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Intimate Partner Violence and Gestational Weight Gain in a Population-Based Sample of Perinatal Women

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Abstract

Objective—To examine the effects of intimate partner violence (IPV) at varied time points in the perinatal period on inadequate and excessive gestational weight gain.

Design—Retrospective cohort using population-based secondary data.

Setting—Pregnancy Risk Assessment Monitoring System and birth certificate data, including New York City and 35 states.

Participants—Data were obtained for 251,342 U.S. mothers who gave birth from 2004–2011 and completed the Pregnancy Risk Assessment Monitoring System survey 2–9 months after birth.

Methods—The exposure was perinatal IPV, defined as experiencing physical abuse by a current or ex-partner in the year before or during pregnancy. Adequacy of gestational weight gain (GWG) was categorized using 2009 Institute of Medicine guidelines. Weighted descriptive statistics and multivariate logistic regression models were used.

Results—Approximately 6% of participants reported perinatal IPV, 2.7% of participants reported IPV in the year before pregnancy, 1.1% reported IPV during pregnancy only, and the remaining 2.5% reported IPV before and during pregnancy. Inadequate GWG was more prevalent among participants who experienced IPV during pregnancy and those who experienced IPV before and

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during pregnancy (23.3% and 23.5%, respectively) than in participants who reported no IPV (20.2%; $P < 0.001$). Participants who experienced IPV before pregnancy only were significantly more likely to have excessive GWG ($P < 0.001$). Results were attenuated in the multivariate modeling; only participants who experienced IPV before pregnancy had weakly significant odds of excessive GWG (aOR 1.14, 95% CI 1.02–1.26).

Conclusions—The association between perinatal IPV with inadequate GWG was explained by confounding variables; however, women who reported perinatal IPV had higher rates of GWG outside of the optimal range. Future studies are needed to determine how relevant confounding variables may affect a woman's gestational weight gain.

Precis

Through a greater understanding of the relationship between intimate partner violence and gestational weight gain, interventions can be developed to promote maternal and child health.

Keywords

Intimate partner violence; gestational weight gain; PRAMS

Gestational weight gain (GWG) is an important predictor of immediate and future health of a pregnant woman and her infant (Siega-Riz et al., 2009). Specifically, excessive GWG is associated with an increased risk of large-for-gestational age infants, cesarean delivery, postpartum complications, postpartum weight retention, and childhood obesity (American College of Obstetricians and Gynecologists, 2013; Durie, Thornburg, & Glantz, 2011; Rasmussen, Catalano, & Yaktine, 2009; Salihu, Weldelesasse, Rao, Marty, & Whiteman, 2011). GWG recommendations aim to optimize health outcomes for the woman and the infant. In 2009, The Institute of Medicine (IOM) released revised GWG guidelines, based on pre-pregnancy body mass index (BMI) ranges for underweight, normal weight, overweight, and obese women. The recommendations include a weight gain of 28–40 pounds for women who are underweight (BMI <18.5), 25–35 pounds for normal weight (BMI 18.5–24.9) women, 15–25 pounds for overweight (BMI 25–29.9) women, and 11–20 pounds for obese (BMI ≥ 30) women (Rasmussen et al., 2009). Despite these recommendations, research findings suggests that up to 84% of overweight and 74% of obese pregnant women gain more than the recommended amount (Johnson et al., 2013).

The determinants of gestational weight gain are multifactorial involving biological, social, psychological, and environmental factors and the interactions among them (Hill et al., 2013). For example, the strongest predictor appears to be pregravid BMI, perhaps because women with a high BMI are already on the trajectory of gaining more weight (Davis, Stange, & Horwitz, 2012; Webb, Siega-Riz, & Dole, 2009). Age is also a determinant, with younger women gaining more weight than older, but older women entering pregnancy at a higher BMI. Evidence also exists that GWG decreases with higher parity (Siega-Riz et al., 2009). In the psychological domain, women with lower self-esteem, more anxiety or depression, and under more stress due to multiple factors, including experiencing intimate partner violence, have higher weight gains, in some but not all studies, in part due to coping mechanisms that use food for soothing (Alhusen, Ayres, & DePriest, 2016; Laraia, Siega-

Riz, Dole, & London, 2009). For some women, these unstable psychological conditions can contribute to loss of appetite and/or increased metabolic activity that results in inadequate weight gain. Given the interconnectedness of these factors during a state where one is encouraged to gain weight anyway, understanding what is the actual driver for adequacy of weight gain that we should intervene upon is rather complex and perplexing.

CALLOUT 1

Intimate partner violence (IPV) during pregnancy is a significant public health issue associated with negative outcomes for women and children (Silverman, Decker, Reed, & Raj, 2006). Research suggests between 3%-9% of women experience IPV during pregnancy, though there are well-established risk factors associated with higher rates of abuse, including young age, single marital status, less education, and low socio-economic status (Alhusen, Lucea, Bullock & Sharps, 2013; Alhusen, Ray, Sharps, & Bullock, 2015; Martin, Mackie, Kupper, Buescher, & Moracco, 2001; Saltzman, Johnson, Gilbert, & Goodwin, 2003; Vest, Catlin, Chen, & Brownson, 2002). Research examining the association between IPV and GWG is quite limited, and largely contained to small, community samples with results suggesting an association between IPV and inadequate GWG (Kearney, Munro, Kelly, & Hawkins, 2004; Parker, McFarlane, & Soeken, 1994). Drawing from the Oklahoma Pregnancy Risk Assessment Monitoring Survey (PRAMS), researchers found that IPV around the time of pregnancy was associated with both excessive and inadequate GWG among women 35 years and older (Beydoun, Tamim, Lincoln, Dooley, & Beydoun, 2011). Thus, the population-level patterns of IPV and GWG remain unclear. We advance this knowledge base through analysis of U.S. population-based data to examine the association between IPV and GWG.

Methods

We analyzed data from the 2004 – 2011 Pregnancy Risk Assessment Monitoring System (PRAMS), an ongoing multi-state surveillance project conducted by the United States Centers for Disease Control and Prevention (CDC) in collaboration with participating state health departments. Per CDC guidelines, data are released for states meeting a minimum response rate, specifically 70% for 2004 – 2006, and 65% for 2007 – 2011. Our analysis includes data from New York City and 35 states.

PRAMS utilizes stratified systematic random sampling of 100 – 250 mothers who delivered a live birth from participating states each month, employing birth certificates as the sampling frame, and oversamples high-risk populations including women who delivered low birthweight infants. Self-reported survey responses are linked to birth certificate data. Weighting accounts for survey design, nonresponse, and the potential for clustering around particular hospitals, counties, or time of year. Further information is available on PRAMS methodology via the implementation manual (Centers for Disease Control and Prevention, 2007).

Sample

Of a total 323,926 participants, 2.3% (n=7,500) was excluded for lack of data on IPV. An additional 10.8% of participants (n= 34,082) lacked data on pre-pregnancy BMI or GWG. Of those remaining, 11.0% (n= 31,002) were excluded for missing data on one or more potential confounders resulting in a final sample size of 251,342 (see Figure 1).

Measures

Exposure variables—The exposure was self-reported perinatal IPV, defined as being pushed, hit, slapped, kicked, choked, or physically hurt by a husband or partner during the year before pregnancy or during pregnancy. 2004–2008 data referred to current or former husband or partner, whereas 2009–2011 data referred to current husband or partner only. Four exposure categories were created based on timing of IPV: IPV only during the year before pregnancy, IPV only during pregnancy, IPV during the year before pregnancy and during pregnancy, or no IPV.

Control variables—Potential confounders were selected a priori based on documented associations with perinatal IPV and GWG and included maternal age, race/ethnicity, years of formal education, marital status, income, smoking during the last three months of pregnancy, adequacy of prenatal care as defined by the Kotelchuck's Adequacy of Prenatal Care Utilization (APNCU) Index, and pre-pregnancy BMI. The APNCU index is a composite of two adequacy dimensions: when prenatal care was initiated and frequency of visits. Inadequate care is defined as prenatal care beginning after the fourth month or making less than 50% of expected visits. Intermediate care begins in the fourth month and receiving between 50% and 79% of expected visits. Adequate care begins in the fourth month and receiving 80% to 109% of expected visits. Adequate plus begins in the fourth month and completing 110% or more of expected visits (Kotelchuck, 1994). Data on maternal age, race/ethnicity, years of formal education, marital status, and adequacy of prenatal care were obtained from the birth certificate data. Data on income and smoking were collected from the PRAMS survey. Income was categorized as <100%, 101–200%, or >200% of the HHS federal poverty guideline by year, state, and family size, using the year prior to the birth of the infant and family size (including the infant) reported in the PRAMS survey.

Outcome variables—The outcome was GWG defined as inadequate, normal, or excessive, taking into account pre-pregnancy BMI category, as recommended by the 2009 IOM guidelines. Pre-pregnancy BMI data were obtained from the PRAMS survey and categorized as underweight, normal, overweight, or obese. Gestational weight gain data were obtained from the birth certificate. Pre-pregnancy BMI values less than 13 or greater than 70 were coded as missing as is convention with PRAMS data.

Data Analysis

To account for the complex survey design, survey weights designed by CDC PRAMS were applied in all statistical analyses. The survey weights take into account oversampling, nonresponse, and the potential for clustering around particular hospitals, counties, or time of year, and yield results that represent the total population of mothers who delivered a live neonate in the areas and time periods under study. Prevalence and 95% confidence intervals

(CI) of perinatal IPV exposure categories and GWG categories in the total population were calculated. The distributions of GWG and other covariates were calculated in the total population and within perinatal IPV exposure categories using column percentages. Bivariate associations between perinatal IPV exposure and other variables were assessed using the Pearson Chi-squared statistic with Rao and Scott's correction for survey design. Column percentages by GWG category were obtained for the exposure variable and covariates. The odds of inadequate GWG compared to normal GWG were calculated by levels of each variable, and the same procedure was carried out to compare the odds of excessive GWG to normal GWG. Multivariate logistic regression was used to estimate the odds of inadequate GWG compared to normal GWG, adjusted for all covariates. Similarly, multivariate logistic regression was used to estimate the odds of excessive GWG compared to normal GWG, adjusted for all covariates. All analyses were carried out using STATA 13.0 software. A significance threshold of $p < 0.05$ was used for all statistical analyses. The University of Virginia Institutional Review Board reviewed the study protocol, and qualified the study as exempt research given its utilization of publicly available, de-identified surveillance data.

Results

Sample Characteristics

Participant demographic and obstetric characteristics overall and by timing of IPV exposure are shown in Table 1. Approximately 6% of participants who gave birth to live neonates reported perinatal IPV (i.e., in the year before pregnancy, during pregnancy, or both), 2.7% reported IPV in the year before pregnancy, 1.1% reported IPV during pregnancy only, and the remaining 2.5% reported IPV before and during pregnancy. Participants who experienced IPV were significantly more likely to be single, younger, have less than high school education, and have incomes $< 100\%$ below the federal poverty guideline (all $P < 0.001$). Further, a disproportionately high representation of Black non-Hispanic women experienced IPV.

With regards to obstetric characteristics, inadequate GWG was more prevalent among participants who experienced IPV during pregnancy and those experienced IPV before and during pregnancy (23.3% and 23.5%, respectively) than among participants who reported no IPV (20.2%; $P < 0.001$). Participants who experienced IPV before pregnancy only were significantly more likely than all other groups to have excessive gestational weight gain ($P < 0.001$). Smoking during the last three months of pregnancy was also significantly more prevalent among participants who reported IPV during any of the three time periods than among their non-abused counterparts (all $P < 0.001$). Participants who experienced IPV during any of the three time periods were significantly more likely to report inadequate prenatal care than their non-abused counterparts (all $P < 0.001$). Finally, there were significant differences in pre-pregnancy BMI classification by IPV status. Specifically, participants who experienced IPV at any of the three time periods were significantly more likely to be underweight or obese than their non-abused counterparts.

Sample Characteristics by Gestational Weight Gain

Patterns of GWG differed by IPV status (Table 2). Compared to participants who did not report perinatal IPV, the odds of inadequate GWG were significantly higher among participants who reported IPV before pregnancy only (OR = 1.15, 95% CI 1.02 – 1.29), and among participants who reported IPV both before and during pregnancy (OR = 1.29, 95% CI 1.15 – 1.45). With regards to excessive GWG, participants who reported IPV before pregnancy were significantly more likely to report excessive GWG than participants who did not report perinatal IPV (OR = 1.21, 95% CI 1.09 – 1.33).

Several demographic characteristics were also significantly associated with patterns of GWG. Specifically, compared to White non-Hispanic women, the odds of inadequate GWG was significantly higher among Black non-Hispanic women (OR = 1.59, 95% CI 1.51 – 1.67), Hispanic women (OR = 1.31, 95% CI 1.23 – 1.39), American Indian/Alaska Native non-Hispanic women (OR = 1.37, 95% CI 1.20 – 1.55) and Asian non-Hispanic women (OR = 1.16, 95% CI 1.09 – 1.25). The risk of excessive GWG was significantly higher among Black non-Hispanic women (OR = 1.12, 95% CI 1.07 – 1.17) and American Indian/Alaska Native non-Hispanic women (OR = 1.19, 95% CI 1.07 – 1.33). Compared to White non-Hispanic women, Asian non-Hispanic women were significantly less likely to report excessive gestational weight gain (OR = 0.58, 95% CI 0.54 – 0.61). Receiving less than a high school education (OR = 1.52, 95% CI 1.44 – 1.60), reporting an income <100% (OR = 1.67, 95% CI 1.61 – 1.75) or 101–200% (OR = 1.33, 95% CI 1.27 – 1.39) of the federal poverty guidelines, and not being married (OR = 1.44, 95% CI 1.39 – 1.50) were all significantly associated with an increased odds of inadequate GWG. Similarly, reporting an income <100% (OR = 1.15, 95% CI 1.11 – 1.19) or 101–200% (OR = 1.10, 95% CI 1.06 – 1.14) of the federal poverty guidelines, and not being married (OR = 1.27, 95% CI 1.23 – 1.31) were all significantly associated with an increased odds of excessive GWG.

Smoking during the last three months of pregnancy conferred a 1.36 (95% CI 1.29 – 1.44) times increased odds of inadequate GWG and a 1.13 (95% CI 1.08, 1.18) times increased odds of excessive GWG as compared to non-smokers. Adequacy of prenatal care was also significantly associated with GWG. Specifically, compared to participants who reported adequate prenatal care, those who reported inadequate (OR 1.84; 95% CI 1.73–1.95), intermediate (OR 1.17; 95% CI 1.10–1.24) or adequate plus (OR 1.20; 95% CI 1.15, 1.25) prenatal care were all significantly more likely to report inadequate GWG. Adequacy of prenatal care was not consistently associated with excessive GWG. Finally, pre-pregnancy BMI was strongly associated with adequacy of gestational weight gain. As compared to participants with normal pre-pregnancy BMIs, underweight and obese participants were approximately 1.4 times more likely to report inadequate GWG. The odds of excessive GWG was approximately 2.6 times higher among obese and overweight participants than those with normal pre-pregnancy BMIs.

Multivariate logistic regression models for the effect of perinatal IPV on inadequate and excessive GWG, respectively, are presented in Table 3. After adjusting for maternal age, race/ethnicity, education, income, marital status, smoking during the last three months of pregnancy, adequacy of prenatal care, and pre-pregnancy BMI, the association between experiencing IPV at any of the three time points and inadequate GWG attenuated to

nonsignificance. Similarly, the association between experiencing IPV during pregnancy or both before and during pregnancy and excessive GWG attenuated to nonsignificance. Participants who experienced IPV before pregnancy had a significantly increased odds of excessive GWG after adjusting for confounders (aOR 1.14, 95% CI 1.02–1.26).

Discussion

The purpose of our study was to examine the effect of experiencing IPV, at varied time points in the perinatal period, on adequacy of GWG. After controlling for potential confounders, experiencing IPV before, during, or both before and during pregnancy was not significantly associated with inadequate GWG. Results suggest experiencing IPV before pregnancy was significantly associated with a slightly increased odds of excessive GWG, after controlling for potential confounders.

Taken together, our results suggest that the association between perinatal IPV with inadequate or GWG was explained by the confounding variables. Our results are similar to Beydoun et al. (2011) who did not find a significant relationship between perinatal IPV and adequacy of GWG among women <35 years of age. However, when stratifying by age, Beydoun et al. (2011) found a significant association between perinatal IPV and adequacy of GWG among women aged 35 and older. Importantly, pre-pregnancy BMI was controlled for in the final model.

Several researchers found a significant association between perinatal IPV and adequate GWG. Among a sample of 394 women in Rio de Janeiro, researchers found more severe IPV to be significantly associated with inadequate GWG, after controlling for several demographic characteristics as well as tobacco, alcohol, and illicit drug use (Moraes, Amorim, & Reichenheim, 2006). Using a matched retrospective cohort design, researchers found an increased risk of both inadequate and excessive gestational weight gain among adult women reporting a history of physical or sexual abuse. When stratified by age, there was not an increased risk among teenagers reporting a history of past or current abuse. Importantly, the final models did not adjust for smoking (Johnson, Hellerstedt, & Pirie, 2002). Finally, among a large sample of Hispanic women ($n = 4,791$) attending public prenatal clinics in California, IPV was associated with a significantly increased risk of poor GWG among overweight and obese women but not among under- or normal weight women (Siega-Riz & Hobel, 1997).

Accumulating evidence supports of the linkages among prenatal stress and poor psychosocial, birth, and developmental outcomes for mothers and their offspring (Beydoun et al., 2011; Monk, Spicer, & Champagne, 2012). IPV reflects a significant stressor during the perinatal period. Less studied is how women deal with psychosocial stress in terms of lifestyle behaviors such as eating, sleeping, and physical activity. Women who have experienced IPV utilize various coping strategies in an attempt to mitigate the impact of abuse in their lives. Smoking is one such maladaptive coping strategy used to reduce symptoms of anxiety and depression. In the final model of our analysis, smoking during the last three months of pregnancy remained a significant predictor of inadequate GWG. Research findings support that women who experience perinatal IPV are significantly more

likely to sustain smoking into the last three months of pregnancy than their non-abused counterparts (Cheng, Salimi, Terplan, & Chisolm, 2015).

Several other variables may confound or mediate the relationship between perinatal IPV and GWG that are not routinely collected through PRAMS, including but not limited to substance use and sleep disturbances. Researchers have demonstrated that women experiencing perinatal IPV are more likely to use alcohol, marijuana, and other illicit substances during pregnancy than their non-abused counterparts, perhaps in an attempt to self-medicate the physical and psychological trauma associated with abuse during pregnancy (Alhusen, Lucea, Bullock, & Sharps, 2013; Bailey & Daugherty, 2007; Udo, Lewis Lmft, Tobin, & Ickovics, 2016). With regards to sleep, researchers found that women experiencing perinatal IPV during the perinatal period were more than twice as likely to report stress-related sleep disturbance and poor sleep quality during pregnancy than their non-abused counterparts (Sanchez, Islam, Zhong, Gelaye, & Williams, 2016). Given the links between poor sleep and GWG, sleep disturbance may be an important mechanism that underlies the lasting adverse effects of IPV on maternal health (Abeysena & Jayawardana, 2011; Althuisen, van Poppel, Seidell, & van Mechelen, 2009).

In our study, women reporting receiving inadequate levels of prenatal care were more than 1.5 times likely to have inadequate GWG as compared to women reporting receiving adequate levels of prenatal care. Receipt of prenatal care may also serve as an important explanatory variable in the relationship between IPV and GWG. Women who experience IPV during pregnancy are twice as likely to miss prenatal care appointments or initiate prenatal care later than recommended (Chambliss, 2008; Goodwin, Gazmararian, Johnson, Gilbert, & Saltzman, 2000; Subramanian et al., 2012). Importantly, women experiencing IPV are twice as likely to not initiate prenatal care until the third trimester (Goodwin et al., 2000). Additional research, particularly qualitative in nature, is needed to better understand the relationship between IPV and receipt of prenatal care.

Consistent with other research findings, our results suggest several maternal characteristics, including maternal age, race/ethnicity, education, and income were associated with an increased risk for both inadequate and excessive gestational weight gain (Cohen et al., 2016; Samura et al., 2016). Associations between sociodemographic factors and GWG are complex, and further studies are needed to explore the multifaceted relationships between these factors. The role of health literacy and prenatal education may provide an enhanced understanding of the role of sociodemographic characteristics and GWG.

Implications for Practice

Gestational weight gain is a significant issue given its association with maternal, fetal, neonatal, and early childhood outcomes. Our study demonstrated the role that IPV may play in GWG, both through direct effects as well as through hypothesized confounding variables. Screening for IPV is an important first step in identifying women who may be at heightened risk for inadequate or excessive GWG. Multiple organizations, including the U.S. Preventive Services Task Force, have endorsed the recommendation to incorporate IPV screening and treatment into prenatal care yet screening rates remain relatively low (ACOG committee opinion no. 518: Intimate partner violence.2012; Taft et al., 2013). Prenatal care offers a

unique window of opportunity for nurses and other health care professionals to foster trusting relationships with pregnant women through repeated contacts. For many women, pregnancy is the only time they engage regularly with the health care system further highlighting the need to establish a trusting patient-provider relationship (McFarlane, Groff, O'Brien, & Watson, 2006).

If a women screens positive for IPV, an enhanced assessment of how she is coping with the violence and its related stressors would be an important consideration based upon the current study findings. An improved understanding of nutritional intake, including the types of food she is eating, difficulties with adhering to GWG recommendations, and any concerns regarding GWG may help elucidate the biopsychosocial mechanisms by which IPV exerts its effect on maternal health.

Limitations—There were several limitations in the current study. First, the PRAMS IPV assessment is limited to experiencing physical abuse, though research supports an association between psychological and sexual abuse with adverse health behaviors and outcomes (Gisladdottir et al., 2014). As with all self-reported data, reporting and recall biases may generate misclassification. Pre-pregnancy BMI and gestational weight gain data may suffer inaccuracies related to maternal recall. Finally, data on substance use and mental health disorders during pregnancy, both important predictors of GWG, are limited in PRAMS.

Conclusion

Our study provides important insights into possible pathways by which experiencing perinatal IPV may influence GWG. Screening for violence and its related sequelae is an important first step in improving maternal and child health outcomes. All women screening positive or at-risk for IPV should receive services at the time of the visit, either through a brief intervention (e.g., counseling) or through an appropriate referral system. Nurses are uniquely positioned to assist women experiencing perinatal IPV given the nature of the patient-provider relationship as well as the repeated contacts during this time period.

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References

- Abeysena C, Jayawardana P. Sleep deprivation, physical activity and low income are risk factors for inadequate weight gain during pregnancy: A cohort study. *The Journal of Obstetrics and Gynaecology Research*. 2011; 37(7):734–740. [PubMed: 21736667]
- ACOG committee opinion no. 518: Intimate partner violence. *Obstetrics and Gynecology*. 2012; 119(2 Pt 1):412–417. [PubMed: 22270317]
- Alhusen JL, Ayres L, DePriest K. Effects of maternal mental health on engagement in favorable health practices during pregnancy. *Journal of Midwifery & Women's Health*. 2016; 61:210–216.

- Alhusen JL, Ray E, Sharps P, Bullock L. Intimate partner violence during pregnancy: Maternal and neonatal outcomes. *Journal of Women's Health*. 2015; 24:100–106.
- Alhusen JL, Lucea MB, Bullock L, Sharps P. Intimate partner violence, substance use, and adverse neonatal outcomes among urban women. *The Journal of Pediatrics*. 2013; 163:471–476. [PubMed: 23485028]
- Althuisen E, van Poppel MN, Seidell JC, van Mechelen W. Correlates of absolute and excessive weight gain during pregnancy. *Journal of Women's Health* (2002). 2009; 18(10):1559–1566.
- American College of Obstetricians and Gynecologists. ACOG committee opinion no. 549: Obesity in pregnancy. *Obstetrics and Gynecology*. 2013; 121(1):213–217. doi:<http://10.1097/01.AOG.0000425667.10377.60>. [PubMed: 23262963]
- Bailey BA, Daugherty RA. Intimate partner violence during pregnancy: Incidence and associated health behaviors in a rural population. *Maternal and Child Health Journal*. 2007; 11(5):495–503. [PubMed: 17323125]
- Beydoun HA, Tamim H, Lincoln AM, Dooley SD, Beydoun MA. Association of physical violence by an intimate partner around the time of pregnancy with inadequate gestational weight gain. *Social Science & Medicine*. 2011; 72(6):867–873. Retrieved from <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med5&AN=21324411>. [PubMed: 21324411]
- Centers for Disease Control and Prevention. Pregnancy risk assessment monitoring system (PRAMS) implementation manual. Atlanta, Georgia: Centers for Disease Control and Prevention; 2007.
- Chambliss LR. Intimate partner violence and its implication for pregnancy. *Clinical Obstetrics and Gynecology*. 2008; 51(2):385–397. [PubMed: 18463468]
- Cheng D, Salimi S, Terplan M, Chisolm MS. Intimate partner violence and maternal cigarette smoking before and during pregnancy. *Obstetrics and Gynecology*. 2015; 125(2):356–362. [PubMed: 25568990]
- Cohen AK, Kazi C, Headen I, Rehkopf DH, Hendrick CE, Patil D, Abrams B. Educational attainment and gestational weight gain among U.S. mothers. *Womens Health Issues*. 2016; 26:460–467. [PubMed: 27372419]
- Davis EM, Stange KC, Horwitz RI. Childbearing, stress and obesity disparities in women: A public health perspective. *Maternal and Child Health Journal*. 2012; 16(1):109–118. [PubMed: 21088987]
- Durie DE, Thornburg LL, Glantz JC. Effect of second-trimester and third-trimester rate of gestational weight gain on maternal and neonatal outcomes. *Obstetrics and Gynecology*. 2011; 118(3):569–575. [PubMed: 21860285]
- Gisladdottir A, Harlow BL, Gudmundsdottir B, Bjarnadottir RI, Jonsdottir E, Aspelund T, Valdimarsdottir UA. Risk factors and health during pregnancy among women previously exposed to sexual violence. *Acta Obstetrica Et Gynecologica Scandinavica*. 2014; 93(4):351–358. [PubMed: 24490826]
- Goodwin MM, Gazmararian JA, Johnson CH, Gilbert BC, Saltzman LE. Pregnancy intendedness and physical abuse around the time of pregnancy: Findings from the pregnancy risk assessment monitoring system, 1996–1997. *Maternal and Child Health Journal*. 2000; 4(2):85–92. [PubMed: 10994576]
- Hill B, Skouteris H, McCabe M, Milgrom J, Kent B, Herring SJ, Gale J. A conceptual model of psychosocial risk and protective factors for excessive gestational weight gain. *Midwifery*. 2013; 29(2):110–114. [PubMed: 23159235]
- Johnson J, Clifton RG, Roberts JM, Myatt L, Hauth JC, Spong CY. Human Development (NICHD) Maternal-Fetal Medicine Units (MFMU) Network. Pregnancy outcomes with weight gain above or below the 2009 Institute of Medicine guidelines. *Obstetrics and Gynecology*. 2013; 121(5):969–975. [PubMed: 23635732]
- Johnson PJ, Hellerstedt WL, Pirie PL. Abuse history and nonoptimal prenatal weight gain. *Public Health Reports*. 2002; 117(2):148–1569. Retrieved from <http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip&db=c8h&AN=106804280&site=ehost-live>. [PubMed: 12356999]
- Kearney MH, Munro BH, Kelly U, Hawkins JW. Health behaviors as mediators for the effect of partner abuse on infant birth weight. *Nursing Research*. 2004; 53(1):36–45. [PubMed: 14726775]
- Kotelchuck M. The adequacy of prenatal care utilization index: Its US distribution and association with low birthweight. *Am J Public Health*. 1994; 84(9):1486–1489. [PubMed: 8092377]

- Laraia BA, Siega-Riz AM, Dole N, London E. Pregravid weight is associated with prior dietary restraint and psychosocial factors during pregnancy. *Obesity* (Silver Spring, Md.). 2009; 17(3): 550–558.
- Martin SL, Mackie L, Kupper LL, Buescher PA, Moracco KE. Physical abuse of women before, during, and after pregnancy. *JAMA: The Journal of the American Medical Association*. 2001; 285(12):1581–1584. [PubMed: 11268265]
- McFarlane JM, Groff JY, O'Brien JA, Watson K. Secondary prevention of intimate partner violence: A randomized controlled trial. *Nursing Research*. 2006; 55(1):52–61. [PubMed: 16439929]
- Monk C, Spicer J, Champagne FA. Linking prenatal maternal adversity to developmental outcomes in infants: The role of epigenetic pathways. *Development and Psychopathology*. 2012; 24(4):1361–1376. [PubMed: 23062303]
- Moraes CL, Amorim AR, Reichenheim ME. Gestational weight gain differentials in the presence of intimate partner violence. *International Journal of Gynaecology & Obstetrics*. 2006; 95(3):254–260. Retrieved from <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med5&AN=17069816>. [PubMed: 17069816]
- Parker B, McFarlane J, Soeken K. Abuse during pregnancy: Effects on maternal complications and infant birth weight in adult and teen women. *Obstetrics & Gynecology*. 1994; 84:323–328. [PubMed: 8058224]
- Rasmussen KM, Catalano PM, Yaktine AL. New guidelines for weight gain during pregnancy: What obstetrician/gynecologists should know. *Current Opinion in Obstetrics & Gynecology*. 2009; 21(6):521–526. [PubMed: 19809317]
- Salihu HM, Weldeleselasse HE, Rao K, Marty PJ, Whiteman VE. The impact of obesity on maternal morbidity and feto-infant outcomes among macrosomic infants. *The Journal of Maternal-Fetal & Neonatal Medicine : The Official Journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstetricians*. 2011; 24(9):1088–1094.
- Saltzman LE, Johnson CH, Gilbert BC, Goodwin MM. Physical abuse around the time of pregnancy: An examination of prevalence and risk factors in 16 states. *Maternal and Child Health Journal*. 2003; 7(1):31–43. [PubMed: 12710798]
- Samura T, Steer J, Michelis LD, Carroll L, Holland E, Perkins R. Factors associated with excessive gestational weight gain: review of current literature. *Global Advances in Health and Medicine*. 2016; 5:87–93. [PubMed: 26937318]
- Sanchez SE, Islam S, Zhong QY, Gelaye B, Williams MA. Intimate partner violence is associated with stress-related sleep disturbance and poor sleep quality during early pregnancy. *PloS One*. 2016; 11(3):e0152199. [PubMed: 27023005]
- Siege-Riz AM, Hobel CJ. Predictors of poor maternal weight gain from baseline anthropometric, psychosocial, and demographic information in a Hispanic population. *Journal of the American Dietetic Association*. 1997; 97(11):1264–1268. [PubMed: 9366864]
- Siege-Riz AM, Viswanathan M, Moos MK, Deierlein A, Mumford S, Knaack J, Lohr KN. A systematic review of outcomes of maternal weight gain according to the institute of medicine recommendations: Birthweight, fetal growth, and postpartum weight retention. *American Journal of Obstetrics and Gynecology*. 2009; 201(4):339.e1–339.14. [PubMed: 19788965]
- Silverman JG, Decker MR, Reed E, Raj A. Intimate partner violence victimization prior to and during pregnancy among women residing in 26 U.S. states: Associations with maternal and neonatal health. *American Journal of Obstetrics and Gynecology*. 2006; 195(1):140–148. [PubMed: 16813751]
- Subramanian S, Katz KS, Rodan M, Gantz MG, El-Khorazaty NM, Johnson A, Joseph J. An integrated randomized intervention to reduce behavioral and psychosocial risks: Pregnancy and neonatal outcomes. *Maternal and Child Health Journal*. 2012; 16(3):545–554. [PubMed: 21931956]
- Taft A, O'Doherty L, Hegarty K, Ramsay J, Davidson L, Feder G. Screening women for intimate partner violence in healthcare settings. *Cochrane Database of Systematic Reviews* (Online). 2013; 4:CD007007.

- Udo IE, Lewis LM, Tobin JN, Ickovics JR. Intimate partner victimization and health risk behaviors among pregnant adolescents. *American Journal of Public Health*. 2016; 106(8):1457–1459. [PubMed: 27310354]
- Vest JR, Catlin TK, Chen JJ, Brownson RC. Multistate analysis of factors associated with intimate partner violence. *American Journal of Preventive Medicine*. 2002; 22(3):156–164. [PubMed: 11897459]
- Webb JB, Siega-Riz AM, Dole N. Psychosocial determinants of adequacy of gestational weight gain. *Obesity* (Silver Spring, Md.). 2009; 17(2):300–309.

Callouts

1. The purpose of our study was to examine the population-level patterns of intimate partner violence and gestational weight gain.
2. Participants who reported perinatal intimate partner violence had higher rates of gestational weight gain outside of the optimal range.
3. To mitigate the effect of intimate partner violence, women use various coping strategies, including smoking and substance use.

Figure 1.
Flow chart defining study population and exclusions

Table 1**Maternal Characteristics by Perinatal Intimate Partner Violence (IPV) Exposure**

Variable	No IPV	IPV Before Pregnancy Only	IPV During Pregnancy Only	IPV Before and During Pregnancy	Total
N (%)	235,463 (93.7%)	6,777 (2.7%)	2,865 (1.1%)	6,237 (2.5%)	251,342 (100.0%)
Weighted N (%)	10,685,987	266,699	116,546	250,630	11,319,863
<i>Column percentages from weighted population</i>					
<i>Gestational weight gain^a</i>					
Inadequate	20.2 (19.9, 20.4)	20.6 (19.0, 22.2)	23.3 (20.8, 26.1)	23.5 (21.7, 25.3)	20.3 (20.0, 20.5)
Normal	33.4 (33.1, 33.7)	29.7 (27.9, 31.6)	32.7 (29.8, 35.8)	30.2 (28.2, 32.2)	33.3 (33.0, 33.6)
Excessive	46.4 (46.1, 46.7)	49.7 (47.6, 51.8)	43.9 (40.8, 47.1)	46.3 (44.1, 48.5)	46.5 (46.1, 46.8)
<i>Maternal age^a</i>					
<20	6.9 (6.7, 7.0)	14.8 (13.4, 16.4)	17.8 (15.5, 20.4)	17.1 (15.5, 18.8)	7.4 (7.2, 7.6)
20–24	22.1 (21.8, 22.4)	39.8 (37.8, 41.9)	33.5 (30.5, 36.5)	39.0 (36.9, 41.2)	23.0 (22.7, 23.3)
25–29	29.8 (29.5, 30.1)	25.8 (24.0, 27.7)	27.7 (25.0, 30.6)	24.7 (22.8, 26.7)	29.6 (29.3, 29.9)
>30	41.2 (40.9, 41.5)	19.5 (17.9, 21.2)	21.0 (18.5, 23.8)	19.2 (17.5, 21.1)	40.0 (39.7, 40.3)
<i>Race/ethnicity^a</i>					
White Non-Hispanic	67.9 (67.6, 68.2)	59.5 (57.5, 61.6)	49.8 (46.6, 52.9)	51.2 (49.0, 53.4)	67.1 (66.9, 67.4)
Black Non-Hispanic	12.8 (12.6, 13.0)	19.9 (18.4, 21.5)	27.6 (25.0, 30.3)	25.6 (23.8, 27.4)	13.4 (13.2, 13.6)
Hispanic	13.6 (13.4, 13.8)	16.4 (14.8, 18.2)	18.4 (15.6, 21.5)	19.0 (17.1, 21.0)	13.9 (13.7, 14.1)
American Indian/Alaska Native Non-Hispanic	0.9 (0.9, 0.9)	1.9 (1.6, 2.3)	1.4 (1.0, 2.0)	1.7 (1.4, 2.0)	0.9 (0.9, 1.0)
Asian Non-Hispanic	4.8 (4.7, 4.9)	2.2 (1.8, 2.7)	2.9 (2.1, 3.9)	2.6 (2.1, 3.2)	4.6 (4.5, 4.8)

Variable	No IPV	IPV Before Pregnancy Only	IPV During Pregnancy Only	IPV Before and During Pregnancy	Total
Education ^a					
<12 years	12.9 (12.7, 13.1)	24.7 (22.9, 26.6)	20.5 (18.0, 23.2)	27.6 (25.6, 29.6)	13.6 (13.4, 13.8)
12 years	87.1 (86.9, 87.3)	75.3 (73.4, 77.1)	79.5 (76.8, 82.0)	72.4 (70.4, 74.4)	86.4 (86.2, 86.6)
Income (% federal poverty guideline) ^a					
0–100	30.8 (30.5, 31.2)	61.5 (59.5, 63.5)	61.7 (58.6, 64.8)	71.2 (69.3, 73.2)	32.8 (32.5, 33.1)
101–200	21.1 (20.8, 21.4)	21.9 (20.1, 23.7)	19.9 (17.4, 22.6)	17.5 (15.9, 19.2)	21.0 (20.8, 21.3)
>200	48.1 (47.7, 48.4)	16.6 (15.1, 18.2)	18.4 (16.0, 21.0)	11.2 (10.0, 12.6)	46.2 (45.9, 46.5)
Marital status*					
Married	67.4 (67.1, 67.7)	31.7 (29.9, 33.7)	30.1 (27.2, 33.0)	26.3 (24.5, 28.3)	65.3 (65.0, 65.6)
Other	32.6 (32.3, 32.9)	68.3 (66.3, 70.1)	69.9 (67.0, 72.8)	73.7 (71.7, 75.5)	34.7 (34.4, 35.0)
Smoke during last 3 months of pregnancy ^a					
No	88.7 (88.5, 88.9)	68.7 (66.8, 70.6)	75.7 (72.8, 78.3)	68.0 (66.0, 70.0)	87.7 (87.5, 87.9)
Yes	11.3 (11.1, 11.5)	31.3 (29.4, 33.2)	24.3 (21.7, 27.2)	32.0 (30.0, 34.0)	12.3 (12.1, 12.5)
Adequacy of prenatal care ^a (Kotelchuck index)					
Inadequate	10.3 (10.1, 10.5)	18.0 (16.5, 19.7)	15.9 (13.8, 18.4)	20.6 (18.9, 22.4)	10.8 (10.5, 11.0)
Intermediate	13.3 (13.1, 13.5)	12.8 (11.4, 14.4)	14.9 (12.8, 17.3)	14.8 (13.3, 16.4)	13.3 (13.1, 13.5)
Adequate	46.4 (46.1, 46.8)	40.5 (38.5, 42.6)	40.2 (37.1, 43.4)	36.9 (34.8, 39.1)	46.0 (45.7, 46.4)
Adequate Plus	30.0 (29.7, 30.3)	28.6 (26.8, 30.4)	28.9 (26.2, 31.9)	27.8 (25.8, 29.8)	29.9 (29.6, 30.2)
Prepregnancy BMI ^a					
Underweight (<18.5)	4.3 (4.1, 4.4)	6.6 (5.7, 7.7)	5.9 (4.4, 7.8)	7.0 (6.0, 8.2)	4.4 (4.3, 4.6)
Normal (18.5–24.9)	51.8 (51.5, 52.1)	48.5 (46.4, 50.6)	47.0 (43.8, 50.2)	47.1 (44.9, 49.3)	51.6 (51.2, 51.9)

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Variable	No IPV	IPV Before Pregnancy Only	IPV During Pregnancy Only	IPV Before and During Pregnancy	Total
Overweight (25.0–29.9)	23.9 (23.6, 24.2)	23.5 (21.8, 25.3)	25.1 (22.5, 28.0)	23.5 (21.6, 25.4)	23.9 (23.6, 24.2)
Obese (≥30.0)	20.1 (19.8, 20.3)	21.3 (19.7, 23.1)	22.0 (19.5, 24.7)	22.4 (20.6, 24.3)	20.2 (19.9, 20.4)

^aFor all comparisons, design-based F statistic $P < 0.001$.

Table 2

Maternal Characteristics by Gestational Weight Gain (GWG)

Variable	Normal GWG		Inadequate GWG		Excessive GWG	
	Column % (95% CI)	OR (95% CI)	Column % (95% CI)	OR (95% CI)	Column % (95% CI)	OR (95% CI)
N (%)	83,816 (33.4%)		60,482 (24.1%)		107,044 (42.6%)	
Weighted N (%)	3,765,920 (33.3%)		2,294,656 (20.3%)		5,259,287 (46.5%)	
Perinatal IPV						
None	94.9 (94.6, 95.1)	--	93.9 (93.5, 94.2)	ref ^d	94.3 (94.1, 94.5)	ref ^d
IPV Before Pregnancy	2.1 (2.0, 2.3)	--	2.4 (2.2, 2.6)	1.15 (1.02, 1.29)	2.5 (2.4, 2.7)	1.21 (1.09, 1.33)
IPV During Pregnancy	1.0 (0.9, 1.1)	--	1.2 (1.0, 1.3)	1.18 (0.99, 1.41)	1.0 (0.9, 1.1)	0.97 (0.83, 1.12)
IPV Before and During Pregnancy	2.0 (1.9, 2.2)	--	2.6 (2.4, 2.8)	1.29 (1.15, 1.45)	2.2 (2.1, 2.4)	1.11 (1.00, 1.23)
Maternal age						
<20	6.4 (6.1, 6.7)	--	8.7 (8.3, 9.1)	1.49 (1.38, 1.60)	7.5 (7.3, 7.8)	1.32 (1.24, 1.41)
20-24	21.4 (21.0, 21.9)	--	24.1 (23.5, 24.7)	1.23 (1.17, 1.29)	23.7 (23.3, 24.1)	1.25 (1.20, 1.30)
25-29	29.1 (28.6, 29.6)	--	27.9 (27.2, 28.5)	1.05 (1.00, 1.09)	30.7 (30.2, 31.1)	1.19 (1.15, 1.23)
>30	43.0 (42.5, 43.6)	--	39.3 (38.6, 40.0)	ref ^d	38.1 (37.7, 38.6)	ref ^d
Race/ethnicity						
White Non-Hispanic	68.0 (67.5, 68.5)	--	60.5 (59.8, 61.2)	ref ^d	69.4 (69.0, 69.8)	ref ^d
Black Non-Hispanic	11.7 (11.3, 12.0)	--	16.5 (16.0, 17.0)	1.59 (1.51, 1.67)	13.3 (13.0, 13.6)	1.12 (1.07, 1.17)
Hispanic	13.8 (13.4, 14.2)	--	16.1 (15.5, 16.7)	1.31 (1.23, 1.39)	12.9 (12.6, 13.3)	0.92 (0.87, 0.97)
American Indian/Alaska Native Non-Hispanic	0.8 (0.8, 0.9)	--	1.0 (0.9, 1.1)	1.37 (1.20, 1.55)	1.0 (0.9, 1.1)	1.19 (1.07, 1.33)
Asian Non-Hispanic	5.7 (5.5, 5.9)	--	5.9 (5.6, 6.2)	1.16 (1.09, 1.25)	3.3 (3.2, 3.5)	0.58 (0.54, 0.61)

	Normal GWG	Inadequate GWG	Excessive GWG
Education			
<12 years	12.4 (12.0, 12.8)	--	17.7 (17.1, 18.3)
12 years	87.6 (87.2, 88.0)	--	82.3 (81.7, 82.9)
Income (% federal poverty guideline)			
0–100	29.7 (29.2, 30.3)	--	39.3 (38.6, 40.0)
101–200	20.5 (20.1, 21.0)	--	21.5 (20.9, 22.1)
>200	49.8 (49.2, 50.3)	--	39.2 (38.6, 39.9)
Marital Status			
Married	69.4 (68.9, 70.0)	--	61.2 (60.5, 61.9)
Other	30.6 (30.0, 31.1)	--	38.8 (38.1, 39.5)
Smoke during last 3 months of pregnancy			
No	88.9 (88.6, 89.3)	--	85.5 (85.0, 86.0)
Yes	11.1 (10.7, 11.4)	--	14.5 (14.0, 15.0)
Adequacy of prenatal care (Kotelchuck Index)			
Inadequate	9.7 (9.4, 10.1)	--	15.4 (14.9, 15.9)
Intermediate	13.7 (13.3, 14.1)	--	13.8 (13.3, 14.3)
Adequate	47.5 (47.0, 48.1)	--	40.9 (40.2, 41.6)
Adequate Plus	29.0 (28.5, 29.5)	--	29.9 (29.3, 30.6)
Pre-pregnancy BMI			
Underweight (<18.5)	5.8 (5.5, 6.0)	--	7.9 (7.5, 8.2)
Normal (18.5–24.9)	61.4 (60.9, 62.0)	--	60.3 (59.6, 61.0)
Overweight (25.0–29.9)	18.7 (18.2, 19.1)	--	13.0 (12.5, 13.5)

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	Normal GWG	Inadequate GWG	Excessive GWG	
Obese (30.0)	14.1 (13.7, 14.5)	18.9 (18.3, 19.4)	1.36 (1.29, 1.43)	25.0 (24.6, 25.5)
				2.68 (2.57, 2.79)

Note. OR = odds ratio; CI = confidence interval
Referent Group.

Table 3

Adjusted Associations of Maternal Characteristics with Inadequate or Excessive Gestational Weight Gain (GWG)

	Inadequate vs. Normal GWG AOR (95% CI)	Excessive vs. Normal GWG AOR (95% CI)
Perinatal IPV		
None	ref ^a	ref ^a
Before pregnancy	0.92 (0.81, 1.03)	1.14 (1.02, 1.26)
During pregnancy	0.96 (0.80, 1.14)	0.87 (0.75, 1.01)
Before and during pregnancy	0.97 (0.86, 1.10)	1.02 (0.91, 1.14)
Maternal age		
<20	0.97 (0.89, 1.05)	1.55 (1.44, 1.67)
20–24	0.94 (0.89, 0.99)	1.28 (1.23, 1.35)
25–29	0.94 (0.90, 0.99)	1.20 (1.15, 1.24)
>30	ref ^a	ref ^a
Race/ethnicity		
White Non-Hispanic	ref ^a	ref ^a
Black Non-Hispanic	1.37 (1.29, 1.45)	0.86 (0.82, 0.91)
Hispanic	1.14 (1.07, 1.22)	0.80 (0.76, 0.85)
American Indian/Alaska Native Non-Hispanic	1.13 (0.99, 1.29)	0.97 (0.87, 1.09)
Asian Non-Hispanic	1.21 (1.13, 1.29)	0.70 (0.65, 0.74)
Education		
<12 years	1.19 (1.12, 1.27)	0.91 (0.86, 0.97)
12 years	ref ^a	ref ^a
Income (% federal poverty guideline)		
0–100	1.33 (1.26, 1.41)	0.91 (0.87, 0.96)
101–200	1.20 (1.14, 1.27)	0.92 (0.88, 0.96)
>200	ref ^a	ref ^a
Marital status		
Married	ref ^a	ref ^a
Other	1.07 (1.02, 1.12)	1.22 (1.16, 1.27)
Smoke during last 3 months of pregnancy		
No	ref ^a	ref ^a
Yes	1.20 (1.13, 1.27)	1.01 (0.96, 1.06)
Adequacy of prenatal care (Kotelchuck Index)		
Inadequate	1.56 (1.46, 1.66)	0.90 (0.85, 0.95)
Intermediate	1.13 (1.06, 1.19)	0.93 (0.89, 0.98)
Adequate	ref ^a	ref ^a
Adequate Plus	1.17 (1.12, 1.22)	1.01 (0.98, 1.05)

	Inadequate vs. Normal GWG	Excessive vs. Normal GWG
	AOR (95% CI)	AOR (95% CI)
Pre-pregnancy BMI		
Underweight (<18.5)	1.28 (1.19, 1.38)	0.48 (0.44, 0.53)
Normal (18.5–24.9)	ref ^a	ref ^a
Overweight (25.0–29.9)	0.65 (0.62, 0.69)	2.68 (2.58, 2.78)
Obese (>30.0)	1.26 (1.19, 1.33)	2.75 (2.63, 2.87)

Note. AOR = Adjusted Odds Ratio; CI = confidence interval

^aReferent Group.