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Does stress attenuate motivation for healthful eating in pregnancy and postpartum?

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Abstract

Despite high motivation for healthful eating during pregnancy, maternal diet quality is inadequate. During pregnancy, women may relax effortful control over eating to reduce stress; thus, stress may override motivation to eat healthfully. This secondary analysis of data from the Pregnancy Eating Attributes Study longitudinal cohort investigated associations of motivation for healthful eating and perceived stress with diet quality during pregnancy (n = 365) and postpartum (n = 266), and investigated whether stress modifies associations of motivation with diet quality. Women (M_{age} = 31.3; gestational age ≤ 12 weeks) were recruited from the Chapel Hill, North Carolina area and completed multiple 24-hour diet recalls (once each trimester of pregnancy, and at 4–6 weeks, 6 months, and 1 year postpartum) and validated measures of perceived stress and motivation for healthful eating (autonomous and controlled). Hierarchical multiple regressions tested associations of diet quality (Healthy Eating Index-2015) with stress, motivation, and their interactions. Additionally, themes extracted from previously-analyzed focus groups conducted with a subsample of participants were re-examined for content relevant to stress, motivation, and diet. Pregnancy and postpartum diet quality was positively associated with autonomous motivation, but was unassociated with controlled motivation and stress. Interaction terms did not appreciably

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Ethical Statement

This study represents a secondary analysis of data from the Pregnancy Eating Attributes Study (PEAS), a longitudinal observational study investigating neurobehavioral influences on eating behavior and weight change during pregnancy (Nansel et al., 2016). Prior to data collection, the PEAS obtained ethics approval from the University of North Carolina at Chapel Hill Institutional Review Board (as described in Nansel et al., 2016). Research staff identified potential participants through review of electronic health records and obtained signed informed consent for eligible individuals who elected to participate.

5. Declaration of Conflicting Interests

The authors declare that there is no conflict of interest.

improve model fit. Focus group participants described both internal and external forces contributing to their motivation for healthy eating during pregnancy and described the impact of stress on eating behaviors through amplification of food cravings. Future research is needed to identify influences on maternal motivation for healthful eating.

Keywords

diet quality; pregnancy; postpartum; stress; motivation

1. Introduction

Maternal diet during pregnancy influences maternal and fetal health outcomes including maternal respiratory infection, hypertension, and gestational diabetes, infant birth weight, childhood cognitive functioning, and childhood asthma (e.g., Borge et al., 2017; Kind et al., 2006; Li & Werler, 2010; Schoenaker et al., 2016). Yet diet quality during pregnancy is characterized by insufficient intake of vegetables and excessive intake of dietary fat relative to dietary recommendations, even in middle- to high-income populations (Blumfield et al., 2012; Caut et al., 2019; Forbes et al., 2018). Beyond pregnancy, maternal diet quality during postpartum is associated with infant weight and adiposity (Tahir et al., 2019), as well as with maternal postpartum depression, anxiety, and stress (Baskin et al., 2015; Trude et al., 2020). However, while research has indicated adverse short- and long-term consequences of poor diet quality for both maternal and child health, there is limited understanding of psychosocial influences on maternal diet quality.

Qualitative data suggest that health behavior motivations during pregnancy originate from external sources, such as societal expectations and provider directives, and internal sources, including personal valuing of maternal and fetal health considerations (Paterson et al., 2016; Szwajcer et al., 2007). Self-determination theory (SDT) attempts to explain human motivation by positing that individuals will tend toward behaviors and goals that satisfy an innate desire to feel competent, capable, and connected (Deci & Ryan, 2000, 2008; Moller et al., 2006), and posits that motivation may differ in its relationship with behavior depending on its source (e.g., internal, external; Verstuyf et al., 2012). According to self-determination theory (Deci & Ryan, 2008), the impact of motivation on health behavior depends on whether that motivation is internally-driven (also termed self-regulated or autonomous) or externally-driven (controlled). Motivation that originates from an internal source or is fully integrated into one’s values is referred to as autonomously regulated motivation, consistent with the idea that it is fulfilling a basic human need for autonomy. Conversely, controlled motivation reflects the influence of external driving forces such as directives (e.g., healthcare provider instructions) or rules that have been only partially internalized (e.g., shame, guilt; Deci & Ryan, 2008). As a consequence, SDT hypothesizes that autonomously regulated motivation is more likely to result in health behavior maintenance than controlled motivation. Although increased motivation of either type may increase target behaviors, this relationship is hypothesized to be stronger for autonomous motivation since controlled motivation requires more conscious effort and is, therefore, more vulnerable to perceived barriers.

In non-pregnant samples, autonomous motivation is positively associated with various health behaviors (e.g., not smoking, healthful eating, physical activity), while associations of these behaviors with controlled motivation are either weaker or inverse (e.g., Hagger et al., 2014; Levesque et al., 2007; Pelletier et al., 2004). One study in pregnant women showed a stronger association of physical activity with autonomous motivation than with controlled motivation (Gaston et al., 2013). Similarly, women who acknowledge the potential positive impact of dietary changes (for mother and fetus) report intention to increase fruit and vegetable intake, and decrease high-fat and high-sugar foods (Gardner et al., 2012), which could suggest integration of these changes into their value system. However, prior research examining motivation for healthful eating during pregnancy has largely been focused on behavioral intentions (e.g., Brown et al., 2016; Reyes et al., 2013).

Stress is associated with greater engagement in health risk behaviors (e.g., cigarette smoking, alcohol use) during pregnancy (Dunkel Schetter & Lobel, 2012), suggesting that stress may compete with motivation for healthful behaviors. In non-pregnant samples, chronic perceived stress is associated with greater total energy intake and proportion of intake from fat (McCann et al., 1990; Morris et al., 2015; Ng & Jeffery, 2003; Torres & Nowson, 2007). Research on the reward-related eating suggests that highly palatable foods may stimulate endogenous opioid (i.e., reward signaling) systems in the brain, which also act to down-regulate the body's stress response system (i.e., the hypothalamic-pituitary-adrenal axis), suggesting one mechanism by which individuals may demonstrate preference for highly palatable foods in stressful contexts (Adam & Epel, 2007). Consistent with the notion of a feedback loop between stress and consumption of highly palatable foods, stress during pregnancy is associated with higher intake of discretionary foods (e.g., sweets and snacks; Forbes et al., 2018; Hurley et al., 2005; Nichols et al., 2019) and poorer diet quality (Doyle et al., 2017; Fowles et al., 2011; Hurley et al., 2005; Lindsay et al., 2017).

Theories of stress and coping (Folkman, 2008; Folkman et al., 1979), and particularly efforts to integrate these with motivational processes (e.g., Ntoumanis et al., 2009), suggest that autonomous motivation may be associated with more adaptive responses to stress (e.g., persisting despite stress response, approaching the situation as a challenge), whereas controlled motivation may be associated with less adaptive responses to stress (e.g., heightened threat appraisal, withdrawing from the situation). Consequently, the interaction of stress with motivation may depend on motivation type. That is, controlled motivation requires more conscious effort to sustain (Deci & Ryan, 2008) and is associated with less adaptive responses in stressful contexts (e.g., Ntoumanis et al., 2009). Thus, any relationship of controlled motivation for healthful eating with diet quality may be vulnerable to the influence of stress. For example, efforts to down-regulate stress by consuming highly palatable foods may contribute to poorer overall diet quality. In contrast, the relationship of autonomous motivation for healthful eating with diet quality may be less vulnerable to the influence of stress given that this type of motivation is thought to require less conscious effort to sustain. Consequently, more cognitive resources would be available to respond adaptively in stressful contexts, leading to persistence of healthful eating behaviors despite stressful contexts. However, the possible influence of stress on the relationships of autonomous and controlled motivation with diet quality has not yet been examined.

Therefore, this paper aims to investigate associations of motivation and stress with diet quality during pregnancy and postpartum, and to examine whether stress modifies the association of motivation with diet quality. Because pregnancy may provide a unique context in which motivation for healthful eating and stress are experienced, we supplement quantitative analyses using well-validated measures of stress and motivation with qualitative findings from a subset of participants. We hypothesize that diet quality is positively associated with autonomous motivation and controlled motivation, that the association of diet quality with autonomous motivation is stronger than that with controlled motivation, and that diet quality is inversely associated with stress. We additionally hypothesize that stress modifies the association of diet quality with controlled motivation, whereas it does not modify the association with autonomous motivation. Finally, exploratory aims include assessing the consistency of the studied relationships between pregnancy and postpartum, and examining the convergence of qualitative descriptions of influences on diet during pregnancy with quantitative findings.

2. Methods

This study represents a secondary analysis of data from the Pregnancy Eating Attributes Study (PEAS), a longitudinal observational study investigating neurobehavioral influences on eating behavior and weight change during pregnancy (Nansel et al., 2016).

2.1 Participants

Study participants ($N = 458$) were recruited from two University of North Carolina at Chapel Hill Healthcare System obstetric clinics between November 2014 and October 2016; data collection was completed in June 2018. Participants met the following inclusion criteria: expected singleton pregnancy (confirmed at enrollment to be ≤12 weeks gestation), body mass index (BMI) ≥ 18.5 kg/m^2, internet and e-mail access, ability to read and write in English, planned delivery at the UNC Women's Hospital, and plan to remain in the geographical area until at least 1 year postpartum. Exclusion criteria included multiple pregnancy, medical or psychosocial conditions that contraindicated participation in the study (e.g., participant-reported eating disorder, pre-existing diabetes, other major chronic illness), or use of medication with a known effect on diet or weight. Additionally, a subsample participated in a focus group sub-study; inclusion criteria for this sub-study required gestational age between 13 and 28 weeks and completion of at least 75% of baseline assessments.

2.2 Procedures

Research staff identified potential participants through review of electronic health records and obtained signed informed consent for eligible individuals who elected to participate. Women were followed from early pregnancy (≤12 weeks gestation) through one year postpartum. Prenatal study visits were conducted at ≤12 weeks (time 1), 16–22 weeks (time 2), and 28–32 (time 3) weeks gestation. Postpartum study visits were conducted at 4–6 weeks (time 4), 6 months (time 5), and 12 months after delivery (time 6). Self-report survey measures were completed online within windows associated with each study visit.

Focus group participants were recruited between 15 and 27 weeks gestation from the larger sample, and 8 focus groups were conducted between March 2015 and October 2016. Focus groups included 5–14 participants each, lasted 60–90 minutes, and were facilitated by an experienced female moderator. Focus groups were audio recorded and later transcribed. All study procedures were approved by the University of North Carolina Institutional Review Board.

2.3 Measures

2.3.1 Diet quality.—Diet quality was evaluated using the Healthy Eating Index-2015 (HEI-2015; Krebs-Smith et al., 2018). Participants completed recalls using the Automated Self-Administered 24-hour Dietary Recall (ASA-24; Subar et al., 2012) during each study visit window. Since multiple recalls are needed to obtain reliable estimates of dietary intake (Thompson & Subar, 2017), pregnancy diet quality was calculated by combining data from each of the three pregnancy visits. Similarly, postpartum diet quality was calculated by combining data from each of the three postpartum visits. The HEI-2015 is a measure of conformance with 2015 Dietary Guidelines for Americans (DGA; U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). Total HEI-2015 scores have a maximum of 100, with higher scores reflecting better diet quality (i.e., a diet that is more closely aligned with US dietary guidelines; Krebs-Smith et al., 2018). Thirteen component scores include nine adequacy components (greater intake contributes to a higher score) and four moderation components (greater intake contributes to a lower score), which are calculated relative to energy intake. The HEI-2015 has accumulated evidence supportive of its construct validity, internal consistency, and criterion validity in U.S. adults (Reedy et al., 2018). While prior research suggests that there may be some detectable variation in diet quality over the course of pregnancy in selected subgroups (e.g., women whose BMI is categorized as “overweight” or “obese”), results of research with more inclusive samples suggests that at the summary level (i.e., when focusing on overall diet quality), diet quality is fairly stable across trimesters during pregnancy (McGowan & McAuliffe, 2013; Moran et al., 2012; Rifas-Shiman et al., 2006; Savard et al., 2019).

2.3.2 Perceived stress.—The 10-item Perceived Stress Scale (PSS; Cohen, 1988; Cohen et al., 1983), a well-validated self-report measure of non-specific current life stress, was administered at times 1, 3, 4, and 5. The PSS queries thoughts and feelings indicative of perceived stress over the past month, for example, “In the last month, how often have you felt that you were unable to control the important things in your life?” Items are rated on a five-point scale (*never* to *very often*; 0–4) and items with a positive valence are reverse scored. Ratings are summed to produce a total score (ranging from 0–40), with higher scores indicating greater perceived stress. The measure has demonstrated adequate test-retest reliability over 2 to 6 weeks (coefficients >.70) and internal consistency ($\alpha > .70$) in multiple samples (Lee, 2012). In the present sample, the PSS demonstrated high internal consistency ($\alpha = .89$ at baseline). In both pregnant and non-pregnant samples, the PSS is associated with stressful life events and shows evidence of convergent validity through expected relationships with measures of related constructs such as anxiety and depression (Chaaya et al., 2010; Lee, 2012). As the research questions conceptualized pregnancy and postpartum each cross-sectionally (e.g., diet quality reflected a summary of multiple dietary recalls

during the course of each time period), PSS scores were compared within pregnancy and postpartum to evaluate the degree to which multiple data points could be summarized to appropriately characterize that time period. PSS scores during pregnancy were highly correlated ($r = .73$, $p < .001$) and did not differ significantly between time 1 and time 3 ($M_{diff} = .09$, $t = .31$, $p = .758$). While PSS scores during postpartum increased from time 4 to time 5 ($M_{diff} = -1.67$, $t = -3.84$, $p < .001$), they were also strongly correlated ($r = .61$, $p < .001$), and the magnitude of the mean difference was considered small in the context of the scale range (0–40). Thus, the mean PSS score for each time period was calculated (summary scores for perceived stress were calculated for participants who had data available for at least one timepoint).

2.3.3 Motivation type.—Participants completed the Self-Regulation Questionnaire-Healthful Eating (SRQ; Levesque et al., 2007) at baseline and time 5. The SRQ is a 15-item self-report questionnaire with subscales assessing the degree to which motivation for healthful eating is regulated autonomously (e.g., "The reason I would eat a healthy diet is because I feel that I want to take responsibility for my own health"), externally controlled (e.g., "The reason I would eat a healthy diet is because others would be upset with me if I did not"), or driven by unknown/uncertain forces (i.e., amotivation; e.g., "I don't really know why"). Items are rated on a seven-point scale (*not at all true* to *extremely true*; 1–7) and ratings for items in each subscale are averaged to reflect the overall strength of each type of motivation (with possible overall scores ranging from 1–7). Scores on the subscales of the SRQ for various health behaviors have demonstrated evidence for predictive validity via expected associations with health behaviors and stability over a one-month period when not exposed to an intervention (Levesque et al., 2007; Williams et al., 2006). However, it is not known whether levels of different motivation types change from pregnancy to postpartum. In the present sample, the autonomous motivation (pregnancy $\alpha = .91$, postpartum $\alpha = .91$), controlled motivation (pregnancy $\alpha = .79$, postpartum $\alpha = .78$), and amotivation (pregnancy $\alpha = .67$, postpartum $\alpha = .67$) subscales demonstrated moderate to high internal consistency during both pregnancy and postpartum.

2.3.4 Qualitative experiences of eating behaviors during pregnancy.—During focus groups, participants ($n = 68$) were asked open-ended questions about eating and weight gain during pregnancy, with follow-up prompts available to the facilitator to use as needed to facilitate further discussion (Appendix A). Questions and prompts were developed by researchers with subject matter expertise in the areas of nutrition/dietetics, clinical/community/developmental psychology, and reproductive epidemiology, and were reviewed with the group facilitator to ensure clarity, accessibility, and neutrality (i.e., avoiding leading questions). Further details regarding the qualitative analysis and primary topics of interest including experience of and response to cravings have been published previously (Blau et al., 2020). Participants were not directly asked about stress or motivation for healthful eating during pregnancy. Rather, themes that resulted from the previous analyses were reviewed to identify concepts that may provide additional context to the quantitative measurements of motivation for healthful eating and relationships of stress to eating behaviors.

2.3.5 Anthropometrics.—

Participants' height was measured at the baseline visit by trained study staff using a stadiometer (recorded to the nearest 0.1 cm), and weight was measured once each trimester (to the nearest 0.1 kg) using a standing scale. Measurements were taken in duplicate, with a third taken if the two initial measurements varied by more than 1 cm (for height) or 0.2 kg (for weight). The mean of the two closest measurements was used as the final value. Body mass index (BMI, kg/m^2) was calculated at baseline.

2.3.6 Demographic characteristics.—

Participant sociodemographic information including education, family income, household composition, and race/ethnicity was obtained via self-report at maternal baseline visit; maternal age and parity was obtained from the electronic medical record system. Race and ethnicity (Hispanic/Latino) were queried separately, and due to small numbers, were dichotomized as white or any other racial/ethnic identity when entered into the analysis. Marital status was dichotomized as married/partnered versus single/separated/divorced/widowed to adjust for the contribution of having a current romantic partner. Maternal education was dichotomized to reflect attainment of a college degree. Income to poverty ratio was calculated by dividing the total family income by the appropriate poverty threshold as dictated by household size (U.S. Census Bureau, 2020).

2.4 Data Analysis

2.4.1 Quantitative data.—

Data exploration, evaluation of normality assumptions, and all visualizations except where noted otherwise were conducted in IBM SPSS Statistics v25 (IBM, 2018). Primary descriptive statistics and zero-order correlations were examined to evaluate distributions and the presence of expected relationships. Histograms of stress, autonomous motivation, and controlled motivation, and scatterplots of their relationships were examined to assess normality of distributions and form of relationships to determine the degree to which the sample distributions met assumptions for the planned analyses.

Focal analyses were conducted in SAS software v9.4 (SAS Institute Inc., 2013). The CALIS procedure for full information maximum likelihood estimation (FIML) was used in order to retain the maximum number of valid cases. Research questions were examined with two separate three-stage hierarchical multiple regression models (one each for pregnancy and postpartum data). In stage one of each regression model, sociodemographic variables previously observed to relate to diet quality (i.e., maternal age, BMI, education, race/ethnicity, and income to poverty ratio) were entered as control variables (Bodnar & Siega-Riz, 2002; Doyle et al., 2017; Most et al., 2019). At stage two, perceived stress, autonomous motivation, and controlled motivation were entered simultaneously to examine their linear effects. Amotivation, or uncertain/unknown motivation, was also entered at this stage but was considered as a control variable, to isolate the unique effects of known sources of motivation (i.e., autonomous and controlled) above and beyond unknown/uncertain drivers of behavior (i.e., lack of motivation). At stage three, each of the respective interactions of motivation type by stress were entered separately to determine any additional variance explained above and beyond linear effects.

Finally, paired sample t-tests were used to explore potential differences in the focal variables between the time periods of pregnancy and postpartum.

2.4.2 Qualitative data.—Focus group transcripts were analyzed in an iterative, stepwise process in accordance with published recommendations on the analysis of focus group data (e.g., Asbury, 1995; Basch, 1987; Onwuegbuzie et al., 2009), using NVivo 11 (QSR International, 2015). One transcript was initially evaluated independently by five members of the study team from a grounded theory approach, to note and categorize topics into broad, preliminary themes. Resultant codes were discussed within this group until consensus was reached. Following this process, the remaining focus group transcripts were reviewed for relevance of existing themes and the presence of any additional themes to refine the emerging thematic framework (i.e., constant comparison analysis; Boeije, 2002; Kolb, 2012). Consensus on the coding scheme was reached through a peer-debriefing process, and then two team members coded each transcript independently, reviewing with remaining team members to reconcile discrepancies. Coding was modified on an as-needed basis to incorporate any emerging constructs identified during this phase of analysis. The initial process is described by Blau et al. (2020), and the present work was a secondary analysis of the resultant themes. For the present study, coding scheme elements were reviewed to identify elements that may relate to stress or to motivation for healthful eating, and data coded to these elements were summarized and illustrated with representative examples or quotes.

3. Results

3.1 Sample Characteristics and Bivariate Associations

Of 458 enrolled, 91(20%) withdrew prior to delivery and 46 (10%) withdrew during the postpartum period. There were no significant differences in sociodemographic variables between those who withdrew and those who remained in the study. Reasons for withdrawal included unwillingness to continue participating in the study ($n = 48$), miscarriage, stillbirth, or death of the baby ($n = 29$), change in medical provider or location ($n = 17$), noncompliance with study visits or lost to follow-up ($n = 37$), and development of a condition resulting in ineligibility ($n = 6$). Dietary data were available for 365 participants during pregnancy, and for 266 participants during postpartum. Sample characteristics for those with pregnancy diet quality data and the focus group participant subsample ($n = 68$) are summarized in Table 1, along with demographic information on the geographic area from which the sample was drawn. Average age of the sample was 31 years. A majority of participants reported being married (92%) and had at least a bachelor's degree (57%), with an average income-to-poverty ratio of nearly four. A majority of the sample identified as non-Hispanic white (75%). The focus group subsample was generally similar to the full sample in these respects.

Descriptive statistics and zero-order correlations are presented in Table 2. On average, the sample reported a relatively high level of autonomous motivation to eat healthfully during pregnancy ($M = 5.43$), similar to the postpartum period ($M = 5.25$). Conversely, this sample reported a relatively low level of controlled motivation during pregnancy ($M = 2.46$) and

postpartum (M = 2.38). On average, participants reported a relatively low level of perceived stress during both pregnancy (M = 13.88) and postpartum (M = 13.50). Diet quality as measured by the HEI-2015 fell on average just above the scale mid-point during both pregnancy (M = 57.70) and postpartum (M = 58.07). Pearson's product moment correlations reflected expected relationships between focal variables, though correlations between stress and diet quality were unexpectedly weak during both pregnancy (r = −.14, p = .02) and postpartum (r = −.04, p = .59). No consistent patterns of missingness were identified, thus the missing data was considered to be missing at random (MAR), and thus eligible for full information maximum likelihood estimation procedures.

3.2 Associations of Motivation and Stress with Diet Quality in Pregnancy and Postpartum

The model including covariates and main effects of autonomous motivation, controlled motivation, and perceived stress accounted for approximately 27% of the variation in pregnancy diet quality (R^2 = .27), which was an improvement of 6% in comparison to the model including only sociodemographic characteristics (ΔR^2 = .06). Autonomous motivation was positively associated with diet quality (b = 1.60, p = .02), whereas both controlled motivation (b = .35, p = .60) and perceived stress (b = −.02, p = .89) demonstrated non-significant negative associations with diet quality. Amotivation was strongly and negatively associated with diet quality (b = −3.05, p = .003). Only the term representing the interaction of stress and autonomous motivation emerged as statistically significant (b = −.21, p = .04); inclusion of interaction terms for autonomous motivation and stress (ΔR^2 = .01), and for controlled motivation and stress (ΔR^2 .007) each resulted in little improvement of model fit beyond the contribution of the individual main effect terms (described above). The interaction term for stress and autonomous motivation suggested that higher stress weakened the relationship between autonomous motivation and diet quality. The full model is summarized in Table 3.

After adjusting for covariates, the addition of autonomous motivation, controlled motivation, and perceived stress resulted in a model that accounted for approximately 33% of the variation in postpartum diet quality (R^2 = .33), representing an improvement of 13% over the model including only covariates (ΔR^2 = .13). Autonomous motivation was positively associated with diet quality (b = 1.92, p = .02) and amotivation was negatively associated with diet quality (b = −3.76, p = .002), whereas both controlled motivation (b = 1.42, p = .15) and perceived stress (b = .12, p = .39) demonstrated non-significant associations with diet quality. None of the interaction terms reached pre-determined thresholds (p < .05) for statistical significance; inclusion of interaction terms for autonomous motivation and stress (ΔR^2 = .003) and for controlled motivation and stress (ΔR^2 = .0004) each resulted in little improvement of model fit beyond the contribution of the individual main effect terms (described above). The full model is summarized in Table 4.

3.3 Comparison of Motivation and Stress between Pregnancy and Postpartum

Results of paired-sample t-tests indicated that autonomous motivation for healthy eating was significantly greater during pregnancy (5.41±1.14) versus postpartum (5.24±1.25, $t(184)$ = 2.61, p = .01), but controlled motivation (2.33±.89 vs. 2.34±.95, $t(184)$ = −.23, p = .82) and stress (13.67±6.07 vs. 13.49±6.12, $t(244)$ = .57, p = .57) were unchanged.

3.4 Qualitative Experiences of Diet During Pregnancy

Multiple divergent narratives regarding experiences and perceptions related to stress, motivation, and diet quality during pregnancy were observed. Participants indicated that stress affected their eating behaviors by increasing their drive to eat sweets or spicy foods and decreasing drive to eat vegetables, and also that their motivation for healthy eating reflected both internal and external sources (representative quotes provided in Table 5).

3.4.1 Stress and eating during pregnancy.—Participants noted a variety of stressors unique to pregnancy despite not being asked directly about them, including societal and interpersonal expectations and pressures with respect to health behaviors (i.e., "doing what's right"), increased scrutiny from others, concerns related to weight gain, and worries about the impact of foods on their physiological experience (e.g., risk of acid reflux, nausea) or the baby's health. They also perceived stress as an influence on eating behaviors, noting that it intensified food cravings (e.g., for sweets, spicy foods). Participants described food cravings as arising in response to stress but also reported and advised others to give in to cravings to reduce stress. Some participants characterized a decision point between "giving in" to cravings, which was associated with guilt and/or shame, versus "beating [themselves] up" to maintain control over urges to eat, which was associated with maternal and infant health.

3.4.2 Motivation for healthy eating during pregnancy.—Participants' discussions of healthy eating (participant-defined) during pregnancy appeared to reflect both internal (e.g., based in values) and external (e.g., perception of societal narratives, others' directives) motivation. External sources of motivation noted by participants included other family members' advice (e.g., spouse, parents) and a sense of societal prescriptions about the responsibility of motherhood, which participants noted as beginning during pregnancy (e.g., "this isn't about you anymore"). In general, participants expressed skepticism in response to external sources of potential motivation, such as healthcare provider directives (described as "confusing" and "inconsistent") and expressed encouragement to "do what feels right." Participants also described a desire for general health for themselves, as well as a desire to avoid pregnancy complications (e.g., preeclampsia) associated with excessive gestational weight gain and focus on the impact on the baby's experience (e.g., "the baby can taste [what you are consuming]," "Do you want your baby to be consuming [this food]?"), which appeared to reflect internal sources of motivation.

4. Discussion

In this examination of motivational and psychosocial influences on diet quality during pregnancy and postpartum, greater autonomous motivation and lower amotivation were strongly associated with higher diet quality during pregnancy and postpartum; however, neither controlled motivation nor stress was associated with diet quality, and stress did not modify the association of autonomous or controlled motivation with diet quality in most cases, with the exception of a statistically significant interaction between autonomous motivation and stress in their relationship with pregnancy diet quality. This interaction suggested that higher stress during pregnancy attenuated the positive relationship between autonomous motivation and diet quality. Otherwise, observed relationships between stress,

motivation type, and diet quality appeared largely similar between pregnancy and postpartum. Consistent with these findings, focus group participants appeared to hold internal motives for healthful eating as more salient than external forces such as advice from peers of healthcare providers. Focus group participants also perceived an impact of stress on eating behaviors through amplification of food cravings. Overall, results indicate the importance of understanding the sources of women's motivation for healthy eating during pregnancy and postpartum as potential contributors to diet quality, and also suggest that stress may change the way that autonomous or internal sources of motivation relate to diet quality during pregnancy.

The association of autonomous motivation with diet quality observed in the present study is consistent with prior research, which has supported similar associations of internally driven or autonomous motivation with indicators of higher diet quality (e.g., fruit and vegetable consumption, lower sodium intake) in both non-pregnant (Coa & Patrick, 2016; Hagger et al., 2014; Koestner et al., 2008; Pelletier et al., 2004) and pregnant samples (Gaston et al., 2013; Malek et al., 2017). Indeed, focus group participants in this study described a desire for general health for themselves and their babies, as well as health risk avoidance, all of which seem to represent autonomous sources of motivation for eating healthfully during pregnancy. Previous qualitative work has similarly found that mothers report the health of the baby as a motivator for healthful eating during pregnancy (Reyes et al., 2013; Svensson et al., 2018).

The absence of an association of controlled motivation with diet quality during pregnancy or postpartum suggests that motivation arising from guilt, shame, or external rules is less likely to promote healthful eating. Consistent with this observation, focus group participants both rejected and warned others about external and societal pressures related to eating behaviors. Though research has not explicitly examined type of motivation in relation to health behaviors during pregnancy, results of the present work are largely consistent with findings of prior work indicating little to no association between controlled motivation and health behaviors (e.g., Levesque et al., 2007).

Unexpectedly, results did not support an association between stress and diet quality. Findings are in contrast to previous research that has largely supported a relationship of greater stress with poorer diet quality in non-pregnant adults and adolescents (De Vriendt et al., 2012; Errisuriz et al., 2016; Isasi et al., 2015; Ng & Jeffery, 2003; Wardle et al., 2000) and in pregnant women (Fowles et al., 2011; Fowles et al., 2012; Hurley et al., 2005). However, in one study examining dietary intake (though not diet quality), perceived stress was not a significant predictor of either healthy eating intentions or adherence to food group recommendations (Malek et al., 2017). Conversely, focus group participants described a connection between external advice and stress, as well as between stress and eating craved food, suggesting the perception that controlled motivation may amplify connections between stress and diet quality. Furthermore, the focus group discussions suggested that women did perceive that increased stress prompted stress-related eating (usually of highly palatable, nutrient-poor foods), and that eating in response to cravings was an important strategy to mitigate the negative impacts of pregnancy-related stress – this suggests a possible explanation for our finding that stress attenuated the association of autonomous motivation

with diet quality during pregnancy, but not postpartum. The lack of association between stress and diet quality in the present study contrasts with positive associations found in a low-income pregnant sample (e.g., Fowles et al., 2012), who likely experience greater financial, housing, and other stress exposures in comparison to the present sample.

This study provides novel findings on relationships of diet quality with motivation and stress during pregnancy and postpartum. Findings of a strong, positive association between autonomous motivation and diet quality (during pregnancy and postpartum), but no association of controlled motivation with diet quality suggest that the source of motivation may be an important area of assessment in understanding eating behaviors during pregnancy and postpartum. Although the nature of the data and analyses do not permit causal inferences, the strong association between autonomous motivation and diet quality and the null association of controlled motivation with diet quality suggest that capitalizing on sources of autonomous motivation such as personal or value-based reasons for healthful eating (e.g., by connecting healthy eating with the baby or mother's long-term health) may be more effective in promoting healthful eating behavior during this critical developmental period than approaches that are rule- or directive-based (e.g., provider directives connected to specific foods or weight outcomes). Notably, work with non-pregnant populations suggests that autonomy support and self-relevant goal-setting interventions are associated with increases in autonomous motivation for physical activity and smoking cessation, for example, though interventions targeting eating behaviors have produced inconsistent results (Contento et al., 2010; Fenton et al., 2014; Rutten et al., 2014; Williams et al., 2002). Moreover, the interaction of stress with autonomous motivation suggests that strengthening autonomous motivation and managing stress may improve the effectiveness of interventions targeting diet quality. Future work could also examine relationships between specific sources of advice or recommendations (e.g., family, providers, media), motivation type, and diet quality during pregnancy and postpartum.

Strengths of the present work include the relatively large sample of women assessed during both pregnancy and postpartum. The inclusion of both quantitative and qualitative data provided opportunities to contextualize the quantitative relationships observed with details from the focus group discussions. Additionally, measures of diet quality were calculated using multiple dietary recalls, resulting in a more reliable indicator of diet quality in comparison to singular measurements of daily intake or food frequency questionnaires. Similarly, stress was assessed at two points during pregnancy and postpartum, providing more reliable summary measures for each time period than one single occasion, particularly given the rapid transitions that often characterize these developmental stages, though stress levels reported by participants in the context of this study did not differ appreciably within pregnancy or within postpartum.

This sample was fairly highly educated with limited socioeconomic diversity and had reliable access to prenatal care, which presents constraints to the generalizability of the relationships observed and themes discussed during the focus groups (Parker et al., 2019). Yet, this sample was largely representative of the region from which the individuals were recruited (Chapel Hill, North Carolina). Certainly, inclusion of more diverse samples (e.g., socioeconomic diversity, racial/ethnic diversity, greater variability in stress) would help

strengthen the external validity of the contrast in observed relationships between autonomous and controlled motivation. However, it is notable that even in this regional sample, considerable variability in diet quality was observed and mean diet quality was similar to national estimates (Rehm & Drewnowski, 2019). Additionally, as the present study represented a secondary analysis of data collected as part of a larger, longitudinal study, the measurement schedule was not designed specifically for this research question. The lack of change in stress within pregnancy, and the need to pool diet recalls across each period, precluded the ability to examine change within pregnancy or within postpartum. Finally, focus group participants were not asked directly about stress, motivation, or diet quality which may have resulted in limited scope of discussion of some of these areas. Yet, emergence of these topic areas in response to other (related) prompts suggests that these may be important subjects to investigate directly in future formal qualitative work.

4.1 Conclusion

During both pregnancy and postpartum, autonomous motivation was uniquely and strongly associated with diet quality, whereas controlled motivation was not associated with diet quality, highlighting the importance of differentiating types of motivation for health behaviors. Notably, stress was not associated with diet quality during either period, and stress attenuated the association of autonomous motivation with diet quality during pregnancy but not postpartum. Results support future research to clarify the stability of the observed relationships across samples and contexts, toward identifying points of greatest impact for interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Sample characteristics (at baseline)

Sociodemographic characteristic	PEAS Sample with Dietary Data (*N* = 365) Mean ± SD *or* N (%)	Focus Group Sub-sample (*N* = 68) Mean ± SD *or* N (%)	Chapel Hill, NC[a] Population (all ages) Mean/Median ± margin of error *or* (%)
Age	30.9 ± 4.6	31.3 ± 4.2	25.8 ± 0.7[b]
Sex (Female)	364 (100)	68 (100)	(53)[b]
Education			
High school graduate or less	27 (7.9)	2 (3.0)	(11.3)[c]
Some college or associate's degree	63 (18.4)	13 (15.4)	(11.7)[c]
Bachelor's degree	106 (31.0)	26 (40.0)	(28.7)[c]
Master's or advanced degree	146 (42.7)	27 (41.6)	(48.2)[c]
Body-mass index (BMI)	27.2 ± 6.9	25.8 ± 5.8	
Race/Ethnicity			
White	262 (75.3)	50 (74.6)	(66.9)[b]
Black	49 (14.1)	6 (8.8)	(10.7)[b]
Asian	17 (4.9)	4 (5.9)	(12.9)[b]
Hispanic/Latino	26 (7.5)	5 (7.4)	(6.3)[b]
Multi-race or Other	20 (5.7)	2 (2.9)	(3.3)[b]
Nulliparity	250 (54.6)	33 (48.5)	
Income to poverty ratio	3.9 ± 1.9	4.1 ± 1.8	
Household size	3.02 ± 1.20	2.71 ± .81	2.5 ± 0.1
Marital status			
Married/Partnered	315 (92.1)	60 (88.2)	(37.2)[d]
Single/Separated/Divorced/Widowed	27 (7.9)	5 (7.4)	(62.8)[d]

Note. Race/ethnicity identification categories are mutually exclusive.

[a] U.S. Census Bureau (2019). *American Community Survey 5-year estimates*. Retrieved from *Census Reporter Profile page for Chapel Hill, NC* http://censusreporter.org/profiles/16000US3711800-chapelhill-nc/

[b] Estimates for whole population of Chapel Hill, NC

[c] Estimates are provided for individuals 25 years and older, data is categorized by "some college or associate's degree" (included here under "some college") and "Bachelor's degree" (included here under Associate's or Bachelor's degree)

[d] Estimates are provided for individuals 15 years of age and older.

Table 2

Descriptive statistics and zero-order correlations for focal variables during pregnancy and postpartum

Variable	Mean ± SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11
Pregnancy*														
1. Autonomous Motivation	5.43 ± 1.19	1.83	7.00	(.91)										
2. Controlled Motivation	2.46 ± 1.03	1.00	6.00	.28^{c}	(.79)									
3. Amotivation	1.51 ± .72	1.00	5.00	−.43^{c}	.02	(.67)								
4. Stress	13.88 ± 6.07	1.00	29.00	−.24^{c}	.13^{a}	.08	(.89)							
5. Diet Quality	57.70 ± 12.44	21.99	90.84	.33^{c}	.08	−.33^{c}	−.11	--						
6. BMI	27.19 ± 6.94	18.60	59.80	−.17^{b}	.03	.18^{b}	.17^{b}	−27^{c}	--					
7. Poverty-Income Ratio	3.84 ± 1.97	.39	8.41	.13^{a}	.09	−.29^{c}	−.12^{a}	.29^{c}	−.31^{c}	--				
8. Maternal age	30.46 ± 4.74	18.00	42.00	.12^{a}	−.06	−.14^{a}	−.12^{a}	.23^{c}	−.03	.34^{c}	--			
9. Race/Etdnicity	--	--	--	−.09	−.01	−.09	.01	.15^{b}	−.27^{c}	.34^{c}	.24^{c}	--		
10. Maternal Education	--	--	--	.24^{c}	.03	−.22^{c}	−.11	.37^{c}	−.29^{c}	.56^{c}	.37^{c}	.47^{c}	--	
11. Marital status	--	--	--	.01	−.09	−.13^{a}	−.02	.20^{c}	−.23^{c}	.43^{c}	.28^{c}	.49^{c}	.74	--
Postpartum**				**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1. Autonomous Motivation	5.25 ± 1.23	1.83	7.00	(.91)										
2. Controlled Motivation	2.38 ± .96	1.00	5.33	.21^{b}	(.78)									
3. Amotivation	1.63 ± .82	1.00	5.33	−.42^{c}	−.0002	(.67)								
4. Stress	13.50 ± 6.14	1.00	30.50	−.17^{a}	.12	.11	(.90)							
5. Diet Quality	58.07 ± 13.59	26.79	88.86	.33^{c}	.13	−.34^{c}	.01	--						
6. BMI	27.19 ± 6.94	18.60	59.80	−.16^{a}	−.05	.11	.03	−.21^{c}	--					
7. Poverty-Income Ratio	3.84 ± 1.97	.39	8.41	.02	.13	−.08	−.09	.28^{c}	−.31^{c}	--				
8. Maternal age	30.46 ± 4.74	18.00	42.00	.03	−.09	.01	−.01	.22^{c}	−.03	.34^{c}	--			

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Variable	Mean ± SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11
Pregnancy*														
9. Race/Ethnicity	--	--	--	−.05	.11	.10	.09	.18[b]	−.27[c]	.34[c]	.24[c]	--		
10. Maternal Education	--	--	--	.12	.03	−.08	−.01	.34[c]	−.29[c]	.56[c]	.37[c]	.47[c]	--	
11. Marital status	--	--	--	.01	−.02	.04	.04	.24[c]	−.23[c]	.43[c]	.28[c]	.49[c]	.74	--

Note.

*N = 365

**N = 267

Measure internal consistency (Cronbach's α) is indicated in the diagonal when applicable.

[a] $p < .05$

[b] $p < .01$

[c] $p < .001$. Autonomous Motivation, Controlled Motivation, and Amotivation reflect subscale scores from the Self-Regulation Questionnaire; Stress = Perceived Stress Scale (PSS) score; Diet quality = Healthy Eating Index-2015 total score.

Table 3

Summary of hierarchical regression analysis for variables predicting pregnancy diet quality

	Step 1 Linear effects Control Variables		Step 2 Linear effects Motivation, Stress		Step 3a Interaction AM x Stress		Step 3b Interaction CM x Stress	
Variable	***b***	***SE***	***b***	***SE***	***b***	***SE***	***b***	***SE***
Race/Ethnicity	−.69	1.41	.23	1.39	−.17	1.39	.28	1.39
BMI	−.37[c]	.09	−.27[b]	0.09	−.31[b]	.09	−.27[b]	.09
Maternal education	8.05[c]	1.99	5.83[b]	2.00	5.84[b]	1.99	5.88[b]	1.99
Poverty-income ratio	.45	.41	.18	0.41	.22	.41	.21	.41
Maternal age	.30[a]	.14	.25	0.14	.24	.14	.23	.14
Marital status	−1.95	2.22	−.52	2.20	−.41	2.19	−.52	.81
Amotivation	--	--	−3.05[b]	1.01	−2.99[b]	1.00	−2.82[b]	1.03
Autonomous motivation (AM)	--	--	1.60[a]	0.67	4.51[b]	1.59	1.69[a]	0.67
Controlled motivation (CM)	--	--	.35	0.67	.36	.66	2.26	1.66
Stress	--	--	-.02	0.11	1.14	.58	.32	.29
AM x Stress	--	--	--	--	−.21[a]	.10	--	--
CM x Stress	--	--	--	--	--	--	−.14	.11
R^2		.21		.27		.28		.27
ΔR^2		--		.06		.01		.003

Note. N = 365. Step 2 analyses added Amotivation, along with AM, CM, and Stress terms simultaneously to examine their linear effects. Each subsequent sub-step (3a, 3b) added interaction terms separately. Dashes (--) indicate that the term was not included in that step of the analysis.

[a] $p < .05$

[b] $p < .01$

[c] $p < .001$.

Table 4

Summary of hierarchical regression analysis for variables predicting postpartum diet quality

	Step 1 Linear effects Control Variables		Step 2 Linear effects Motivation, Stress		Step 3a Interaction AM x Stress		Step 3b Interaction CM x Stress	
Variable	***b***	***SE***	***b***	***SE***	***b***	***SE***	***b***	***SE***
Race/Ethnicity	.35	1.84	1.41	1.82	1.26	1.83	1.30	1.84
BMI	−.23	.13	−.11	.13	−.13	.13	−0.12	.13
Maternal education	6.57[a]	2.75	3.95	2.71	3.44	2.75	3.69	2.75
Poverty-income ratio	.82	.51	.75	.49	.74	.49	.76	.49
Maternal age	.30	.19	.34	.19	.36	.19	.34	.19
Marital status	1.02	3.15	2.77	3.19	3.22	3.21	2.89	3.19
Amotivation	--	--	−3.76[b]	1.19	−3.93[b]	1.20	−3.79[b]	1.19
Autonomous motivation (AM)	--	--	1.92[a]	.83	3.64[a]	1.80	1.92[a]	.83
Controlled motivation (CM)	--	--	1.42	.98	1.51	.98	2.58	2.53
Stress	--	--	.12	.14	.80	.66	.31	.41
AM x Stress	--	--	--	--	−.13	.12	--	--
CM x Stress	--	--	--	--	--	--	−.08	.16
R^2		.21		.33		.33		.33
ΔR^2		--		.12		.003		.0005

Note.

$N = 267$. Step 2 analyses added Amotivation, along with AM, CM, and Stress terms simultaneously to examine their linear effects. Each subsequent sub-step (3a, 3b) added interaction terms separately. Dashes (--) indicate that the term was not included in that step of the analysis.

[a] $p < .05$

[b] $p < .01$

[c] $p < .001$.

Table 5

Representative quotes of the relationships between stress, motivation, and eating behavior during pregnancy

Motivation and eating behavior	
Reflective of autonomous motivation	"you gotta think not only about yourself, but about that baby, and what's best all around"
	"my giving into cravings or not is motivated by the health of my baby and what I look like"
	"We all have our different bodies, our bodies deal with things differently, we have different environments we're in, and different factors that affect our weight, and so I'm not following some code that some average meaning or whatever, forget it, you know, I will do what I feel like is appropriate for me."
	"I start eating better for the first time and this time with getting pregnant just cause there's such an awareness that you're setting up somebody else for life"
Reflective of controlled motivation	"I think the only thing I try not to, like, just do what somebody else says unless they feel it's right. You know, you know your body and you'll be more comfortable and more, um, you won't be so stressed. I mean, you'll get stressed trying to impress other people and do what other people expect you to do and things like that."
	"I've seen conflicting things…not only are people encouraging you but I feel less like people are judging me, which I know is a horrible reason to let you eat but I was like, you know – I have no shame in eating that second piece of whatever that is 'cause I'm pregnant."
	"people making comments about like how big your belly is, or what you're eating and it's really hard not to have feelings about that"
	"I just gained so much weight so fast but I don't, just that I need to pick a better diet, better meal plan. She referred me to a nutritionist and dietician and I mean, I can't starve and I can't eat just this. I have to eat like what I want, like what I have a taste for, otherwise it's not really helping"
Stress and eating behavior	"your doctor tells you things so you start overthinking it and I weigh myself every morning. Um, because it's become a little kinda obsessive in a way just because, I'm, like, I wanna make sure but you – what control do you really have to not being able to feel like you're satisfied enough so you're gonna get uncomfortable."
	"I mean, emotional health is so tied to – I guess, our eating"
	"[Cravings occur] When I'm in a bad mood."
	"Stressed out. Definitely when I'm stressed…it's really bad…I think to myself…that's not good for you. Don't do it. As I'm doing it…And it's really bad but I just can't stop myself from doing it. And it immediately takes my stress away."
	"Um, well my stress level at work has been a lot higher this time around. Um, and so I'm definitely a stress eater."