eating at one signal would predict experiencing a stigma event at the subsequent signal. No significant findings emerged to support this hypothesis.

Full Day Stigma and Full Day Negative Emotion, Stress, Overeating, and Binge Eating

Finally, to improve our statistical power, we also tested the model by examining relationships between these variables within an entire day, with the expectation that experiencing stigma on any given day would be associated with higher levels stress, negative emotion, overeating, and binge eating on that day. The structure of these data, which were nested within individuals, was merited by significant ICCs for daily state stress ($ICC = 0.76$) and daily negative emotion ($ICC = 0.72$), indicating that 76% of the variance in state stress and 72% of the variance in negative emotion was between persons, with the remainder being within-person

variation. ICCs were also significant for daily overeating ($ICC = .35$) and daily negative emotion ($ICC = .40$), indicating that 35% of the variance in state stress and 40% of the variance in negative emotion was between persons, with the remainder being within-person variation.

Overall, day-level findings provided strong support for the theoretical framework proposed in the current study. For example, women who reported experiencing stigma on any given day (yes/no) reported higher levels of sum negative emotion on that day ($b = 0.03$, $SE = 0.009$, $t(1,413) = 3.24$, $p = .001$, $RR = 0.97$) and higher state stress on that day ($b = 0.06$, $SE = 0.012$, $t(1,413) = 4.42$, $p < .001$, $RR = 0.95$), results that did not change when baseline depression and perceived stress were added into the model as covariates. Participants who experienced stigma on any given day also endorsed significantly more episodes of overeating on that day ($b = 0.35$, $SE = 0.072$, $t(1,413) = 4.89$, $p < .001$, $RR = 0.70$) as well as greater episodes of binge eating on that day ($b = 0.43$, $SE = 0.148$, $t(1, 413) = 2.92$, $p = .004$, $RR = 0.65$), findings that remained consistent when controlling for baseline binge eating and disordered eating. As expected, higher levels of one covariate, baseline binge eating symptoms, also significantly predicted greater daily binge eating ($b = 0.11$, $SE = 0.045$, $t(1,386) = 2.49$, $p = .013$, $RR = 1.12$).

A full breakdown of main effects for Aim 2 and 3 analyses examining stigma predicting EMA stress, negative emotion, overeating and binge eating at the prompt-level and day-level are included below in Table 5.

Table 5. Main effects for Aims 2 and 3: Generalized linear mixed models of stigma predicting EMA stress, negative emotion, overeating and binge eating at the prompt-level and day-level

Predictor		Dependent Variable							
		Prompt-level analyses				Day-level analyses			
		EMA Stress	EMA Negative Emotion	EMA Overeating	EMA Binge Eating	EMA Stress	EMA Negative Emotion	EMA Overeating	EMA Binge Eating
Stigma (yes/no)	b	0.04	0.05	0.30	-0.04	0.06	0.03	0.35	0.43
	SE	0.03	0.02	0.14	0.19	0.01	0.01	0.07	0.15
	t	1.34	2.61**	2.18*	-0.23	4.42***	3.24**	4.89***	2.92**
	RR	1.04	1.05	0.74	1.04	0.95	0.97	0.70	0.65
Lag Stigma (yes/no)	b	0.01	0.02	0.04	-0.01	---	---	---	---
	SE	0.05	0.03	0.19	0.21	---	---	---	---
	t	0.11	0.64	0.19	-0.04	---	---	---	---
	RR	1.01	1.02	1.04	0.99	---	---	---	---
EMA Negative Emotion	b	---	---	0.06	0.13	---	---	---	---
	SE	---	---	0.02	0.03	---	---	---	---
	t	---	---	3.37***	4.66***	---	---	---	---
	RR	---	---	0.94	0.88	---	---	---	---
EMA Stress	b	---	---	0.05	0.13	---	---	---	---
	SE	---	---	0.03	0.05	---	---	---	---
	t	---	---	1.62	2.75**	---	---	---	---
	RR	---	---	0.96	0.88	---	---	---	---

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

IV. Discussion

A growing body of evidence indicates that sexual minority women have higher rates of obesity (Everett & Mollborn, 2013; Fredriksen-Goldsen et al., 2013; NIH, 2014; Thayer, 2010) and disordered eating behaviors (Austin et al., 2009; Bankoff & Pantalone, 2015; Polimeni, 2009) relative to their heterosexual counterparts. Despite the distinct prevalence of greater body mass and disordered eating among sexual minority women, little research has investigated *why* or *how* sexual minority status confers risk for obesity in women and no theoretical framework currently exists to explain the weight disparity in this population (Thayer, 2010).

The current study aimed to fill this gap by using mixed methods, including cross-sectional assessments and EMA, to test the hypothesis that minority stress, or being stigmatized based on one's minority identities, contributes to obesity by increasing risk for overeating and binge eating behavior among sexual minority women. To test this hypothesis, this study examined reports of baseline distal minority stress, proximal minority stress, disordered eating, and binge eating among 55 overweight and obese sexual minority women. These women then used a smartphone application to record stigmatizing events, negative emotion, stress, overeating, and binge eating in the context of their daily lives five times per day for five days.

Results indicate mixed but overall favorable support for the proposed model. Most study findings were consistent with hypotheses, as lifetime and recent distal minority stress and proximal weight-based stress at baseline were associated with greater baseline stress and negative emotion, greater baseline disordered eating and binge eating, and greater daily stress and negative emotion during the EMA period. This evidences that being stigmatized for being female, non-heterosexual, and overweight is stressful, and is related to higher levels of stress, negative emotion, and obesogenic eating behavior.

Momentary data provided further support for the proposed model. Women who experienced stigma at any signal during the EMA period reported higher concurrent negative emotion and overeating at that signal. Further, being stigmatized on any given day was associated with greater average stress, negative emotion, overeating, and binge eating on that day. Together, these findings demonstrate significant linkages between minority stress and the proposed pathways to obesity: negative emotion, stress, and obesogenic eating behaviors like overeating and binge eating.

However, several study findings did not support the proposed model. Several baseline distal minority stressors predicted *less* engagement in binge eating and overeating during the EMA period, baseline proximal minority stressors were not as strong predictors of EMA stress, negative emotion, overeating, and binge eating as expected, and acute stigma events were not associated with prospective stress, negative emotion, overeating, or binge eating reported at the subsequent signal. While these results were unexpected, when considered within the scope of broader study results and within the context of additional moderating variables, these findings align more closely with the proposed model than was initially evident.

All together, study findings reveal mixed yet promising evidence for the proposed model that minority stress contributes to greater obesity among sexual minority women. Particularly given the current study's small and preliminary nature, findings outlined here justify future, larger research studies that can unpack the relevance and significance of minority stress as a risk factor for obesity among sexual minority women. Study results, implications, limitations, and future directions are discussed in greater detail below.

Minority Stress as a Predictor of Stress and Negative Emotion

According to both the proposed model and to Meyer's *Minority Stress Model* (2003), minority stress heightens risk for greater stress and negative emotion among minority group members. The current study tested this hypothesis in several ways, and the majority of findings supported this connection. Cross-sectional associations revealed that women who reported greater lifetime distal minority stress based on sexual orientation, weight, and gender at baseline were also more likely to report greater perceived stress and depression symptoms at baseline.

Findings were also significant when tested micro-longitudinally, as women who reported greater heterosexist and gender-based stigma at baseline reported higher average daily stress and negative emotion during the five day EMA period. Further, even acute experiences of distal minority stress were associated with greater stress and negative emotion, as women who experienced stigma at any signal during the day were more likely to report higher negative emotion at the same signal, and higher average stress and negative emotion on that day. Together, these data demonstrate compelling evidence that distal minority stress may increase risk for heightened negative emotion and stress both acutely and over time, findings that align with both Meyer's *Minority Stress Model* (2003) and with the proposed model.

Findings examining the relation between proximal minority stress, overall stress, and negative emotion provided less compelling support for the proposed model. Only weight-based proximal stress, and not heterosexist or gender-based proximal stress, demonstrated consistent associations with baseline and momentary stress and negative emotion in the current study. As expected, women who reported greater internalized weight bias and anti-fat attitudes at baseline endorsed higher baseline stress, baseline depression symptoms, and more average daily stress during the EMA period. And, while greater baseline sexual orientation concealment predicted higher daily average negative emotion during the EMA period, levels of internalized

homophobia and internalized misogyny at baseline were not associated with baseline or momentary stress or negative emotion.

Together, this suggests that women with higher internalized negative beliefs about their overweight status, but not about their gender or sexual minority status, are more at risk for elevated stress and depression. It is possible that this effect emerges because weight, unlike gender and sexual orientation, is understood to be within an individual's control, making overweight status a minority identity that's more conducive to self-blame and stress. In fact, this is in line with research showing that overweight individuals, unlike most minority group members, favor out-group members over members of their own group (Rudman, Feinberg & Fairchild, 2002).

Alternatively, it is also possible that study findings regarding proximal minority stress were influenced by the geographic location of the study sample. This study was conducted in a liberal area of the northeast, where sexual orientation-based and gender-based "self-stigma" may be less prevalent or severe than in other, less liberal and diverse geographic areas. This lack of severity and variance in "self-stigma" may have underpowered us to detect significant relationships between proximal stress and EMA outcomes in particular. Future studies should investigate minority stress and eating behavior in a geographic area where religiously and politically conservative views are more predominant.

Minority Stress as a Predictor of Overeating and Binge Eating

Both the proposed model and Tomiyama's COBWEBS model (2011) suggest that minority stress, by generating chronically elevated stress and negative emotion, also increases risk for disordered eating, overeating, and binge eating among sexual minority women. The current study

tested the link between minority stress and eating behavior in multiple ways. Findings revealed mixed support for the model, with results emerging that both supported and contradicted model expectations.

Cross-sectional associations at baseline largely supported the proposed model. As expected, women who reported greater lifetime weight stigma, lifetime gender-based stigma, and recent heterosexist stigma at baseline also endorsed higher levels of baseline disordered eating and binge eating. Further, women with greater internalized weight bias, anti-fat attitudes, and internalized misogyny at baseline, perhaps not surprisingly, also reported more disordered eating and binge eating behaviors. Together, these results provide strong support for the hypothesis that being stigmatized because of your sexual orientation, weight, and gender, and then internalizing these negative views about yourself, increases risk using maladaptive eating behaviors to cope.

However, because the directionality of these cross-sectional effects was impossible to determine, micro-longitudinal analyses were performed. Consistent with the proposed model, women who reported greater lifetime heterosexist stigma at school and work reported more overeating during the five day EMA period. EMA data also revealed, as expected, that women who experienced stigma at any signal during the day were more likely to report more overeating at the same signal, as well as more episodes of overeating and binge eating on that day. These findings demonstrate compelling connections between lifetime and acute experiences of stigma and obesogenic eating behaviors, suggesting that being stigmatized may trigger sexual minority women to use food as a strategy for coping.

EMA data also provided support for the proposed mechanism of this effect, that minority stressors increase risk for overeating and binge eating by increasing stress and negative emotion. In the current study, women's reports of negative emotion at any one signal were positively

associated with their reports of overeating and binge eating at that signal. And, as expected, reports of stress were related to concurrent levels of binge eating. These findings align with proposed model, which suggests that experiencing stigma feels stressful and aversive for sexual minority women, who may try to regulate these negative states by overeating or binge eating.

Despite these findings supporting the connection between minority stress and obesogenic eating behavior, the current study also found evidence to contradict this hypothesis. First, no baseline proximal minority stressors, including internalized homophobia, sexual orientation concealment, internalized weight bias, anti-fat attitudes, and internalized misogyny, predicted overeating or binge eating behaviors reported during the EMA period. This suggests that women's internalized beliefs about their minority identities do not impact their eating behavior in systematic ways, contrary to what is suggested in the proposed model. However, as mentioned earlier, this finding should be investigated in a sample of sexual minority women living in a more religious or politically conservative area, where the intensity of heterosexist and gender-based self-stigma may be higher and more variable.

Several micro-longitudinal results also appeared to oppose model expectations. Women who reported greater total lifetime heterosexist stigma, greater recent heterosexist stigma overall and at work, and greater lifetime gender-based stigma reported *less* binge eating events during the EMA period, and those reporting greater recent gender stigma endorsed both less EMA binge eating and less EMA overeating events. Though these findings initially appeared to contradict the proposed model, moderation analyses revealed that greater baseline heterosexist stigma predicted *greater* EMA binge eating and overeating, but only when participants experienced a sufficient number of stigmatizing events during the EMA period. This suggests that having a greater history of heterosexist distal minority stress, while not sufficient to predict eating

behavior over a five day period, may make sexual minority women more sensitive to the effects of acute stigma, increasing risk for subsequent overeating and binge eating. Considered in light of this moderating variable, this initially contradictory finding is certainly consistent with the proposed theoretical framework. However, it is notable that women who reported more distal gender-based stigma engaged in *less* EMA binge eating regardless of EMA stigma frequency, a finding that remains contrary to study hypotheses.

The final oppositional result to explore is the finding that acute stigma during the monitoring period was not linked with concurrent stress and binge eating, or with prospective stress, negative emotion, overeating, or binge eating. While these findings were unexpected, they are not necessarily oppositional to the proposed model when considered in the context of broader study findings. For example, the current study found that experiencing stigma on any given day was most significantly associated with expected outcomes at the full day level, predicting greater average stress, negative emotion, overeating, and binge eating on that day.

These findings may suggest that the association between stigma and obesogenic eating behavior is not always as immediate as the proposed model might expect. For example, it is possible that, for obese sexual minority women, stigma events may be just one cue for stress and negative emotion among many. These stressful cues may accumulate throughout the day in variable ways, increasing risk for overeating or binge eating at some point within the day, but not necessarily immediately following the stigma event, depending on factors like food availability, work schedule, the presence and support of others, and so on. These day-level findings suggest that while minority stress may be a broad contributor to obesogenic eating behavior, there may be significant variability in the immediate outcomes of any particular stigma event.

Alternatively, the unexpected results from concurrent and prospective analyses may be an artifact of limited statistical power. This study's significant day-level findings aggregate measurements from all five signals throughout the day into one index, providing greater statistical power to detect effects than signal-level analyses. These day-level results can therefore be interpreted with greater confidence than the concurrent associations explored in Aim 2 and the prospective associations that were assessed in Aim 3, which may not have been sufficiently powered to detect relationships between stigma, emotion, stress, and eating behavior, even if they were present. To increase power, future studies should consider recruiting a larger sample size, and extending the EMA period to two weeks.

Limitations and Future Directions

This study was designed to investigate the preliminary validity of minority stress as a risk factor for obesogenic eating behavior in overweight and obese sexual minority women, and study results must be interpreted in light of an array of limitations. Two notable methodological limitations that may have undermined this study's ability to detect support for the proposed model include the study's short EMA monitoring period and small sample size. The current study employed a five day EMA monitoring period, a time frame that is notably shorter than the typical two week period used in larger EMA studies (Seacat et al., 2014; Selby et al., 2015; Thomas et al., 2011). Our five day monitoring period was used to reduce participant assessment burden, but in so doing, it provided a less extensive sampling of participants' experiences of stigma, emotion, and eating than a two week period would have provided. Future studies should consider using longer EMA monitoring periods to enhance their ability to detect concurrent and prospective links between stigma, emotion, and eating behaviors.

Power in the current study was also diminished by the study sample size. While the current sample size was adequately powered to detect the within-subjects effects that were explored in Aims 2 and 3, this study was less well-powered to detect the between-subjects effects that were investigated in Aim 1. Study power was also diminished by our sample's heterogeneous sexual orientation identification, as the experiences of lesbian, bisexual, and queer women were examined together due to the preliminary nature of this study. In reality, it is likely that bisexual women and lesbian women have differential experiences of stigma, particularly because bisexual women's sexual minority identity may be less socially evident depending on the gender of their current partner. This hypothesis was supported by this study's finding that lesbian women reported twice as many stigma events as bisexual or queer women during the monitoring period, an effect that closely approached but did not reach significance. Given that this study's participants were disproportionately bisexual (61%), our results may paint a more diluted picture of the link between minority stress and eating behavior than perhaps a homogeneous sample of lesbian women. Future studies should consider studying lesbian and bisexual women's experiences of stigma separately, or should recruit adequately sized samples of both groups to allow for the study of between-group differences.

The external validity of study findings may also be diminished by the sample's age and geographic location. This study was conducted in a liberal area of the northeast, where sexual orientation-based and gender-based stigma and "self-stigma" may be less prevalent or severe than in other, less diverse geographic areas. Therefore, future studies should investigate the link between minority stress and eating behavior in a geographic area where politically conservative views are more predominant. Another factor that may have reduced the potency of study findings is the relatively low mean age of the current sample ($M = 25$). Individuals around this age may

be less likely than their older counterparts to experience sexual orientation based distal and proximal minority stress, given cultural shifts. In fact, age was positively associated with significantly greater stigma due to sexual orientation, weight, and gender in the current study. This study should be replicated a sample that has greater age diversity and a greater mean in age.

Further, due to the preliminary nature of this study, no control groups were employed to tease apart the differential roles that sexual minority status and weight status may have had on study findings. For example, recruiting a comparison sample of overweight heterosexual women would allow us to parse out risk factors for obesity that are unique to sexual minority women compared to their heterosexual counterparts. Additionally, recruiting a comparison group of normal weight sexual minority women would allow us to tease out unique predictors of weight status. Future studies should consider employing comparison groups to allow us to understand whether and how sexual minority status and weight status differentially contribute to the relationship between minority stress and eating behavior.

The final notable limitations of this study involve aspects of construct measurement. All measures used in the study were subjective reports, which rely on participants' accurate recall of past experiences of stigma and eating behaviors, and their insight into their own emotional state and social environment. These measures were also administered multiple times per day, repetition that may result in demand effects that decrease participants' attention to questions when administered. These concerns were minimized in this study by randomizing question order and shortening survey lengths as appropriate. This study also minimized concerns by using EMA methods, which employ state measures within the participant's natural environment close in time to relevant events, reducing problems with retrospective recall and increasing the validity of self reports.

Conclusion

The current study was the first to test a theoretical model for understanding the disparity in obesity among sexual minority women, to examine the impact of minority stress on eating behavior in sexual minority women, and to examine the correlates of obesogenic behaviors in sexual minority women using EMA methods. Taken together, results indicate moderate support for the hypothesis that minority stress contributes to greater risk for obesogenic eating behaviors in sexual minority women. Given the paucity of research in this area and the current study's small and preliminary nature, findings outlined here are significant enough to justify future research studies to unpack the relevance and significance of minority stress as a risk factor for obesity among sexual minority women using longer monitoring periods and larger, more diverse samples. This research will be essential for developing effective, informed, and tailored interventions to reduce unhealthy eating behaviors and obesity, to increase knowledge and resources for coping, and to improve health among sexual minority women.

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Appendix

Table 6. Summary of Baseline Measures

Broad Construct	Minority Stress	Specific Construct	Measure	No. of Items
BMI		Objective weight & height	Advanced digital scale and stadiometer	n/a
Sexual Orientation		Self-reported sexual orientation	Participants rate sexual orientation identification on a categorical scale. "Do you consider yourself to be: heterosexual or straight, homosexual or lesbian, bisexual, pansexual/queer/something else, not sure"	1
Sexual Orientation Minority Stress	Distal	Lifetime experiences of sexual-orientation based discrimination	Heterosexist Harassment, Rejection and Discrimination Scale (HHRDS; Szymanski, 2006)	14
	Proximal	Internalized homophobia	Lesbian Internalized Homophobia Scale, 'personal feelings about being a lesbian' subscale (LIHS; Szymanski & Chung, 2001)	8
		Sexual orientation concealment	Sexual Orientation Concealment (SOC; Meyer, Rossano, Ellis & Bradford, 2002)	5
Weight-based minority stress	Distal	Lifetime experiences of weight-based stigmatization	Stigmatizing Situations Inventory (SSI; Myers & Rosen, 1999).	50
	Proximal	Anti-fat attitudes	Anti-fat Attitudes Questionnaire (AFA; Crandall, 1994)	13
		Internalized weight bias	Weight Bias Internalization Scale (WBIS; Durso & Latner, 2008)	11
Gender Minority Stress	Distal	Lifetime and past year experiences of perceived gender-based discrimination	Schedule of Sexist Events (SSE; Klonoff, 1995)	20
	Proximal	Internalized misogyny	Internalized Misogyny Scale (IMS; Piggott, 2004)	17
Eating patterns and behavior		Disordered eating behaviors & attitudes	Eating Disorder Examination-Questionnaire (Fairburn & Beglin, 1994)	28
		Binge eating severity	Binge Eating Scale (BES; Gormally, Black, Daston & Rardin, 1982)	16
		Lifetime history of weight fluctuations and dietary restraint and concern	Restraint Scale (RS; Herman & Polivy, 1980)	10
		Recent eating patterns and behaviors	24 hour dietary recall	n/a
Overall stress		Perceived stress	Perceived Stress Scale (PSS; Cohen, Kamarck & Mermelstein, 1983)	10
Depression		Depressive symptoms	Patient Health Questionnaire-9 (PHQ-9; Kroenke, Spitzer & Williams, 2001)	10

Table 7. Summary of Momentary Measures

<p>Distal Minority Stress (6 items)</p> <p>Have you experienced stigma in any form since the last signal? Below, check all the stigmatizing situations that have occurred since the last signal:</p> <ul style="list-style-type: none"> Based on your [SO, weight, gender], you were: a) treated with less courtesy and respect than others, b) made fun of, teased or called derogatory names, c) glared at or singled out, d) treated unfairly or prevented from doing something, e) been made to feel inferior, f) excluded, g) been harassed or threatened, h) been judged or criticized, i) had others make unfair assumptions about you, j) felt singled out by the environment (can't fit in a seat, find clothes), k) unrelated problems were blamed on your sexual orientation or weight, l) overheard disparaging comments about your group (LGB, women, overweight), m) family/friends were ashamed of you, n) other <p>If yes:</p> <ul style="list-style-type: none"> How many times have you experienced stigmatization since the last signal? In your opinion, what was the reason you were discriminated against? (e.g., your weight, sexual orientation, gender, race, age, social class, religion, other, none) How intense was the stigmatization? 0 (mild) to 10 (severe) How did you respond to this event? (1 = this event made me feel good, 2 = It did not bother me, 3 = It bothered me slightly, 4 = It upset me, 5 = This event upset me extremely) Where did the event occur? (e.g., at work, at home, at a healthcare provider, on the street, in a public setting, other)
<p>Eating Behaviors (13 items)</p> <ul style="list-style-type: none"> Right now, how much are you craving food? Right now, how hungry are you? <p>Have you eaten food since the last prompt? (yes/no) If yes:</p> <ul style="list-style-type: none"> How many separate episodes of eating did you have? What did you eat? Note the specific food(s), beverage(s), and number of servings you consumed. In what location did you eat? (home, car, work, school, cafeteria, restaurant, outside, other) Did you eat more than usual? (yes/no) While you were eating, did you feel out of control? (yes/no) Was the time you ate typical eating time for you? (yes/no) If no: Were you making up for a missed meal or snack? (yes/no) Check any of the following that were true during the time that you were eating (I ate alone, I ate with others, I ate while using a screen (watching TV or using phone/computer), I ate in a public place). How quickly did you eat? To what extent did you overeat? Did you eat what most people would regard as an unusually large amount of food (given the circumstances)? (yes/no)
<p>State Stress and Emotion (10 items)</p> <p>On a scale where 0=never, 1=almost never, 2=sometimes, 3=fairly often, and 4=very often, since the last signal:</p> <ul style="list-style-type: none"> How often have you felt confident about your ability to handle your personal problems? How often have you felt that things were going your way? How often have you felt that you were unable to control the important things in life? How often have you felt difficulties were piling up so high that you could not overcome them? <p>On a scale from 0-10, what is your current level of:</p> <ul style="list-style-type: none"> Negative emotions (Sadness, Loneliness, Anxiety, Shame/Embarrassment, Anger, Guilt, Disgust)

Table 8. Means, standard deviations and bivariate correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Lifetime heterosexual stigma	-												
2. Recent heterosexual stigma	.81**	-											
3. Lifetime weight stigma	.32*	.30*	-										
4. Lifetime gender stigma	.56**	.53**	.47**	-									
5. Recent gender stigma	.46**	.56**	.32*	.86**	-								
6. Internalized homophobia	.09	.13	.28*	.37**	.37**	-							
7. Internalized weight stigma	.17	.14	.57**	.24	.17	.25	-						
8. Internalized misogyny	-.04	-.03	.12	-.35**	-.30*	-.05	.31*	-					
9. EMA Stigma	.47**	.29*	.15	.30*	.23	.15	.15	.09	-				
10. EMA Overeating	.14	-.07	-.05	-.15	-.30*	-.03	.04	.00	.42**	-			
11. EMA Binge eating	-.06	-.12	.10	-.00	-.13	.10	.17	.05	.30*	.53**	-		
12. EMA Negative Emotion	.23	.15	.14	.23	.21	.14	.30*	.03	.04	.04	-.09	-	
13. EMA Stress	.39**	.29*	.02	.35*	.39**	.03	.22	.02	.21	-.02	-.05	.70**	-
Mean	32.8	2.19	26.6	1.1	60.4	11.0	46.3	35.1	4.5	4.2	1.1	1.8	2.5
SD	6.3	0.6	10.1	0.7	17.9	6.5	15.3	13.6	5.3	3.4	1.8	0.8	1.3

Note: $p < 0.05 = *$, $p < 0.01 = **$. Lifetime heterosexual stigma = Baseline lifetime heterosexual stigma episodes reported on the HHRDS Lifetime measure. Recent heterosexual stigma = Self-report of baseline past year stigma on the HHRDS past year measure. Lifetime weight stigma = Self-report of baseline weight-based stigma on the SSI global measure. Lifetime gender stigma = Self report of lifetime gender-based stigma using the SSE Lifetime measure. Recent gender stigma = Past-year gender-based stigma reported at baseline on the SSE Past year measure. Internalized homophobia = Baseline internalized homophobia reported on the LIHS measure. Internalized weight stigma = Baseline internalized weight bias reported on the WBIS measure. Internalized misogyny = Baseline internalized misogyny reported on the IMS measure. EMA Stigma = Total number of stigma episodes reported over monitoring period. EMA overeating = Total number of overeating episodes reported over monitoring period. EMA binge eating = Total number of binge eating episodes reported over monitoring period. EMA Neg. Emotion = Average sum state negative emotion during monitoring period. EMA Stress = Average sum state stress during monitoring period.

Table 9. Descriptive Data for EMA Stigma Episodes, Eating Episodes, Stress, and Emotion

	N	M	SD	Range
Stigma Episodes	180	4.52	5.19	0-25
State Stress	-	7.03	3.57	0-16
State Negative Emotion	-	12.18	5.35	0-35
Eating Episodes	700	12.56	3.88	3-19
Binge Eating Episodes	60	1.07	1.79	0-9
Overeating Episodes	236	4.29	3.40	0-14
<i>Day-level analyses</i>		<i>Events per day per participant</i>		
Stigma Events by Day	39	2.76	2.97	0-6
State Stress (mean/day)	-	7.02	3.12	0-16
Negative Emotion (mean/day)-		12.23	4.56	7-27
Binge Eating per Day	15	0.22	0.55	0-4
Overeating per Day	27	0.86	1.09	0-5

Table 10. Baseline and EMA Outcomes by BMI Category and Sexual Orientation

Baseline	BMI Category			Sexual Orientation		
	Overweight	Obese	Very Obese	Queer	Bisexual	Lesbian
	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)
Body Mass Index	28.3 (1.7)	31.6 (1.5)	37.6 (2.8)	29.8 (.98)	32.5 (4.8)	33.6 (4.7)
Lifetime Heterosexist Stigma (HHRDS)	29.6 (7.7)	28.4 (10.0)	29.2 (11.2)	28.3 (4.3)	24.4 (8.4)	37.0 (6.9)
Lifetime Weight Stigma (SSI)	1.0 (0.5)	1.4 (0.7)	1.4 (0.7)	0.64 (.41)	1.35 (.65)	1.31 (.66)
Binge eating symptoms	17.0 (8.6)	20.2 (9.0)	18.1 (12.4)	13.5 (9.1)	18.8 (9.7)	18.8 (11.2)
Eating Disorder Symptoms	2.6 (1.1)	2.8 (0.9)	3.2 (1.5)	1.5 (1.2)	3.1 (1.0)	2.9 (1.4)
EMA Measures	BMI Category			Sexual Orientation		
	Overweight	Obese	Very Obese	Queer	Bisexual	Lesbian
	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)
Sum Stigma Events	3.7 (2.8)	3.3 (2.7)	6.5 (8.0)	4.0 (3.6)	3.9 (5.4)	6.0 (5.9)
Sum Binge Eating Events	0.5 (.85)	0.9 (2.0)	1.7 (2.5)	0 (0)	1.05 (1.7)	1.38 (2.5)
Sum Overeating Events	2.5 (2.2)	5.4 (3.9)	5.7 (3.7)	2.5 (1.9)	4.4 (3.5)	5.1 (4.0)
Average sum negative emotion	12.2 (4.3)	14.1 (5.3)	10.6 (4.4)	12.4 (3.4)	12.4 (5.5)	11.7 (3.9)
Average state stress	7.9 (2.4)	7.9 (3.9)	6.7 (3.6)	5.6 (1.5)	7.5 (3.6)	7.9 (3.2)

**No significant differences between groups on any dependent variable in this table*

Figure 6. Consort diagram.

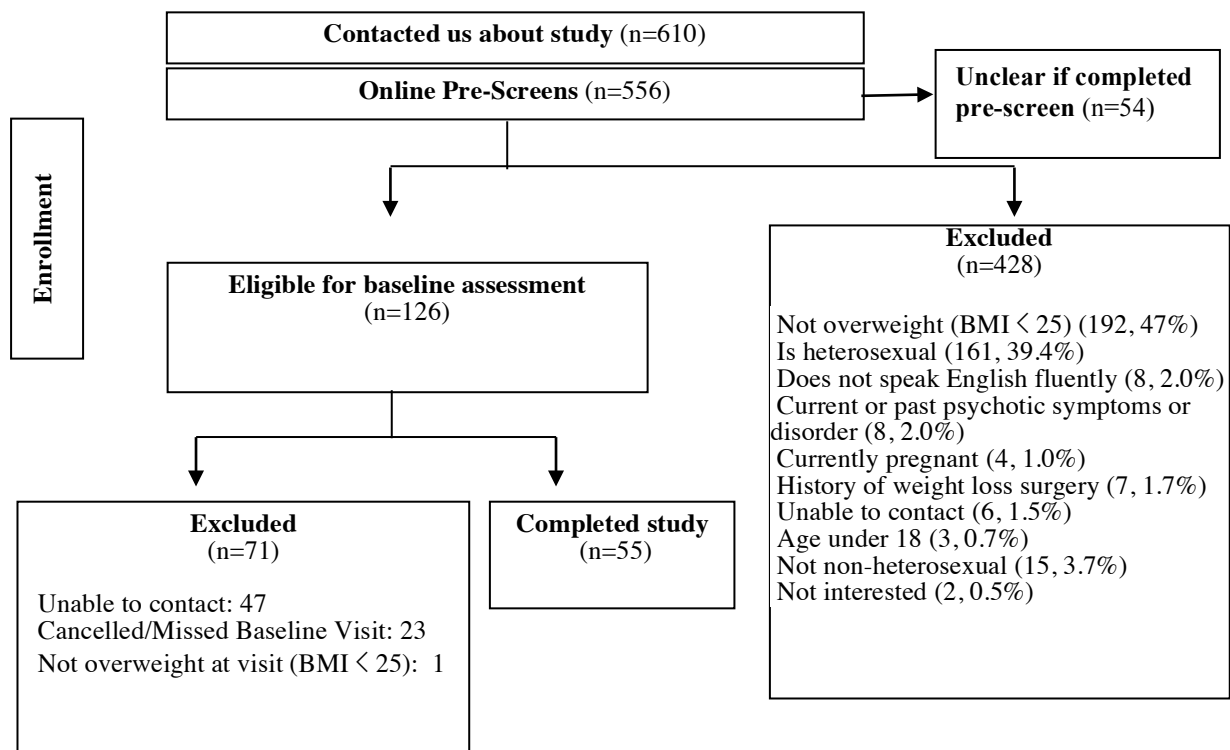


Figure 7. Sample Lifedata App Screens

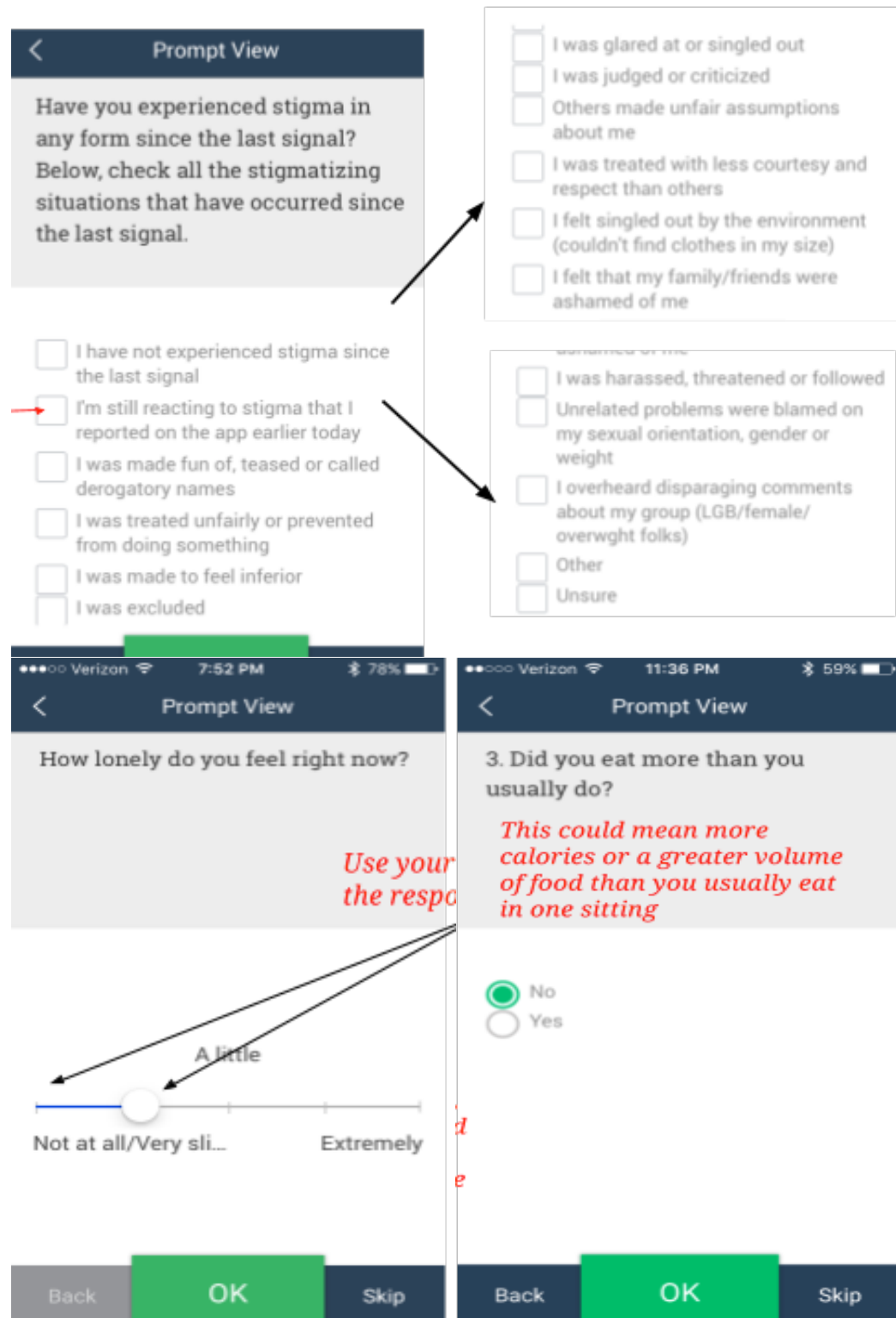


Figure 8. Prompt-level stigma predicting concurrent overeating

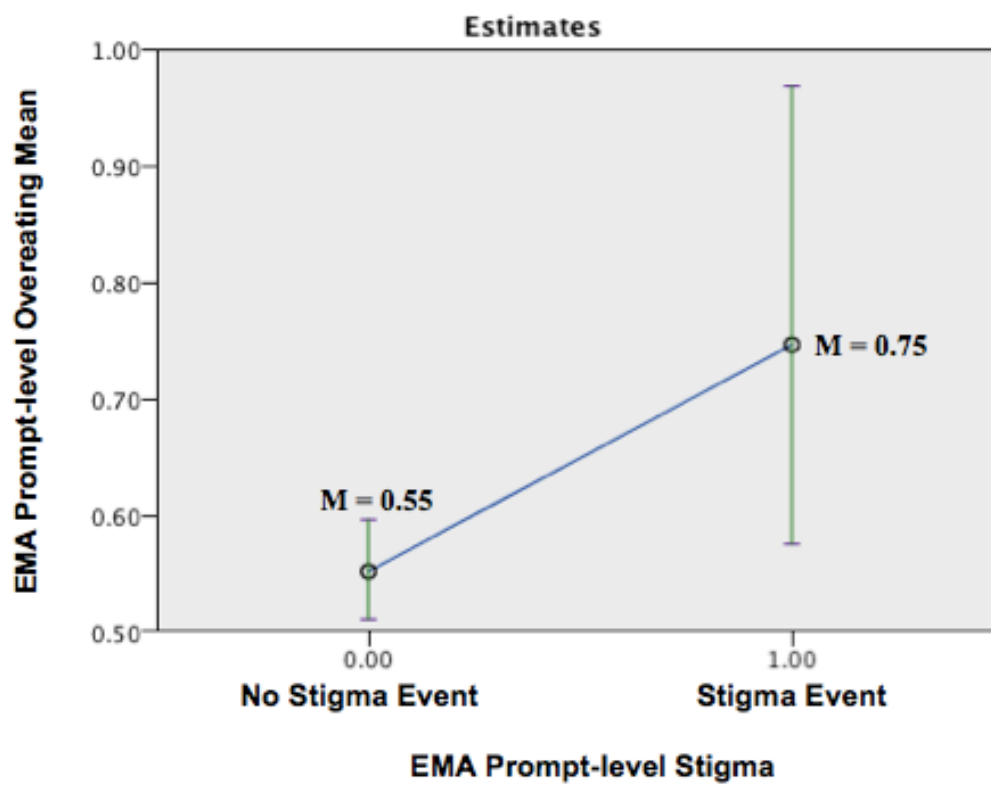


Figure 9. Prompt-level stigma predicting concurrent negative emotion

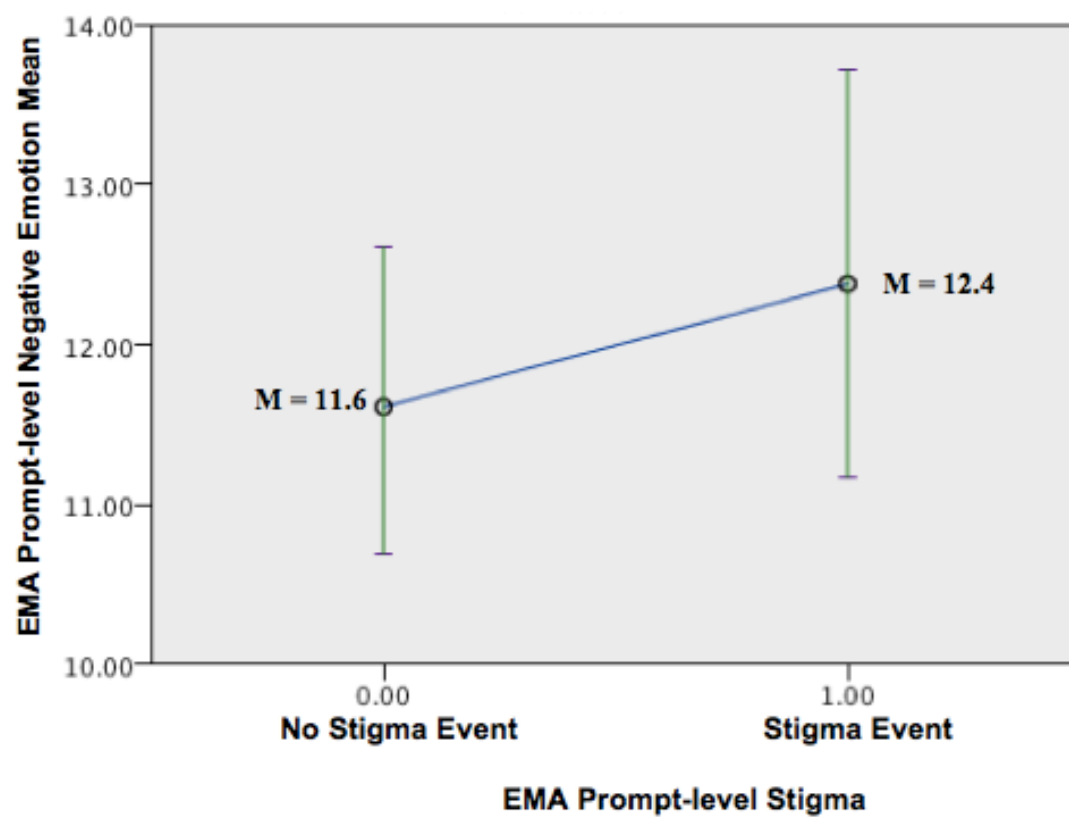


Figure 10. Daily stigma event predicting daily overeating event

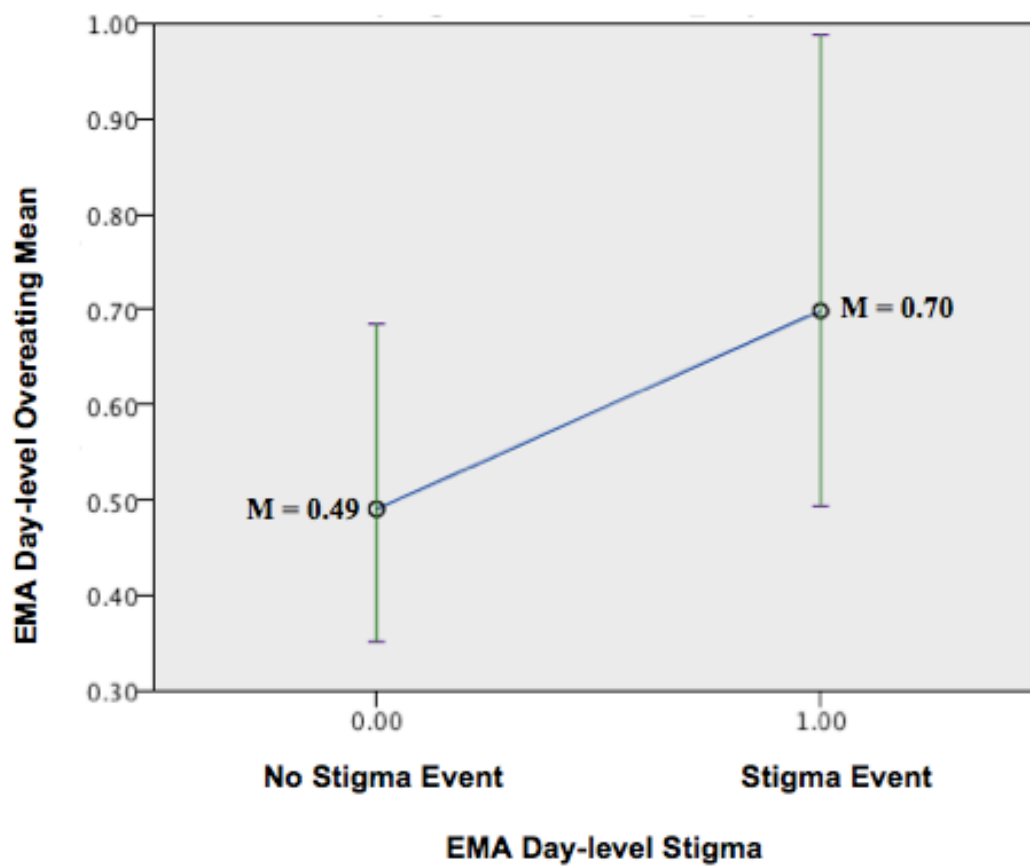


Figure 11. Daily stigma event predicting daily binge eating event

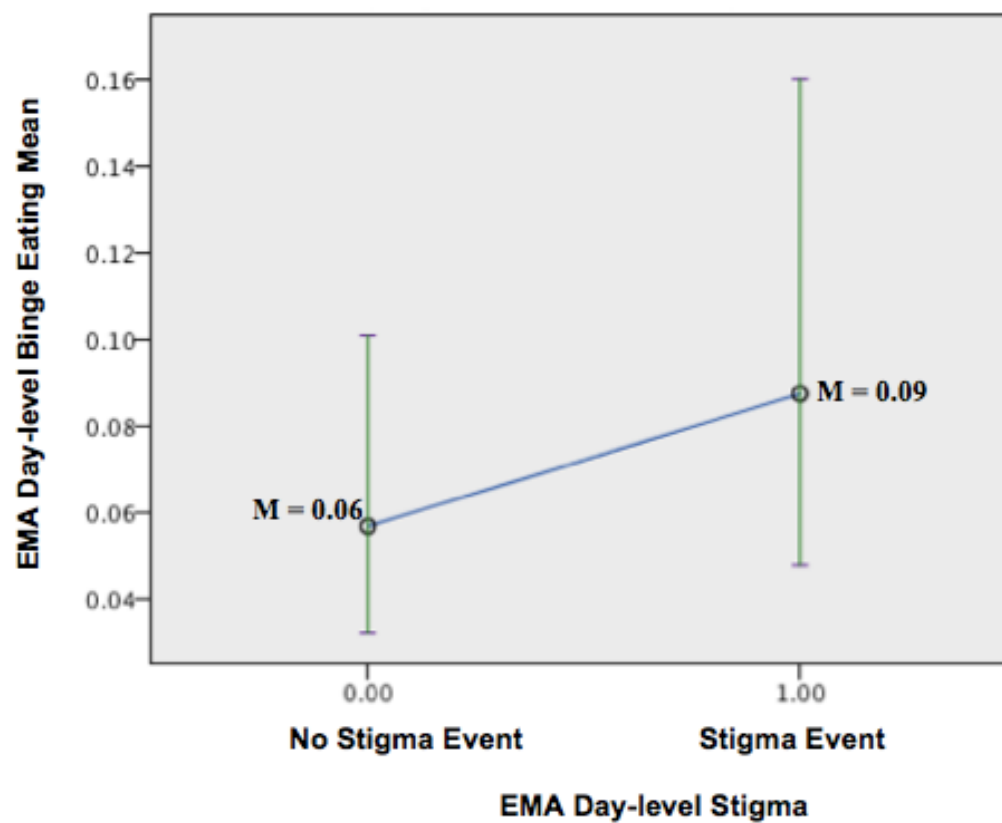


Figure 12. Daily stigma event predicting daily stress levels

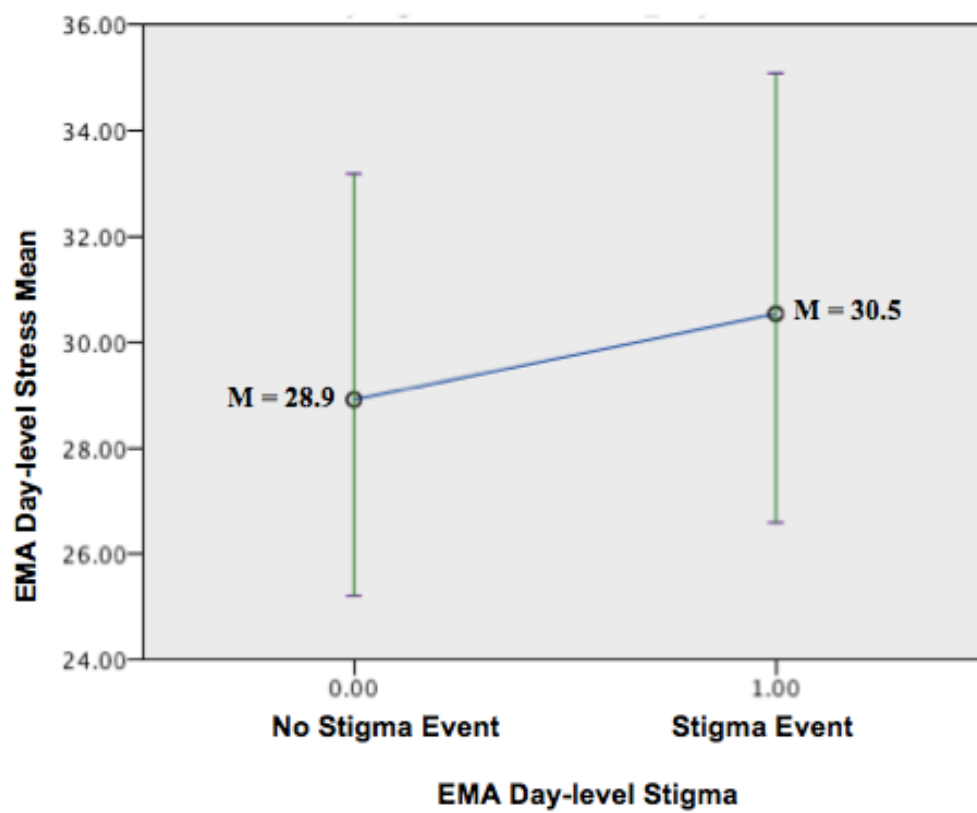


Figure 13. Daily stigma event predicting daily negative emotion

