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# How Educational Attainment Modifies the Relationship between Perceived Stress and the Risk of Developing Gestational Diabetes

By

Rachel Lundstrum

Master of Science in Public Health

Epidemiology

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Penelope P. Howards, PhD

# How Educational Attainment Modifies the Relationship between Perceived Stress and the Risk of Developing Gestational Diabetes

By

Rachel Lundstrum

Bachelor of Science

University of Southern California

2023

Thesis Advisor: Penelope P. Howards, PhD

An abstract of

A thesis submitted to the faculty of the

Rollins School of Public Health of Emory University

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## Abstract

How Educational Attainment Modifies the Relationship between Perceived Stress and the Risk of Developing Gestational Diabetes

By Rachel Lundstrum

**Objective** Gestational diabetes mellitus affects 5 to 10% of pregnancies in the United States and poses health risks for both mother and child. While perceived stress has been suggested as a risk factor for gestational diabetes, the modifying role of educational attainment remains unclear. Using data from the nuMoM2b cohort of over 10,000 nulliparous women, this study examined whether education level alters the relationship between perceived stress and gestational diabetes.

**Methods** Stress was measured using a 10-item version of the validated Cohen Perceived Stress Scale. Gestational diabetes was diagnosed based on medical records or based on abnormal results from glucose tolerance tests. Logistic regression models were used to assess the relationship between stress and gestational diabetes, adjusting for age, body mass index, physical activity, and race/ethnicity and including interaction terms for education.

**Results** When incorporating an interaction term for educational attainment, our results were null across all levels of stress and education.

**Conclusions** Findings suggest that perceived stress in early pregnancy is not a strong predictor of gestational diabetes and that educational attainment does not modify this relationship.

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# Chapter 1: Literature Review

## Background

Gestational diabetes mellitus affects approximately 5 to 9% of pregnancies in the United States, though the incidence varies by ethnic and racial group [20]. This high prevalence of gestational diabetes is of public health concern due to the associated maternal and neonatal health risks, including pre-eclampsia or hyperglycemia for the mother and breathing problems and higher risk of obesity for the babies. Thus, the causes of the racial and ethnic disparities in the prevalence of gestational diabetes in the United States must be better understood to work towards more equitable and healthier communities.

Lifestyle changes such as exercise and a healthy diet are the primary evidence-based interventions to reduce the risk of developing gestational diabetes. However, research has identified psychosocial stress, which varies across racial and ethnic groups, as a potential risk factor for gestational diabetes [7, 8, 9, 12]. Although the linkage of perceived stress to gestational diabetes has been examined, research on whether this association is modified by socioeconomic factors is limited. Specifically, whether educational status modifies the association of perceived stress and gestational diabetes, remains unexplored.

This chapter evaluates current literature on the association of perceived stress and gestational diabetes, education and gestational diabetes, and why education could modify the relationship of stress and gestational diabetes.

**Prevalence of Stress**

The prevalence of stress varies by race and has been linked to being a large contributor to the relationship between race and poor health outcomes. Particularly, older Black adults and foreign-born Hispanics have been reported to have more stress exposure than their white counterparts [4]. Further, higher stress scores are correlated with poor health outcomes, with financial and relationship stressors suggesting stronger effects [16]. Additionally, women of low socioeconomic status (SES) experience symptoms of psychological distress 4.5 times as often and symptoms of stress 2.5 times as often as women of high SES [8]. Perceived stress during pregnancy has often been viewed as a modifiable risk factor for developing gestational diabetes [11, 12].

**Methods of Measuring Stress**

Stress can be evaluated through stressful experiences (exposures) or physical responses to stress. Stress exposure categories include chronic, life events, traumatic life events, daily hassles, and acute stress, whereas stress responses include elevated cortisol, sleeping problems, and anxiety resulting from physiological and psychological impacts of stressful events [6]. Stress exposures are gathered through self-report, an interviewer, or proximity to an event [6]. Stress responses are assessed through self-report measures (e.g. perceived stress levels, or feelings of anxiety), behavioral coding, or physiological assessments [6]. In this study, we will focus on self-reported stress exposures and responses as measured by the Perceived Stress Scale. The Cohen Perceived Stress Scale is a common and validated way to measure stress [5].

**Stress and Gestational Diabetes**

The research on perceived stress and gestational diabetes is limited (Table 1). Two studies using the Cohen Perceived Stress Scale reported that higher stress was associated with an increased risk of gestational diabetes. One small (n=373) prospective case-control study done in Karnataka, India, found that the odds of gestational diabetes were 13 times higher amongst those with high perceived stress compared to those with low perceived stress [11]. This study utilized the 10-item Perceived Stress Scale. Another study of predominantly Puerto Rican women (n=1,115) reported 2.6 times the risk of gestational diabetes among those who experienced an increase in stress from early to mid-pregnancy based on the 14-item Perceived Stress Scale compared to those with no change or a decrease in stress [15]. However, this same study found no association between level of perceived stress and risk of developing gestational diabetes. Relatedly, a study (n=2,690) assessing the association of stressful life events with gestational diabetes reported that experiencing 5 or more stressful events 12 months before the baby was born was associated with gestational diabetes with an odds ratio (OR) of 2.49 (95% confidence interval (CI): 1.49, 4.16) [9].

In contrast, a study conducted in Utah, among predominantly non-Hispanic White, married/partnered women (n=4,682) reported no association (OR=1.01 95% CI 0.86, 1.18) between stress and gestational diabetes [14]. This study defined stress levels based on significant life events split into 4 categories including “emotional”, “traumatic”, “financial”, or “partner.” Participants were assigned a stress level ranging from 0-4 based on how many categories the mother experienced significant life events in the 12 months prior to their pregnancy.

**Indirect Links between Stress and Gestational Diabetes**

In addition to studies that have directly assessed the relationship between stress and gestational diabetes, there are several areas of research that indirectly suggest that stress may affect gestational diabetes. For example, stress has been associated with type 2 diabetes through mechanisms that might also be relevant for gestational diabetes. Specifically, stress has been linked to increases in hypercortisolemia and constant sympathetic nervous system activation which is directly related to visceral obesity and type 2 diabetes [10]. Similarly, glucocorticoids are hormones that are released when triggered by the stress response, and they have been tied to metabolic diseases, such as type 2 diabetes and obesity [18]. Additionally, higher financial stress has been linked to cost-related non-adherence to diabetes management advice, which is directly related to experiencing poorer diabetes management, higher Hemoglobin A1c, and decreased functional status [7]. These linkages between stress and type 2 diabetes could be relevant to the pathways by which stress affects gestational diabetes.

**Maternal Education and Gestational Diabetes**

Overall, current evidence suggests that higher maternal educational attainment decreases the risk of gestational diabetes, with some uncertainty. One study of 7,511 pregnant women in the Netherlands found a strong association between maternal education and gestational diabetes, where women without a university degree were 3 times more likely (OR 3.07, 1.37-6.89) to develop gestational diabetes compared to women with a university degree [3]. Similarly, a study of 6,886 participants in China reported that being a high school graduated was associated with a protective effect against gestational diabetes compared not having graduated from high school (OR, 0.74; 95% CI, 0.58-0.95) [16].

**Summary and Remaining Gaps in Knowledge**

Stress negatively impacts both physiology and behavior, leading to worsened health outcomes [19]. While direct associations between stress and gestational diabetes have not been extensively studied in diverse populations, existing evidence remains inconsistent. This could be related to unaddressed heterogeneity of the effect of stress on gestational diabetes by key factors, like education.

Although prior research suggests that higher education is associated with reduced gestational diabetes risk, we found no studies exploring if educational attainment modifies the relationship between stress and gestational diabetes. However, research has found that other socioeconomic status factors can act as a modifier in the relationship between psychosocial factors (e.g., anxiety, depression) and adverse pregnancy outcomes [1]. Understanding whether the relationship between perceived stress and gestational diabetes differs by educational attainment could add to the existing literature by helping to identify which cohorts are most vulnerable and would be the most likely to benefit from interventions to decrease perceived stress.

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**Table 1. Summaries of Research looking at stress and gestational diabetes.**

| Author, Year | Population | N | Research Question | Conclusion |
|---|---|---|---|---|
| Mishra, et al. 2020 | Pregnant women in Karnataka, India. | 373 | Association between maternal perceived stress and gestational diabetes risk. | The odds of gestational diabetes were 13 times those among those with high antenatal stress compared to those with low perceived stress. |
| Mendez, et al. 2024 | Working pregnant individuals in South Carolina. | 1,163 | Association of adverse childhood experiences and maternal work and non-work-related stress with the risk of gestational diabetes. | Only maternal work stressors were associated with an increased risk of GDM. |
| Silveira, et al. 2014 | Hispanic women residing in Western Massachusetts. | 1,115 | Relationship between stress and glucose intolerance. | 2.6 times increased odd of developing gestational diabetes amongst women with an increase in stress from early to mid-pregnancy. |

| | | | | |
|---|---|---|---|---|
| Hsieh, et al. 2025 | Racial diverse American pregnant women. | 2,310 | Relationship between pregnancy anxiety and the risk of gestational diabetes. | No association found between Pregnancy-Specific Anxiety and gestational diabetes. |
| Pathirana, et al. 2023 | Australian pregnant women | 1,281 | Association between poor mental health and the risk of developing gestational diabetes. | No difference in markers of poor mental health in early pregnancy between women who subsequently did or did not develop gestational diabetes. |

# Chapter 2

## Introduction

Gestational diabetes mellitus is a significant health concern, affecting approximately 5 to 10% of pregnant women in the United States [2]. This condition poses serious risks for both mother and child. For the mother, gestational diabetes increases the likelihood of developing type 2 diabetes postpartum [6], as well as being associated with a higher risk of pre-eclampsia and other adverse pregnancy outcomes [18]. For the child, the risks include macrosomia, an increased likelihood of developing diabetes later in life, and a greater risk of heart disease in adulthood [13].

Stress has been suggested as a contributing factor to the development of gestational diabetes, although findings across studies are mixed [10, 8, 15, 7, 9, 12]. However, most studies indicate that elevated stress levels are associated with an increased risk of developing the condition [10, 8, 15, 7].

Research has begun to explore the role of socio-economic factors in the development of gestational diabetes. Factors such as poverty, community resources, healthcare access, and educational attainment have all been shown to influence gestational diabetes outcomes [16, 3, 4].

This thesis specifically examines the role of educational level as a potential modifier in the relationship between perceived stress and the development of gestational diabetes using data from the nuMoM2b (Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-be) study, which included nearly 10,000 nulliparous women [5].

**Methods**

The nuMoM2b study recruited nulliparous women with no previous pregnancy lasting 20 weeks or more. Eligible women had a viable singleton gestation at enrollment, had pregnancies between 6 and 13 weeks and 6 days gestation at the first study visit, and intended to deliver at a participating hospital. The exclusion criteria included: being under 13 years old, having a history of 3 or more spontaneous abortions, having a fetal malformation evident by enrollment, having a known fetal aneuploidy, having a donor oocyte pregnancy, having a history of multifetal reduction, participating in an intervention study that was anticipated to influence maternal or fetal morbidities or mortality, having previously enrolled in nuMoM2b, having a planned pregnancy termination, or being unable to provide informed consent [5]. This study included interviews at each trimester, blood work, and medical records, yielding a comprehensive, longitudinal dataset.

All participants provided written informed consent. The study protocol was approved by the Institutional Review Board at each participating site.

Gestational diabetes was identified via medical records, based on the results of clinical glucose tolerance testing. Diagnostic criteria included at least one of the following [17]:

- A 3-hour 100g oral glucose tolerance test with ≥2 abnormal values
- A 2-hour 75g oral glucose tolerance test with ≥1 abnormal value
- A non-fasting 50g glucose challenge test with a result ≥200 mg/dL

Individuals with pregestational diabetes, as documented in medical records, were excluded from the analysis.

Perceived stress was assessed during the first trimester using the Perceived Stress Scale, a validated 10-question survey used to measure perceived psychological stress (Figure 1). Responses were rated on a 5-point Likert scale, with total scores ranging from 10 to 50, with higher scores indicating greater perceived stress.

Perceived stress was categorized into 3 levels:

1. Low level of stress: PSS Score <24
2. Moderate level of stress: PSS Score 24-36
3. High level of stress: PSS Score >36

Educational attainment was measured via self-report at baseline and categorized into three categories:

1. Lower Level: Less than high school graduate, high school graduate, or General Educational Development (GED) credential
2. Mid-Level: Some college, but no degree or associate/technical degree
3. Higher Level: Bachelor's degree or degree beyond bachelor's

Covariates included maternal age, body mass index (BMI), physical activity, and race/ethnicity, which were all assessed at the baseline visit:

- Age was categorized into 13–17, 18–24, 25–39, and ≥40 years.
- BMI was calculated from measured height and weight from the first prenatal visit and classified by standard cutoffs: underweight (<18.5), normal weight (18.5–24.9), overweight (25.0–29.9), and obese (≥30.0).

- Physical activity was self-reported and quantified as average weekly minutes. Categories were low (<150 minutes), moderate (150–299 minutes), and high (≥300 minutes), based on physical activity guidelines for Americans.
- Race/ethnicity was self-reported and classified into five groups: non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, Hispanic, and other races.

Some literature has suggested diet is a confounder for the relationship between stress and gestational diabetes. Diet was measured via a food frequency questionnaire in a subset of individuals. The percentage of total caloric intake from fat was then calculated and categorized based on National Institute of Health dietary recommendations as:

- Low (<20%),
- Moderate (20–35%), and
- High (>35%)

Additionally, stress and gestational diabetes have the potential to be confounded by poverty status, however this was only measured in a subset of the population, therefore we used this variable for a sensitivity analysis.

Poverty status was self-reported via a standardized questionnaire, and was defined using federal poverty thresholds and categorized as:

1. 200% of the federal poverty level (above low-income)
2. 100%–200% of the federal poverty level (low-income)
3. <100% of the federal poverty level (below poverty line)

Descriptive statistics were calculated stratified by gestational diabetes status. Logistic regression models were used to assess the association between maternal perceived stress and gestational diabetes, adjusting for age, BMI, physical activity, and race/ethnicity. Confounders were selected based on a Directed Acyclic Graph (DAG), informed from previous literature. A separate model was used to evaluate the association between educational attainment and gestational diabetes, adjusting for the same covariates, based on a DAG reflecting the relationship between education and gestational diabetes.

To explore effect modification, we included an interaction term between perceived stress and educational attainment in a logistic model. This model adjusted for age, BMI, physical activity, and race/ethnicity.

We conducted sensitivity analyses adjusting for dietary fat intake and poverty status, individually and in the same model. Dietary data were available for a subset of participants (n = 7,229). Analyses including poverty status but not diet had a sample size of 7,000. The subset with both diet and poverty data included 6,031 participants.

**Results**

Among nulliparous mothers, those who developed gestational diabetes were, on average, older (29.61 years old) than those who did not develop gestational diabetes (26.81 years old) (Table 2). Additionally, those who developed gestational diabetes were more likely to have a BMI categorized as obese (21.14% versus 11.48%) or morbidly obese (22.76% versus 9.19%). There were no notable differences between poverty levels or insurance types between those who developed gestational diabetes and those who did not. However, among those who developed

gestational diabetes, 10.03% identified as Asian, whereas this racial group made up only 3.65% of those without gestational diabetes. The non-Hispanic Black and non-Hispanic White groups made up similar percentages of the population with gestational diabetes and without gestational diabetes.

In our model examining perceived stress and gestational diabetes, neither high nor low levels of stress were associated with the outcome, compared to moderate stress, after adjusting for BMI, age, race/ethnicity, and physical activity (Table 3). Similarly, our model evaluating educational attainment and gestational diabetes, yielded null results when adjusting for the same covariates.

When we included an interaction term between stress and education, the relationship between high stress and gestational diabetes was null, compared to those with moderate stress (OR =0.99, 95% CI: 0.34, 2.88) among those with the higher level of education (Table 3). In this same educational category, the association between low stress and gestational diabetes was also approximately null, when compared to moderate stress levels (OR= 0.79, 95% CI: 0.59, 1.05).

Among those with mid-level education, the results for high versus moderate stress and low versus moderate stress were null after adjustment for confounders.

Among those with a lower level of education, we found approximately null results as well. Those with high stress had 1.10 (95% CI: 0.44, 2.71) times the odds of developing gestational diabetes compared to those with moderate stress levels, and women with low levels of perceived stress had 1.21 (95% CI: 0.72, 2.03) times the odds of developing gestational diabetes compared to those with moderate levels of perceived stress.

The sensitivity analyses yielded mixed results, particularly among participants with mid-level and lower-level educational attainment. When adjusting for dietary fat intake, we observed a weakly protective association for high versus moderate stress in the lower educational level group (OR = 0.73; 95% CI: 0.22, 2.50) (Table 3). However, in models adjusting for poverty alone, or for both poverty and dietary fat percentage, the direction of association reversed, for those with lower education (OR = 1.80; 95% CI: 0.68, 4.75 adjusted for poverty; OR = 1.30; 95% CI: 0.36, 4.76 adjusted for diet and poverty) which is a stronger association than what was found in our main analysis (Table 3). Among participants with mid-level education, high stress was associated with higher odds of gestational diabetes when adjusting for poverty alone (OR= 1.32, 95% CI:0.38, 4.60). Additionally, when adjusting for both poverty and dietary fat intake, low stress in the lower-level educational group was associated with higher odds of gestational diabetes compared to moderate stress levels (OR = 1.38, 95% CI: 0.68, 2.81). Overall, the sensitivity analysis results were imprecise because of the reduced sample size.

**Discussion/Conclusion**

In this analysis of data from the nuMoM2b cohort, we hypothesized that higher levels of stress would be associated with increased odds of gestational diabetes and that this association would be stronger among women with less education and weaker among women with the most education. However, in our study, the association between stress and gestational diabetes was approximately null and did not conform to our hypothesis. Across all models, including those with an interaction term with educational attainment, perceived stress was not meaningfully associated with gestational diabetes (Table 3). Educational attainment also showed no independent association with gestational diabetes.

Prior studies on stress and gestational diabetes have yielded inconsistent results but have suggested stress is associated with gestational diabetes. Our results are more consistent with the null studies. Some studies have reported positive associations using the Perceived Stress Scale, including a study in India [10] and another among Hispanic women in the U.S. [15]. However, these were conducted in different populations than ours. In contrast, the largest prior study (n=4,682), which used a life-events-based stress measure, also found null results in a U.S. cohort [14]. These differences in findings may be due to variations in population characteristics.

Studies examining educational attainment and gestational diabetes have previously found an association between the two. These studies focused on different nations (China and Netherlands) and categorized educational attainment differently [1,16]. In our cohort, we did not observe this relationship.

We conducted sensitivity analyses to assess whether unmeasured confounding by dietary fat intake or poverty status might explain the null associations observed in our main models. Among participants with lower educational attainment, when adjusting for dietary fat intake, high stress initially showed a weakly, positive association with gestational diabetes (Table 3). However, when adding adjustments for poverty, and for both poverty and dietary fat intake, the direction of this association shifted, with high stress being associated with increased odds of gestational diabetes. These changes in direction suggest that unmeasured confounding by socioeconomic or dietary factors may have influenced the associations observed. However, the wide confidence intervals in these models reflect imprecision and raise the possibility of selection bias due to reduced sample sizes in the sensitivity analyses. Despite these fluctuations in effect estimates, the overall pattern remained consistent with our primary findings of a null

association between perceived stress and the risk of gestational diabetes across educational levels.

The strengths of this study include the use of a large and geographically diverse cohort of nulliparous women across the United States. The availability of detailed demographic, dietary and clinical data allowed for adjustment of important confounders. Notably, there is strength in perceived stress being assessed prior to the diagnosis of gestational diabetes, allowing for a clearer temporal relationship between exposure and outcome.

This study also has several limitations. Although the overall cohort is large, some strata in the models had relatively small sample sizes, particularly those involving combinations of high stress and lower education, which results in wide confidence intervals and imprecise estimates. Additionally, the nuMoM2b dataset relies on self-reported data for perceived stress, dietary intake, and physical activity, which introduces the potential for information bias. Misclassification of exposure due to measurement error in self-reported stress could have obscured true associations. Furthermore, residual confounding may remain despite adjustment for education, poverty, and dietary fat intake, particularly with respect to unmeasured environmental or behavioral factors.

**Public Health Implications**

This research adds to the literature on perceived stress and gestational diabetes. However, it does not suggest an association between stress levels and the risk of developing gestational diabetes. Gestational diabetes is associated with an increased risk of postpartum type 2 diabetes. Therefore, future research may evaluate whether the risk of postpartum type 2 diabetes increases

with higher vs. lower stress levels during pregnancy among women with gestational diabetes. If such an association were substantiated, then it could be used to help identify which women with gestational diabetes were at highest risk of postpartum type 2 diabetes.

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**Tables and Figures**

| |
|---|
| In the last month, how often have you been upset because of something that happened unexpectedly? |
| In the last month, how often have you felt that you were unable to control the important things in your life? |
| In the last month, how often have you felt nervous and 'stressed'? |
| In the last month, how often have you felt confident about your ability to handle your personal problems? |
| In the last month, how often have you felt that things were going your way? |
| In the last month, how often have you found that you could not cope with all the things that you had to do? |
| In the last month, how often have you been able to control irritations in your life? |
| In the last month, how often have you felt that you were on top of things? |
| In the last month, how often have you been angered because of things that were outside of your control? |
| In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? |

Figure 1. Validated, 10 -Item Perceived Stress Scale Questionnaire administered to mothers at their first trimester visit, used to determine perceived stress levels.

Table 2. Demographic and Health-Related Characteristics of study participants with gestational diabetes (n=369) and those with no gestational diabetes (n=8173)

| | **Gestational Diabetes N (%)** *369 (4.31%) | **No Gestational Diabetes (excluding those with diabetes prior to pregnancy) N (%)** *8173(95.69%) |
|---|---|---|
| **Age category at visit 1:** | | |
| 13-17 | 2 (0.54%) | 205 (2.51%) |
| 18-34 | 287(77.78%) | 7256 (88.78%) |
| 35-39 | 62(16.80%) | 610(7.46%) |
| >=40 | 18(4.88%) | 102 (1.25%) |
| **Body Mass Index (BMI)** | | |
| <18.5 (underweight) | 8 (2.17%) | 189 (2.31%) |
| 18.5-<25 (normal weight) | 107(29.00%) | 4265 (52.18%) |
| 25-<30(overweight) | 92 (24.93%) | 2030(24.84%) |
| 30-<35 (obese) | 78 (21.14%) | 938(11.48%) |
| >-=35 (morbidly obese) | 84 (22.76%) | 751(9.19%) |
| **Poverty Categories** | | |
| >200% of fed poverty level | 224 (60.70%) | 4677 (57.23%) |
| 100-200% of fed poverty level | 47 (12.74%) | 953 (11.66%) |
| <100% of fed poverty level | 44 (11.92%) | 1055 (12.91%) |

| | | |
|---|---|---|
| Missing | 54 (14.63%) | 1488 (18.21%) |
| **Insurance payment:** | | |
| Government | 101 (27.37%) | 2273 (28.00%) |
| Military | 3 (0.81%) | 52 (0.64%) |
| Commercial | 249 (67.48%) | 5583 (68.77%) |
| Personal income | 61 (16.53%) | 1419 (17.48%) |
| Other | 6 (1.63%) | 110 (1.36%) |
| **Race:** | | |
| Non-Hispanic White | 203 (55.01%) | 5057 (61.87%) |
| Non-Hispanic Black | 39 (10.57%) | 1068 (13.07%) |
| Hispanic | 68 (18.88%) | 1341(16.41%) |
| Non-Hispanic, Asian | 37 (10.03%) | 298 (3.65%) |
| Other Race & Ethnicity | 22 (5.96%) | 409 (5.00%) |
| **Education** | | |
| Less than high school grad | 22 (5.96%) | 651 (7.97%) |
| High school graduate or GED | 45 (12.20%) | 943 (11.54%) |
| Some college | 75 (20.33%) | 1572 (19.23%) |
| Associate's/Technical degree | 39 (10.57%) | 824 (10.08%) |
| Completed college | 91 (24.66%) | 2294 (28.07%) |
| Degree work beyond college | 97 (26.29%) | 1889 (23.11%) |

Table 3. Crude and adjusted odds ratios of gestational diabetes.

| | Education Level | Perceived Stress | N | OR | 95% CI |
|---|---|---|---|---|---|
| **Adjusted, no interaction term** | | High | 291 | 0.96 | 0.54-1.71 |
| | | Moderate | 3229 | 1.00 | |
| | | Low | 5022 | 0.88 | 0.71-1.09 |
| **Adjusted, no interaction term** | Higher-Level | | 5234 | 0.95 | 0.73-1.24 |
| | Middle-Level | | 1647 | 1.00 | |
| | Lower-Level | | 1661 | 0.88 | 0.71-1.09 |
| **Unadjusted, with interaction term** | Higher-Level | High | 72 | 1.10 | 0.39-3.08 |
| | | Moderate | 1589 | 1.00 | |
| | | Low | 3573 | 0.79 | 0.57-1.00 |
| | Middle-Level | High | 70 | 0.90 | 0.27-3.00 |
| | | Moderate | 766 | 1.00 | |
| | | Low | 811 | 0.94 | 0.59-1.52 |
| | Lower- Level | High | 149 | 1.10 | 0.45-2.68 |
| | | Moderate | 874 | 1.00 | |
| | | Low | 638 | 1.25 | 0.75-2.08 |
| **Adjusted, with interaction term** | Higher-Level | High | 72 | 0.99 | 0.34-2.88 |
| | | Moderate | 1589 | 1.00 | |
| | | Low | 3573 | 0.79 | 0.59-1.05 |
| | Middle-Level | High | 70 | 1.01 | 0.30-3.42 |
| | | Moderate | 766 | 1.00 | |

| | | | | | |
|---|---|---|---|---|---|
| | | Low | 811 | 1.00 | 0.62-1.62 |
| | Lower- Level | High | 149 | 1.10 | 0.44-2.71 |
| | | Moderate | 874 | 1.00 | |
| | | Low | 638 | 1.21 | 0.72-2.03 |
| **Sensitivity** | Higher-Level | High | 54 | 1.06 | 0.31-3.61 |
| **analysis: diet** | | Moderate | 1363 | 1.00 | |
| | | Low | 3205 | 0.83 | 0.61-1.14 |
| | Middle-Level | High | 53 | 0.86 | 0.20-3.77 |
| | | Moderate | 612 | 1.00 | |
| | | Low | 662 | 1.09 | 0.65-1.83 |
| | Lower- Level | High | 104 | 0.73 | 0.22-2.50 |
| | | Moderate | 668 | 1.00 | |
| | | Low | 508 | 1.27 | 0.73-2.24 |
| **Sensitivity** | Higher-Level | High | 63 | 1.12 | 0.38-3.29 |
| **analysis: poverty** | | Moderate | 1448 | 1.00 | |
| | | Low | 3400 | 0.80 | 0.60-1.08 |
| | Middle-Level | High | 57 | 1.32 | 0.38-4.60 |
| | | Moderate | 531 | 1.00 | |
| | | Low | 588 | 1.04 | 0.59-1.84 |
| | Lower- Level | High | 88 | 1.80 | 0.68-4.75 |
| | | Moderate | 493 | 1.00 | |
| | | Low | 332 | 1.27 | 0.65-2.50 |

| | | | | | |
|---|---|---|---|---|---|
| **Sensitivity** | Higher-Level | High | 47 | 1.17 | 0.34-4.08 |
| **analysis: diet &** | | Moderate | 1247 | 1.00 | |
| **poverty** | | Low | 3048 | 0.84 | 0.61-1.16 |
| | Middle-Level | High | 44 | 1.08 | 0.24-4.88 |
| | | Moderate | 433 | 1.00 | |
| | | Low | 492 | 1.13 | 0.62-2.06 |
| | Lower- Level | High | 54 | 1.30 | 0.36-4.76 |
| | | Moderate | 397 | 1.00 | |
| | | Low | 269 | 1.38 | 0.68-2.81 |