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Psychological and behavioral pathways between perceived stress and weight change in a behavioral weight loss intervention

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Abstract

Black women have a higher prevalence of obesity and tend to have suboptimal outcomes in behavioral weight loss programs for reasons that are not fully understood. Studies have shown a potential relationship between perceived psychological stress and weight loss in behavioral interventions. This study sought to assess whether baseline stress was directly or indirectly associated with 6-month weight change among Black women participating in a behavioral weight loss study. Indirect pathways of interest included depressive symptoms and dietary intake. A secondary analysis of data (n = 409) collected from a cluster, randomized behavioral weight loss trial was conducted. Demographics, anthropometry, surveys, and dietary data were collected at baseline and 6 months. Path analysis was used to test for direct and indirect effects of baseline stress on 6-month weight change while controlling for sociodemographic factors and intervention group. Baseline stress was not directly associated with 6-month weight change nor was it indirectly associated via depressive symptoms in the adjusted model. However, each of the direct

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Author Contributions MLB conceived the original research study. TLC conceived the research question for this secondary analysis. TLC and MB collected data. KM analyzed data. DL critically reviewed the paper. KM, MB, and TLC were involved in data interpretation. KM and TLC co-led writing the paper. All authors reviewed and approved the final versions.

Conflict of interest The authors Kristine Molina, Monica L. Baskin, Dustin Long and Tiffany L. Carson declared no conflict of interest.

Ethical approval All study-related protocols and ques-tionnaires received approval from The University of Alabama at Birmingham Institutional Review Board for human subjects.

Informed consent Informed consent was obtained from all patients for being included in the study.

paths linking baseline stress to weight loss were statistically significant. Stress was not associated with 6-month weight change via dietary intake. Baseline stress was positively associated with 6-month depressive symptoms which in turn was associated with less weight change. Depressive symptoms may offer an additional psychosocial target to consider when designing behavioral weight loss interventions for Black women.

Introduction

Black women have a higher prevalence of obesity than any other demographic group in the United States (Flegal et al., 2016) and tend to have suboptimal outcomes in behavioral weight loss programs for reasons that are not fully understood (Fitzgibbon et al., 2012). This high prevalence of obesity and limited weight loss success in traditional behavioral weight loss programs are thought to contribute to the disproportionate burden of obesity-related diseases (e.g., hypertension, Type 2 diabetes) among Black women. Potential contributors to obesity include hereditary/biological, environmental, behavioral, and psychological factors (The Obesity Society Infographic Task Force, November 2015). Additional studies of obesity-related risk factors may help to further elucidate reasons for the high prevalence of obesity among Black women and provide guidance on interventions to treat or prevent obesity.

Stress, which is reported as higher among women and Black adults (American Psychological Association, 2017), has been implicated as a contributor to weight gain but research findings are mixed (Wardle et al., 2011). Some studies have shown a positive association between stress level and weight gain, while others have reported no association (Wardle et al., 2011). Two review/meta-analytic papers concluded that psychosocial stress is a risk factor for weight gain although the effect size may be small (Block et al., 2009; Wardle et al., 2011). In studies of behavioral weight loss interventions, researchers have reported that lower stress levels at baseline were associated with more weight loss (Kim et al., 2009). However, other studies have reported no direct association between stress and weight loss among individuals engaged in a behavioral weight loss program (Carson et al., 2017; Delahanty, et al., 2013). One reason for this may be the use of different stress measures across studies that capture different aspects of stress. Another reason for varied outcomes is that the relationship between stress and weight is mediated by another factor that is associated with both stress and weight such as depression or eating behavior. Nevertheless, stress may be a particularly important consideration for weight management among Black women who exist at the intersection of two groups reporting the highest stress levels in the country (American Psychological Association, 2017). Consistent with an intersectional perspective, Black women living in the Deep South—who are more likely to have obesity and be of lower socioeconomic status—may experience discrimination at the intersection of multiple stigmatized identities, which may constitute a qualitatively unique type of stress among this group. Indeed, identity-based discrimination, whether due to gender, ancestry, weight and appearance, or other marginalized identities, is associated with unhealthy-related eating behaviors (Sutin et al., 2016), suggesting that such a response may constitute general coping strategies to stress resulting from identity threats (Berjot & Gillet, 2011).

Role of psychological and behavioral mechanisms

Although the relationship between psychosocial stress and depression is complex and potentially bi-directional, research suggests that chronic stress (i.e., stress that lasts at least a month) can lead to depression in those who are susceptible (Kessler, 1997; Khan & Khan, 2017). Pro-longed exposure to stress leads to increased levels of hormones like cortisol and reduced levels of serotonin and dopamine which have been linked to depression (Hammen, 2005; van Praag, 2004). While this stress response is physiologically normal, extended periods in this state can lead to depression in some people. Indeed, substantial evidence indicates that chronic stress can cause depression (Hammen, 2005; van Praag, 2004). Taken together, one might hypothesize that not only does stress contribute to obesity directly through physiologic mechanisms such as increased cortisol, but also indirectly through depression which has also been positively associated with obesity, especially among women (de Wit et al., 2010; Jantaratnotai et al., 2017).

From a behavioral perspective, stress may relate to weight change via eating behavior. Previous research suggests that psychosocial stress is associated with obesity via dietary intake. For example, research has suggested that individuals may cope with psychosocial stress by engaging in unhealthy eating behaviors (e.g., binge or comfort eating) to make themselves feel better (Adam & Epel, 2007; Ball & Lee, 2000). Likewise, prior studies have found that stress increases appetite (Kandiah, Yake, Jones, & Meyer, 2006) and is associated with preferences for more palatable, higher fat, energy dense foods (Adam & Epel, 2007), sweet foods (Kandiah et al., 2006), and salty snacks (Errisuriz et al., 2016), all of which contribute to excess calories (Epel et al., 2001). Further, people in the South report they have a more difficult time managing their stress in healthy ways compared to those in other regions in the U.S., with over one quarter reporting they eat to manage stress (27%), overeat (35%) or eat unhealthy foods (26%) as a result of stress (American Psychological Association, 2012). Therefore, it is likely that psychosocial stress is related to obesity via behavioral mechanisms such as engagement in greater unhealthy dietary intake (e.g., foods high in sugar and fats).

To investigate the complex relationship between stress and weight change, we systematically, using path analysis, examined pathways between stress, depressive symptoms, diet and weight among a group of Black women living in the Deep South of the United States who participated in an evidence-based behavioral weight loss program. The weight loss program was a 24-month behavioral intervention that translated phase 1 of the evidence-based weight loss maintenance (WLM) trial delivered by trained local lay staff and volunteers (Brantley et al., 2008). The intervention leveraged traditional evidence-based behavioral change strategies such as goal setting, problem-solving, and self-monitoring. Given that stress can impact cognition and motivation (Morgado & Cerqueira, 2018), it is theorized that stress may result in decreased motivation (American Psychological Association, 2012), deficits in problem-solving abilities (e.g., ability to plan, taking action) and challenges to goal setting, which may create adherence challenges related to self-monitoring dietary intake (Murawski et al., 2009). Further, perceived inability to cope with stress due to problem-solving difficulties may act as a mechanism linking stress to depression, consistent with theories of stress and coping (Folkman & Lazarus, 1988). As such, we hypothesized that depressive symptoms would emerge as a potential pathway by which stress is associated with less weight loss. We also hypothesized that stress would be indirectly associated with weight change via increased dietary intake.

Methods

Brief overview

The full details of the main intervention study are reported elsewhere (Ard et al., 2017). Briefly, 409 Black women with overweight or obesity living in one of eight pre-determined counties in Alabama or Mississippi were recruited to participate in a cluster, randomized trial to compare the effectiveness of an evidence-based behavioral weight loss intervention supplemented with support to implement health-promoting community strategies to the same evidence-based weight loss intervention alone. Both groups received a 24-month intervention delivered by trained local lay staff and volunteers. Months 1–6 were the intensive weight loss period and were the focus of the analysis for this report. This period included group sessions focused on evidence-based behavioral strategies for weight loss such as goal setting, problem solving, and self-monitoring. The intensive weight loss period was followed by stepped down monthly maintenance meetings in months 7–12. This period focused on reinforcement, relapse prevention, and social support. All meetings in year 1 were face-to-face. For the second year of the study, participants received monthly coaching phone calls to promote weight loss maintenance.

Data collection

Data collection took place in the local community where the intervention was offered. University staff traveled to each county and worked with the paid lay staff and volunteers to collect demographic, anthropometric, and survey data. For the current analysis, measures completed at baseline and 6-months are included. Measures collected are described below.

Measures

Anthropometry—The outcome of interest was weight loss, which was operationalized as weight change from baseline to 6 months. Weight was measured to the nearest 0.1 kg at eachNational Cancer Institute Automated Self-Administered 24-h Dietary Recall (ASA-24) (Kirkpatrick et al., 2014; Subar et al., 2012): Interviews were conducted using ASA-24 to assess dietary intake. Two dietary recalls (one weekday, one weekend day) were completed for each participant at each time point. Total calories, macronutrient composition, and nutrient estimates were computed based on reported intake. From this, baseline and 6-month dietary composite scores were created that included total fat, total sugars, and total 2012 salt–dietary components that have been associated with food preferences among highly stressed individuals.

time point using a calibrated digital scale. Participants wore light clothing without shoes during assessments.

Perceived stress scale-10 (PSS-10) (Cohen et al., 1983)—Perceived psychological stress was measured using the PSS-10. This instrument measures the degree to which an individual perceives life events to be stressful. Sample items include: “In the past month, how often have you felt that you could not cope with all the things that you had to do?” and “How often have you felt that you were unable to control the important things in your life?” Responses are on a 5-point Likert sale (0 = never to 4 = very often). Four items (e.g., “felt confident about ability to handle personal problems”; “I felt things were going your way”) were positively worded and therefore reverse coded. The total score on the 10 items was used, with higher scores corresponding to greater perceived stress. The internal consistency of the PSS for the current sample was good ($\alpha_{baseline} = 0.77$; $\alpha_{6\text{-month}} = 0.82$). Although the PSS-10 is not a diagnostic instrument, it can be categorized to assess a respondent’s level of stress: “low stress (0–13)”; “moderate stress” (14–26); “high stress” (27–40). The PSS is a rapid and psychometrically sound measure and one of the most widely used to assess chronic stress (Cohen et al., 2012; Lee, 2012). The PSS has shown concurrent validity with multidimensional measures of stress among African Americans (Warren et al., 2010). Lastly, the PSS has been shown to have strong predictive validity, with studies showing that it associates with behavioral practices, biological markers, and mental and physical health outcomes (Cohen & Janicki-Deverts, 2012; Lee, 2012).

Center for epidemiological studies (CES-D) (Radloff, 1977)—CES-D is a 10-item survey used to evaluate depressive symptoms. It assesses emotions and response behaviors to situations during the past week (i.e., “I had trouble keeping my mind on what I was doing”) where valid responses include: ‘less than 1 day’, ‘1–2 days’, ‘3–4 days’, or ‘5–7 days’. Two positively stated items (i.e., “I felt hopeful about the future” and “I was happy”) were reverse coded. A summary score is calculated, with higher total values indicating higher depression symptoms. The internal consistency of the CES-D measure in the current sample was high ($\alpha_{baseline} = 0.70$; $\alpha_{6\text{-month}} = 0.79$). The CES-D has also been used to identify individuals at risk of depression (Björgvinsson et al., 2013). Based on previous research (Andresen et al., 1994; Perreira et al., 2015), a respondent was classified as at-risk for clinically relevant levels of depressive symptoms based on a CES-D cut-off point of 10 or greater.

Demographics—The following demographics were collected using a self-reported paper survey: age, education, employment, income, marital status, and self-rated health status. *Age* was defined as the self-reported age at survey; *education* was categorized as ‘High school graduate or less’, ‘Some Post-HS education’, and ‘College graduate’; *Employment* was categorized as ‘Employed or self-employed’, ‘Unemployed’, and ‘Other’; *Income* was categorized as ‘ ≤ $10 k’, ‘$10 k-$19 k’, ‘$20 k-$29 k’, ‘$30 k-$39 k’, and ‘$40 k +’; *Marital status* was categorized as ‘Married’, ‘Never Married’, ‘Divorced’, and ‘Other’. Self-rated health status was a 1-item question asking respondents, “How would you describe your overall physical health?” Response categories ranged from 0 (“Poor”) to 4 (“Excellent”). Height was measured at baseline without shoes using a portable calibrated stadiometer. We also controlled for intervention arm (active intervention: behavioral weight loss intervention plus support for strategies vs. comparison group: behavioral weight loss intervention only).

Statistical analysis

Descriptive statistics include means and standard deviations for continuous variables and frequencies and percentages for categorical variables. We used maximum likelihood robust (MLR) estimation to include all respondents (N = 409) in the analyses. Main analyses consisted of conducting path analysis using Mplus Version 7.1 (Muthen & Muthen, 2012) to examine direct and indirect effects simultaneously, controlling for the following covariates: intervention arm, age, education, income, marital status, employment, self-rated health status, height at baseline, baseline dietary intake, and baseline depressive symptoms. Specifically, a parallel multiple mediation model was fitted using the robust maximum likelihood estimator (MLR) for continuous variables, accounting for missing data, heteroscedasticity and non-normality (Enders, 2010). Although MLR is robust to violations of model assumptions (e.g., non-normality and heteroscedasticity), the skewness and kurtosis index of endogenous variables were examined. The deviation from normality was acceptable: the skewness and kurtosis index were below 3 and 10, respectively (Kline, 2011). Simulation studies suggest parameter estimates and standard errors (SEs) using robust maximum likelihood would be identical to those obtained with the bootstrapping procedure (Enders, 2010). Further, a correlated error term between baseline perceived stress and baseline depressive symptoms was added in the model given the moderate correlation between the two variables ($r = 0.57$, $p < 0.001$).

The path model was defined as fitting underlying data adequately according to global goodness-of-fit indices: Comparative Fit Index (CFI) equal to 0.95 or higher; Standardized Root Mean Square Residual (SRMR) below 0.08; and Root Mean Square Error of Approximation (RMSEA) below 0.06 (Kline, 2011). Additional support for the point estimate of the RMSEA is demonstrated if the upper and lower bound values of the 90% confidence interval (CI) are below 0.05 (MacCallum et al., 1996). Mplus uses the Sobel test to calculate indirect effects and employs the Delta method to calculate SEs of the indirect effects. The SE estimates were used to test whether each of the indirect effects are different from zero through z-statistics (i.e., $z > 1.96$) (Mackinnon, 2008). All path regression coefficients (β) included in the figures are standardized for ease of interpretation of the effect sizes (Mackinnon et al., 2007).

Results

Descriptive statistics and preliminary analyses

Table 1 presents descriptive statistics of sociodemographic characteristics at baseline for the overall sample.

Table 2 presents descriptive statistics of key study variables at baseline and 6-month follow-up. Regarding our main predictor variable, perceived stress levels did not change significantly from baseline to 6-months follow-up ($M_{diff} = -0.06$, $p = 0.84$). When categorized by stress level, Fisher's exact test showed significant differences in proportions from baseline to 6-month follow-up ($p = 0.000$); however, a large proportion of the sample remained within the "moderate levels" of stress (46.17%). Regarding our outcome measure, the average weight at baseline was 227.97 lbs ($SD = 50.03$; range = 133.8 lbs to 484 lbs), and 220.67 lbs at 6-month (*SD* = 49.03; range = 126.8 lbs to 431.5 lbs). The mean change in weight status between these two time points was 6.24 lbs (*SD* = 10.14); this change was statistically significant.

Bivariate associations revealed that perceived stress at baseline was associated with depressive symptoms at 6 months ($r = 0.38$, $p < 0.001$), not associated with dietary intake ($r = -0.08$, $p = 0.13$), and not associated with weight change at 6 months follow-up ($r = -0.10$, $p = 0.06$). Depressive symptoms at 6 months follow-up were associated with weight change at 6 months ($r = -0.25$, $p < 0.001$), but not with dietary intake at 6 months ($r = -0.04$, $p = 0.50$). Dietary intake at 6 months follow-up was significantly associated with weight change at 6 months ($r = -0.11$, $p < 0.05$).

Model testing and indirect effects

The parallel mediator model was found to have excellent fit to the data ($\chi^2 = 259.29$, $df = 51$; $p < .000$; RMSEA = 0.012; 90% CI [0.000, 0.038]; CFI = 0.99; SRMR = 0.02). The model explained 12.0% of the variance in weight change at 6 months. Figure 1 shows the standardized regression coefficients, SE, and p-values of the tested model (adjusted for covariates and intervention arm). Tests of specific indirect effects from baseline perceived stress to weight change at 6-month follow-up via depressive symptoms did not reach statistical significance ($I = -0.030$, *S.E.* = 0.016, 95% C.I. = −0.061, 0.001, $p = 0.058$). The test of specific indirect effect when total dietary intake was the mediator was also not significant ($I = 0.009$, *S.E.* = 0.008, 95% C.I. = −0.006, 0.024, $p = 0.230$).

We conducted supplementary analyses to test whether the non-significant indirect effect was sensitive to the separate components of the total dietary intake variable. We found that perceived stress at baseline was significantly associated with total sugars in grams ($\beta = -0.10$, $p < 0.05$), and, in turn, total sugars was associated with less weight loss ($\beta = -0.01$, $p < 0.05$). However, the indirect effect of perceived stress on weight change, through total sugar intake, did not reach statistical significance ($I = 0.010$, *S.E.* = 0.007, 95% C.I. = -−0.004, 0.02, $p = 0.153$), perhaps given the weak estimates associated with each path. No other dietary component was associated with perceived stress or weight change.

Discussion

In this study of Black women in the rural Deep South in a behavioral weight loss program, we tested the direct association between baseline perceived stress and 6-month weight change and the indirect association by way of depressive symptoms and dietary intake. We did not find support for our hypotheses. However, we observed that some of the paths between baseline perceived stress and weight change at 6-month follow-up were statistically significant.

Previous literature displays the complexity of the relationships between stress, depressive symptoms, eating behavior and weight. Indeed, when examining even one psychological factor, i.e., stress *or* depressive symptoms, and eating behavior *or* weight loss, research findings are mixed. Some studies show that baseline stress is inversely associated with weight loss among participants in a behavioral weight loss program (Elder et al., 2012;

O'Brien et al., 2015; Trief et al., 2014) while other studies show no association (Delahanty et al., 2013; Svetkey, Ard, Stevens, Loria, Young, Hollis, Appel, Brantley, Kennedy, Kumanyika, Batch, Corsino, Lien, Vollmer, et al., 2012). Similarly, studies investigating the relationship between depressive symptoms and weight loss have yielded mixed findings with some reporting a significant association (Carson et al., 2017; Trief et al., 2014) while others report no association (Elder et al., 2012; Svetkey et al., 2012). While much of the previous work has examined the relationship between stress or depression and weight status, our study is among the first to simultaneously examine these relationships in a path analytic model.

Stress, depressive symptoms, weight change

Although the indirect effect from baseline stress to weight change at 6-month follow-up did not reach statistical significance, we observed that each direct path in this link was significant. Stress at baseline was associated with increased depressive symptoms, which in turn were associated with less weight loss at 6 months follow-up. Each component of this pathway has been observed previously in the literature. For example, Trief et al. reported that individuals with higher stress were more likely to report elevated depressive symptoms and that individuals with elevated depressive symptoms lost less weight compared to without (Trief et al., 2014). Consistent with other studies, stress was positively associated with elevated depressive symptoms which, in turn, were associated with BMI (Carson et al., 2017; Trief et al., 2014). Several reasons are provided for the non-significant indirect effects. First, statisticians have noted that non-significant indirect effects can occur in spite of significant direct effects because of the needed higher power for the test of indirect effect or other intervening variable effects (MacKinnon et al., 2002). The power analysis for the larger intervention study was not based on the secondary data analysis aims of our manuscript; thus, our analyses may have been underpowered, particularly within a multiple-mediator path analysis framework. Simulation studies of mediational testing have shown that a sample size of 667 is generally needed to achieve 0.80 power when there is a small-to-medium-sized direct effect (i.e., $\beta = 0.14–0.39$) in the model and effect sizes of the a and b regression parameters are both small (Fritz & Mackinnon, 2007). Thus, mediation could be really happening in the model, but the total indirect effect may be non-significant simply because the sample size is small (MacKinnon et al., 2002).

Finally, we may not have found a significant indirect effect due to unmeasured common causes of the mediator and outcome (Loeys et al., 2014). Researchers have shown that among individuals with obesity, failed attempts at weight loss may be attributed internally and can elicit negative emotional responses such as shame and feelings of worthlessness, which can result in disengaging coping responses (e.g., negative self-talk, avoidance/ withdrawal) that are positively associated with psychological distress and depressive symptoms (Conradt et al., 2008). These results are in line with anecdotal evidence from a qualitative study comprised primarily of Black women who participated in a weight loss program (Reyes et al., 2012). One of the women in the "regainers" group (i.e., did not maintain weight loss) noted: *"(I say) 'What are you doing? You did so good. You know how to do it.' You get kind of depressed, like you're failing. It's hard to get back positive*" (Reyes et al., 2012). This suggests that increases in depressive symptoms may be driven by experiences associated with weight change, particularly among those individuals who did not lose weight (or lost the least) as part of the intervention. Prior research finds that Black women with overweight or obesity are less likely to achieve weight loss goals and lose weight more slowly (DeLany et al., 2014; Kumanyika et al., 1991). Thus, future work should account for perceived failure at weight loss as well as weight-related feelings of shame and the use of coping strategies, given these variables may play a role in changes in depressive symptoms and weight loss.

Stress, dietary intake, weight change

When examining whether baseline stress was indirectly associated with weight change by way of dietary intake, our hypothesis was not supported. From a statistical standpoint, this effect is partly attributed to the fact that the first path (perceived stress to dietary intake) was not significant. While dietary intake was associated with weight change as consistently observed in the literature, the first path in the indirect pathway between stress and dietary intake was not significant. The literature on the relationship between stress and dietary intake is mixed. Several studies have demonstrated significant relationships between stress and dietary intake which supported our initial hypothesis (Laugero et al., 2011; R. Sims et al., 2008; Wardle et al., 2000; Yau & Potenza, 2013). However, the findings of the current study are consistent with what we have observed in our previous work among a similar population (Carson et al., 2015) and suggest that the relationship between stress and dietary intake among Black women in the Deep South may not be consistent with other groups. Moreover, other studies find that obese and non-obese women differ in their dietary intake (e.g., salty snacks, fruit juice) in the presence of chronic stress (Sedaqat, Rabiei, Faria, & Rastmanesh, 2013). It is possible that we may have found different results had we also included women who did not have overweight/obesity, given that the effects of stress on dietary behavior appear to be weight-dependent. It will be important for future research to compare stress and its effects across samples of women with different weight statuses. At the same time, it is possible that among our sample of Black women, stress levels are associated with dietary intake via psychosocial mechanisms tied to adherence to intervention components (e.g., problem-solving, self-monitoring). For example, a systematic review of factors of adherence to lifestyle modification programs for weight management found that being female was associated with lower completion of weekly online-self-monitoring journals and that autonomous motivation is associated with greater completion of food and exercise diaries (Leung, Chan, Sea, & Woo, 2017).Thus, it could be that women who are stressed are less likely to feel motivated to self-monitor their dietary intake, thereby resulting in no dietary behavior change. Future research should investigate behavioral factors (e.g., adherence) and psychosocial mechanisms (e.g., motivation) that may link stress to eating behavior.

Prior studies also suggest that the effects of stress on dietary intake may be dependent on the type of stressor and eating behavior measured. For example, a national study found that Black women (as well as women who have obesity and who have lower levels of education) report the highest rates of weight-based discrimination (Puhl et al., 2008). Prior research finds that weight discrimination is associated with overeating, more frequent consumption of convenience foods, and less regular meal timing (Sutin et al., 2016). Other studies also indicate that racialized stress, such as in the form of racial discrimination, is associated with less healthy eating (Brodish et al., 2011) and increased dietary fat consumption (M. Sims et al., 2016) among African Americans, whereas other studies (Isasi et al., 2015) find that perceived stress is associated with lower diet quality as measured by the Alternative Healthy Eating Index. Future research should examine how Black overweight/obese women's multiple subordinate social locations interact to shape exposure to intersectional oppression, and in turn, how these experiences are internalized and affect obesogenic health behaviors and outcomes.

Interestingly, we found in our supplementary analyses, that perceived stress was associated with less total sugar consumption. The direction of this association could be partly accounted for by the fact that all the women in the study received some form of weight loss intervention and therefore may have been more susceptible to eating less sweets. Further, it has been reported previously that stress can also be associated with less eating (Torres & Nowson, 2007) and skipping meals (American Psychological Association, 2014), with at least 40% of people decreasing their eating when stressed (Sedaqat et al., 2013). Future studies would do well by incorporating different measures of psychosocial stress as well as different dietary assessments beyond dietary intake recall.

Limitations, strengths, and future research

Although the focus on Black women who are overweight was appropriate to the research goals of the larger intervention study, there are limitations to the use of homogeneous designs. For instance, this approach may allow us to understand how certain phenomena manifests among specific groups (e.g., Black women in the Deep South who are overweight). However, this type of design limits our ability to test theories across groups, assess the scope and significance of our phenomena, or examine any potential differences and similarities across groups (e.g., Black men, White women, Blacks in the Midwest)—all of which can contribute to generalization of findings and to the improvement or development of new theoretical models. Future research would benefit from work that triangulates homogeneous and comparative approaches.

Another limitation is that depressive symptoms, commonly underreported by Black women, were assessed using a self-reported survey. Other evaluative approaches for depressive symptoms such as structured psychiatric interviews may have yielded different results. Similarly, the dietary assessment used in our study (i.e., dietary recalls) may not be the optimal method to assess behavioral responses to psychosocial stress; methods such as ecological momentary assessment may better capture exposure to stress and concurrent responses in real time (Isasi et al., 2015). Likewise, future studies might consider other eating-related responses to stress, such as emotional eating and skipping meals.

Lastly, we did not control for medications shown to associate with weight gain and obesity (e.g., antidepressants, antipsychotics). Prior research with women finds increased risk of obesity among women with depression taking antidepressants (Grundy et al., 2014). However, we should note that given the make-up of our sample (e.g., predominantly low-income Black women with "low-risk" of clinical depression [i.e., baseline: 79.66%; 6-month follow-up: 70.20%), we speculate that it is more likely than not that the majority of our sample was not on antidepressants which is consistent with population-level data demonstrating that Black adults are significantly less likely to use antidepressants compared to White adults (González et al., 2008). Nevertheless, future research would be strengthened by assessing for mental health disorders and medication use (e.g., antidepressants, stimulants) that may result in weight changes.

Limitations notwithstanding, this study has several strengths. The longitudinal design of this study allows us to establish temporality which extends beyond much of the work in this area that has been cross-sectional. Objectively measured weight is another study strength. Additionally, to our knowledge, this study is among the first to simultaneously study the relationships between stress, depression, eating behavior, and weight change using a parallel mediator model. Lastly, despite the limited generalizability, a strength of this study is the focus on rural Black women—a group that is currently understudied while simultaneously evidencing a higher risk of social determinants of health and bearing a disproportionate burden of obesity.

Implications and Conclusion

Our study findings suggest that perceived chronic stress is prospectively associated with increased depressive symptoms, which in turn are associated with less weight loss among Black women participating in a behavioral weight loss program. These findings suggest that instead of depression being indicated as an exclusion criterion as commonly observed in behavioral weight loss trials, future research should explore whether augmenting current evidence-based behavioral weight loss programs with strategies to manage both stress and depressive symptoms leads to better weight loss outcomes among Black women. Our findings also provide initial evidence that help emphasize the importance of investing in mental health care services if we want to reduce or eliminate stress-related obesity disparities among rural communities, specifically among rural Black women. Lastly, our findings suggest focusing on the role that context- and identity-specific stressors may have with unhealthy eating habits (Brodish et al., 2011; Sutin et al., 2016), and whether this helps explain the association between stress and weight loss. and the need for assessing other possible mechanisms triggered by non-specific and contextual stress (e.g., weight stigma), including perceived failure at weight loss and associated responses (e.g., shame, guilt) and their related coping strategies.

Given the high prevalence of Black women suffering from psychosocial stress, obesity and obesity-related illness (e.g., diabetes, heart disease) and the potential role of depressive symptoms, further examination of psychosocial, biobehavioral, and socioenvironmental factors is warranted among this specific population. Thus, future weight-loss interventions for Black women should also be tailored to include stress management strategies for coping with general and contextual and identity-related stressors. Future interventions should also consider including strategies for managing elevated depressive symptoms as augmentation to a standard behavioral weight loss program and involve interventionists with appropriate mental health training. In sum, identifying effective mechanisms for implementing interventions at the population-level should help us to achieve equity in Black women's health (Belgrave & Abrams, 2016).

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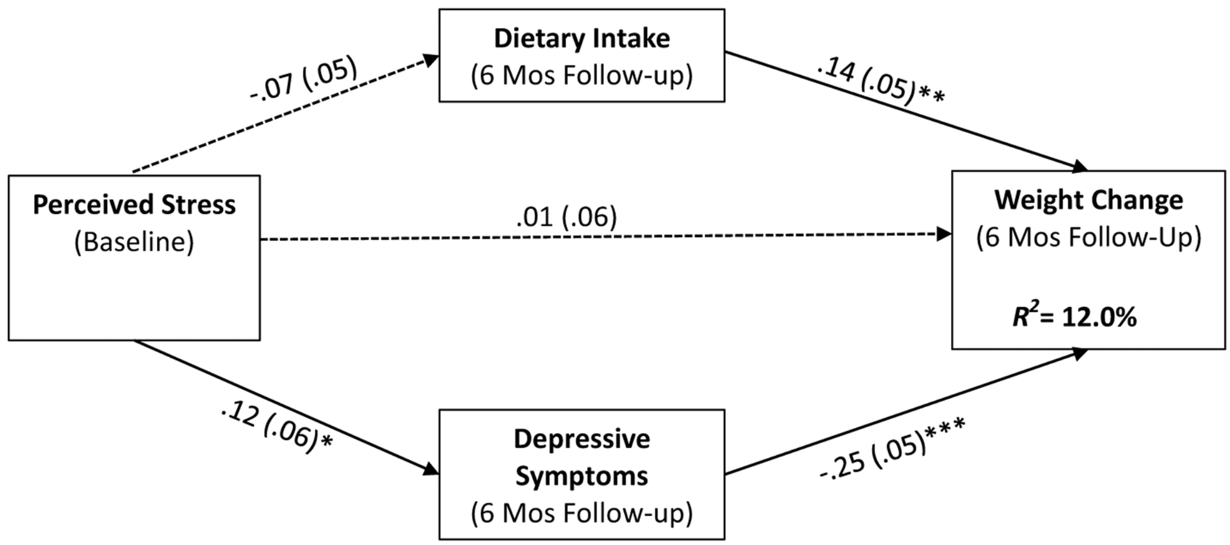

Fig. 1.

Standardized estimates of parallel multiple mediation model of the relationships of perceived stress to dietary intake, depressive symptoms, and weight change status. *Note*. Mos = Months. Dashed lines represent non-significant paths. Path analysis adjusted for intervention arm, age, education, income, marital status, employment, self-rated health status, height at baseline, baseline dietary intake, and baseline depressive symptoms. *$p < .01$; **$p < .01$; ***$p < .001$

Table 1

Descriptive Statistics of Sample Characteristics at Baseline, N = 409

	M or %	SE or SD
Characteristics		
Age	46.51	(9.9)
Education		
HS graduate or less	40.9	0.02
Some post HS	18.45	0.02
College grad	40.65	0.02
Marital status		
Married	40	0.02
Divorced	13.33	0.02
Other	13.83	0.02
Never Married/Single	32.84	0.02
Household income		
Less than $10 k	20.77	0.02
$10 k—19,999 k	23.33	0.02
$20 k—29,999 k	21.54	0.02
$30 k—39,999 k	15.64	0.02
$40 k and over	18.72	0.02
Employment status		
Employed	72.8	0.02
Unemployed/Other	27.2	0.02
Self-rated Health[a]	1.87	(.82)
Height (in inches)	64.38[b]	(2.45)

[a]Range of overall health variable is 0(“poor”) to 4(“excellent”)

[b]Average height corresponds to 5 feet and 4 inches

Percentages may not add up to 100% due to missing data. Values in parentheses correspond to SD

Table 2

Descriptive statistics of main study measures at baseline and 6-month follow-up

	Baseline		6-Month		Mean difference	*p*-value
Measure	M or %	SE or SD	M or %	SE or SD		
Perceived stress	14.11	(5.77)	14.24	(6.59)	−0.06	0.840
Depressive symptoms	6.66	(4.56)	7.71	(5.45)	−1.17	0.000
CES-D < 10	79.7%	0.02	70.2%	0.02		
CES-D ≥ 10	20.3%	0.02	29.8%	0.02		
Dietary intake (grams)	151.74	(62.06)	128.75	(52.63)	22.96	0.000
Weight (lbs)	227.97	(50.03)	220.67	(49.03)	6.24	0.000
Body mass index	38.63	(8.04)	37.50	(7.86)	1.05	0.000

Values in parentheses correspond to SD. *p*-values are based on t-tests for continuous variables. Body mass index (BMI) was calculated from measured height and weight using the standard formula of BMI = kg/m^2