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## Association of physical violence by an intimate partner around the time of pregnancy with inadequate gestational weight gain in Oklahoma

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### Abstract

Intimate partner violence has been previously examined in relation to numerous pregnancy, labor and delivery outcomes. We evaluated whether women who experienced physical violence by their intimate partners around the time of pregnancy were less likely to achieve weight gain according to Institute of Medicine (IOM) guidelines. A cross-sectional study was conducted using the 2000–2006 Oklahoma Pregnancy Risk Assessment Monitoring Survey (PRAMS) data for post-partum women, 20 years and older. Physical violence perpetrated by an intimate partner before and/or during pregnancy was prevalent in nearly 6.5% of women. Weight gain was adequate in 38.8%, deficient in 28.4% and excessive in 32.8% of these women, respectively. After adjusting for maternal age, marital status, education, pregnancy intention, stressful life events, third-trimester use of tobacco and alcohol and gestational age at delivery, physical violence by an intimate partner around the time of pregnancy was positively but non-significantly associated with excessive (but not deficient) gestational weight gain. After stratifying by age group, positive and significant associations between physical violence by an intimate partner around the time of pregnancy and inadequate gestational weight gain were observed only among women 35 years and older. With the exception of mothers 35 years of age, deficient and excessive gestational weight gains were not significantly related to experiences with physical violence by an intimate partner prior to delivery. Prospective cohort studies are needed to establish whether other forms of violence, including emotional and sexual abuse, can affect gestational weight gain and whether gestational weight gain can mediate the effect of physical, sexual and emotional abuse on pregnancy, labor and delivery outcomes.

### Keywords

gestational weight gain; violence; body mass index; pregnancy

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## Introduction

Since 1990, the Institute of Medicine (IOM) has established evidence-based guidelines for gestational weight gain aimed at achieving optimal health for women and their offspring (Kaiser & Allen, 2008; Olson, 2008). While it is anticipated that women in the “low” weight-for-height category (BMI:  $< 19.8 \text{ kg/m}^2$ ) will gain a total of 12.5–18.0 kg during their pregnancies, those in the “normal” (BMI: 19.8–26.0  $\text{kg/m}^2$ ) and “high” (BMI:  $>26.0$ –29.0  $\text{kg/m}^2$ ) categories are expected to gain 11.5–16.0 kg and 7.0–11.5 kg, respectively. A gestational weight gain of at least 6.8 kg is projected for “obese” women whose BMI exceeds 29.0  $\text{kg/m}^2$  (IOM, 1990). However, current research suggests that a large proportion of women do not comply with these guidelines (Abrams, Altman, & Pickett, 2000). A recent review article by Olson (Olson, 2008) estimated that 33–40% of US women gain within recommended ranges and that excessive weight gain was more frequent than deficient weight gain. The role of intimate partner violence (IPV), a worldwide public health concern, has rarely been explored in relation to adequacy of weight gain in the context of pregnancy. For pregnant women, IPV has been examined in relation to antenatal hospitalization (Lipsky, Holt, Easterling, & Critchlow, 2004), low birth weight (Boy & Salihu, 2004; Neggers, Goldenberg, Cliver, & Hauth, 2004), preterm delivery (Neggers et al., 2004), fetal growth restriction (Janssen, Holt, Sugg, Emanuel, Critchlow, & Henderson, 2003), maternal (Boy & Salihu, 2004), perinatal (Coker, Sanderson, & Dong, 2004; Janssen et al., 2003) and infant (Boy & Salihu, 2004) mortality. Yet, evidence supporting a role of IPV in adverse pregnancy, labor and delivery outcomes remains inconclusive (Janssen et al., 2003), and many studies have not adjusted for relevant confounders (Chambliss, 2008). So far, the few studies that have explicitly assessed the role of IPV in gestational weight gain have yielded inconsistent results (Kearney, Munro, Kelly, & Hawkins, 2004; Moraes, Amorim, & Reichenheim, 2006). Most of these studies were conducted within healthcare institutions, limiting extrapolation beyond clinical populations. The CDC Pregnancy Risk Assessment Monitoring System (PRAMS) conducts large population-based surveys at the state level. In the current study, analyses of the 2000–2006 Oklahoma PRAMS were performed to evaluate whether women who had experienced physical violence by an intimate partner around the time of pregnancy were less likely to gain weight within IOM guidelines. Specifically, we hypothesized that exposure to physical violence by an intimate partner around the time of pregnancy would be associated with an increased odds of excessive or deficient gestational weight gain. A previous study analyzed the relationship between history of abuse and gestational weight gain among teens and adults, separately (Johnson, Hellerstedt, & Pirie, 2002). Distinct patterns were noted whereby experiences with abuse affected gestational weight gain among adults but not among teens (Johnson et al., 2002). Furthermore, since age is an established effect modifier of numerous exposure-outcome relationships (Last, 2001), we further hypothesized that the magnitude of the association between IPV before and/or during pregnancy and adequacy of gestational weight gain will vary according to maternal age.

## Materials and Methods

### CDC PRAMS

The CDC PRAMS is an ongoing surveillance project that collects state-specific, population-based data on maternal attitudes and experiences before, during and shortly after pregnancy. Standardized data collection procedures have been adopted by participating PRAMS states. Every month, each PRAMS state selects a stratified sample of 100 to 250 new mothers from eligible birth certificates. A PRAMS state may sample between 1300 and 3400 women per year. Each selected mother receives a letter introducing the survey, followed by a 14-page questionnaire 2–6 months postpartum. Those who do not respond receive a second mailed questionnaire and in most states, a third. If there is no response to repeated mailings, women

are contacted and interviewed by telephone. The PRAMS over-samples women at high risk of poor pregnancy outcomes, including having low birth weight infants, young age, Black race or Hispanic ethnicity. PRAMS system uses a complex survey design. Therefore, information from the birth certificate file was used to statistically weight the collected data for sample stratification, non-coverage and non-response (Adams, Shulman, Bruce, Hogue, & Brogan, 1991; Colley Gilbert, Johnson, Morrow, Gaffield, & Ahluwalia, 1999). While data on sexual and emotional types of abuse is available in few of the PRAMS states, data on physical abuse are collected by all PRAMS states. In addition, only one state (Oklahoma) has systematically collected data on gestational weight gain. We, therefore, examined recent (2000–2006) PRAMS data from the state of Oklahoma. It is worth noting that only physical violence was consistently assessed in the Oklahoma PRAMS over the specified time period. The study was granted research exempt status by an institutional review board.

## Exposure

Physical violence by an intimate partner either before or during pregnancy was defined using two PRAMS questions. Specifically, women were classified as physically abused by an intimate partner before pregnancy if they replied affirmatively to the following ‘yes’ or ‘no’ question: “During the *12 months before* you got pregnant, were you physically hurt in any way by your husband or partner?”. Women were classified as physically abused by an intimate partner during pregnancy if they replied affirmatively to the following ‘yes’ or ‘no’ question: “During your most recent pregnancy, were you physically hurt in any way by your husband or partner?”. Furthermore, physical violence by an intimate partner around the time of pregnancy was defined in women who replied affirmatively to either one of these two questions. Because physical violence was not consistently measured for teenage mothers throughout the study period, we restricted our analyses to women who were 20 years and older.

## Outcome

Pre-pregnancy BMI was defined based on PRAMS questions that measure height and weight, namely: “*Just before* you got pregnant with your new baby, how much did you weigh?” and “How tall are you, without shoes?” These questions were used to compute the pre-pregnancy BMI ( $\text{weight}_{(\text{kg})} / (\text{height}_{(\text{m})}^2)$ ). BMI was further categorized as ‘< 19.8’; ‘19.8–26.0’; ‘>26.0–29.0’; ‘> 29.0’  $\text{kg}/\text{m}^2$ . Total gestational weight gain was analyzed, in kilograms, and defined using the following PRAMS question developed for the state of Oklahoma: ‘How much weight did you gain during your pregnancy?’ A ‘zero’ gestational weight gain was imputed for women who replied they had either not gained or had lost weight during their pregnancies. Adequacy of gestational weight gain was defined based on the IOM guidelines. A woman was classified as having ‘deficient’, ‘adequate’ or ‘excessive’ weight gain, respectively, if she had gained weight, below, within or above the IOM recommendation according to her pre-pregnancy BMI. Women with ‘adequate’ gestational weight gain were selected as the referent group.

## Covariates

Socio-demographic health and lifestyle factors were used to describe the study sample and assess their role as potential confounders. Socio-demographic variables included *age* (‘20–24’; ‘25–29’; ‘30–34’; ‘35’ years), *race* (‘White’, ‘Black’; ‘Native American’; ‘Asian’), *marital status* (‘Married’; ‘Unmarried’), *education* (‘Less than high school’; ‘High school’; ‘More than high school’) and *parity* (‘0’; ‘1’; ‘2’; ‘3 or more’). Health variables included *prenatal care initiation* (‘1<sup>st</sup> trimester’; ‘2<sup>nd</sup> trimester’; ‘3<sup>rd</sup> trimester’; ‘None’), *number of stressors* (‘0’; ‘1’; ‘2’; ‘3 or more’), *pregnancy complications* (‘None’; ‘Any’) and *pregnancy intention* (‘Intended’; ‘Unintended’). Lifestyle variables included *cigarette smoking* (‘Yes’; ‘No’) and *alcohol drinking* (‘Yes’; ‘No’) in the last trimester of pregnancy.

In calculating the number of stressors, a short list of stressful life events experienced during pregnancy was used, namely 'unwanted pregnancy by partner', 'interpersonal problems with partner', 'divorce', 'inability to pay bills', 'homelessness', 'relocation', 'illness of family member', 'death of a close family member or friend', 'drug use', 'woman (or her partner) jailed', 'woman losing her job' and 'partner losing his job'. A complicated pregnancy was defined in women who experienced hypertension, vaginal bleeding, diabetes, urinary tract infections, preterm labor, premature rupture of membranes (PROM) or placenta previa. Pregnancy intention was defined using the following question: "Thinking back to *just before* you got pregnant with your *new* baby, how did you feel about becoming pregnant?" Respondents were given the following answer choices: 'I wanted to be pregnant sooner', 'I wanted to be pregnant later', 'I wanted to be pregnant then', 'I didn't want to be pregnant then or at any time in the future'. Women who answered 'I wanted to be pregnant sooner' or 'I wanted to be pregnant then' were classified as having an intended pregnancy. Otherwise, their pregnancy was unintended.

### Statistical analysis

The SURVEYFREQ, SURVEYMEANS and SURVEYLOGISTIC procedures in SAS (version 9.1) were applied for analyses that require taking complex survey design into consideration. All statistical tests were two-sided, conducted at an alpha level of 0.05. The Rao-Scott Chi-square test was used for evaluating the statistical significance of bivariate associations. Logistic regression analyses were performed for computing crude, and adjusted odds ratios (COR and AOR) and their 95% confidence intervals (CI). Initially, socio-demographic, health and lifestyle characteristics of the study sample were described. Second, the prevalence of physical violence perpetrated by an intimate partner before and/or during pregnancy was assessed in relation to these characteristics. Third, adequacy of gestational weight gain was evaluated by these characteristics. Fourth, stratified analyses were performed to evaluate effect of physical violence by an intimate partner before and/or during pregnancy on gestational weight gain, after controlling for each covariate; a covariate was kept in the final logistic model, if the crude and adjusted odds ratios differed by at least 10%. Separate multivariate logistic models were constructed to estimate the net effect of physical violence perpetrated by an intimate partner around the time of pregnancy on deficient and excessive gestational weight gain. Gestational age at delivery (defined, in weeks, as a continuous variable) was included in both models as an *a priori* confounder. Finally, interaction terms were added to multivariate models for the purpose of evaluating the role of maternal age; in the presence of significant interactions, stratified logistic regression models were presented.

### Results

A total of 13442 women were surveyed by Oklahoma PRAMS from 2000 to 2006. Of those 11561 (86.0%) were 20 years and older and were, therefore, included in the analyses. Mean age ( $\pm$  standard error) was  $27.0 \pm 0.07$  years. Almost 81% were White, 69% were married, 34% were nulliparous and 48% had above high school education. Nearly 86% initiated prenatal care during their first trimester of pregnancy, 55% had one or more pregnancy complication, 9% smoked cigarettes and 1.7% drank alcohol in the third trimester of pregnancy. Nearly 34% of these women experienced three or more stressful life events during pregnancy and 46% had an unintended pregnancy. Physical violence by an intimate partner against these women was self-reported in 5.4% ( $\pm$  0.35%) before pregnancy, 3.8% ( $\pm$  0.29%) during pregnancy and 6.5% ( $\pm$  0.38%) before and/or during pregnancy; it was least reported among women 30–34 years of age and those with more than a high school education. Black race, being unmarried, late initiation of prenatal care, stressful life events during pregnancy, pregnancy complications, unintended pregnancies, cigarette smoking and

alcohol drinking during the last trimester of pregnancy were positively associated with physical violence (Table 1). Whereas weight gain was adequate in 38.8% ( $\pm 0.75\%$ ), it was deficient in 28.4% ( $\pm 0.69$ ) and excessive in 32.8% ( $\pm 0.72\%$ ), respectively. Higher education and obesity were protective against less than adequate gestational weight gain. Black, Asian, unmarried, multiparous women and those who did not seek prenatal care, drank alcohol during the last trimester of pregnancy or had an unintended pregnancy were likely to gain weight below IOM guidelines. Variables with increased odds ratios and statistically significant relationships to excessive weight gain included young age, unmarried status, nulliparity, three or more stressful life events, an unintended pregnancy and overweight (Table 2). Deficient weight gain was weakly and non-significantly associated with physical violence by an intimate partner around the time of pregnancy (COR=1.14; 95% CI: 0.83–1.57). By contrast, a positive and significant crude relationship was observed between physical violence by an intimate partner around the time of pregnancy and excessive weight gain (COR=1.46; 9% CI: 1.09–1.96). Multivariate logistic regression models for the effect of physical violence by an intimate partner before and/or during pregnancy on deficient and excessive weight gain, respectively, are presented in Table 3. After adjusting for age, marital status, education, pregnancy intention, stressful life events, smoking and alcohol use during the third trimester of pregnancy as well as gestational age at delivery, the effect of physical violence on excessive weight gain decreased and became statistically non-significant (AOR=1.28; 95% CI: 0.93–1.76). The net effect of physical violence on deficient weight gain remained statistically non-significant (AOR=0.99; 95% CI: 0.69–1.40) after confounders were taken into consideration. Significant interaction terms ( $P < 0.05$ ) were found when examining the net effects of physical violence before and/or during pregnancy on deficient and excessive weight gain according to age group. As shown in Table 4, positive and significant associations with physical violence around the time of pregnancy were observed only among mothers with a self-reported age of 35 years or more. For excessive weight gain, the AOR was 7.54 with a 95% CI of (1.63–34.89), whereas for deficient weight gain, the AOR was 8.76 with a 95% CI of (2.18–35.15). Physical violence before and/or during pregnancy was not associated with adequacy of gestational weight gain for women in younger age categories.

## Discussion

The main objective of our study was to identify the net effect of physical violence by an intimate partner around the time of pregnancy on adequacy of gestational weight gain. Whereas deficient weight gain was generally unrelated to physical violence by an intimate partner around the time of pregnancy, we found slightly elevated but statistically non-significant odds of excessive weight gain among women who reported physical violence by an intimate partner around the time of pregnancy. The relationship between physical violence by an intimate partner around the time of pregnancy and inadequate gestational weight gain was strongest among women  $\geq 35$  years of age.

Study findings are not entirely consistent with the few studies that have examined similar hypotheses. For instance, Moraes *et al.* (Moraes et al., 2006) assessed whether net gestational weight gain during pregnancy was linked to IPV among 394 women from Rio de Janeiro public maternities. Physical IPV was found to be an independent risk factor for deficient weight gain during pregnancy, after controlling for socioeconomic, demographic, reproductive, and nutritional or lifestyle factors (Moraes et al., 2006).

The finding of an interaction between maternal age and IPV in relation to gestational weight gain has been previously reported. In a matched retrospective cohort study of 578 clients of an urban prenatal care clinic, Johnson *et al.* examined current and past physical or sexual abuse in relation to total gestational weight gain, deficient weight gain and excessive weight

gain, stratifying by maternal age (Johnson et al., 2002). For teens, abuse was not associated with total weight gain. For adults, total weight gain was 6.9 pounds greater for women who reported current abuse versus those who reported no abuse (Johnson et al., 2002).

Elucidating the bio-psychosocial mechanism that underlies the effect of IPV on adverse pregnancy outcomes by examining its effect on gestational weight gain, among other mediators, can help in the future development of preventive strategies. Evidence for an association between physical violence and adverse maternal and infant outcomes remains mixed (Boy & Salihu, 2004) and gestational weight gain has been formerly shown to play a role as a mediator between being victimized by an intimate partner and various pregnancy, labor and delivery outcomes (Kaiser & Allen, 2008; Kearney et al., 2004; Olson, 2008). In a prospective cohort study, Parker *et al* (Parker, McFarlane, & Soeken, 1994) evaluated the effect of abuse during pregnancy on birth weight among 1203 African-American, Hispanic, and White pregnant women. Abuse during pregnancy was reported by 20.6% of teens and 14.2% of adult women. In addition to being a significant risk factor for low birth weight, abuse during pregnancy was related to infections, anemia, smoking, substance use and low maternal weight gain. A study by Kearney *et al.* (Kearney et al., 2004) used a sample of 1969 women who had been screened for abuse during pregnancy by their clinicians. The investigators found that recent physical or psychological abuse had a small but significant effect on birth weight, whereas smoking and low weight gain were weak but significant mediators of the relation between recent abuse and birth weight.

Social isolation (Coker, Watkins, Smith, & Brandt, 2003; Staggs, Long, Mason, Krishnan, & Riger, 2007), lifestyle (Caetano, McGrath, Ramisetty-Mikler, & Field, 2005; Fals-Stewart & Kennedy, 2005; Kearney et al., 2004; Lipsky, Caetano, Field, & Bazargan, 2005) and stress response (Breiding, Black, & Ryan, 2008; Chambliss, 2008; Dutton, Green, Kaltman, Roesch, Zeffiro, & Krause, 2006; Goldstein & Martin, 2004) are tentative explanations for a putative role of physical abuse in adequacy of gestational weight gain. First, a physically abusive partner may use power and control to limit a pregnant woman's access to healthcare services whereby diet and physical exercise can be monitored by a physician, nurse or dietician (Castro, Casique, & Brindis, 2008; Coker, Davis, Arias, Desai, Sanderson, Brandt et al., 2002; Gage & Hutchinson, 2006; Gee, Mitra, Wan, Chavkin, & Long, 2009; Krantz & Nguyen, 2009). Second, physically abused women may lack the social support they need to maintain a positive lifestyle through diet and exercise and avoid cigarette smoking and alcohol drinking which can compromise their health and that of their unborn child (Beeble, Bybee, Sullivan, & Adams, 2009; Staggs et al., 2007). Third, an abusive relationship can cause chronic stress in pregnant women, leading to elevated cortisol levels and subsequently excessive weight gain (Vicennati, Pasqui, Cavazza, Pagotto, & Pasquali, 2009).

To our knowledge, this is one of few studies to specifically evaluate the association of partner violence around the time of pregnancy with gestational weight gain. Existing studies have indicated that gestational weight gain can be compromised by IPV. However, many were conducted in healthcare institutions, limiting generalization to women in the general population. Our study was population-based, used standard questions and a large sample size. However, our results should be interpreted in light of certain limitations, including cross-sectional design, retrospective self-reporting and the use of data from one PRAMS state.

The greatest limitation of the PRAMS data is its cross-sectional nature, and the fact that it is impossible to infer a causal relationship between physical violence around the time of pregnancy and the significant finding of greater than adequate weight gain among older women. The PRAMS data do not gather information on severity or chronicity of physical violence by an intimate partner, and there are no data in PRAMS on factors that specifically

relate to the potential mechanisms through which physical IPV might operate on weight gain. Furthermore, self-reporting of gestational weight gain and BMI may have led to non-differential misclassification of the outcome of interest and an under-estimation of measures of association. A related limitation is the definition of physical violence based on two distinct time periods, namely before pregnancy and during pregnancy. Whereas it is plausible that physical violence during pregnancy can lead to inadequate or excessive weight gain, potentially operating through stress, cigarette smoking, alcohol drinking, and partner restriction of access to medical care or nutrition, this mechanism may not be as plausible for physical violence that occurred before pregnancy for women who do not also experience violence during pregnancy. Restricting analyses to women who experienced IPV during pregnancy would require a larger sample size.

Self-selection bias is also plausible given that women who experience abuse by their intimate partners may be less likely to partake in the PRAMS study; non-disclosure may also have led to under-reporting of experiences with physical abuse. Residual confounding cannot be eliminated as an alternative explanation. For instance, marital status was pre-defined as 'married' or 'unmarried', although 'unmarried but living with a partner' is a distinct risk group from 'single'. Emotional, sexual and other types of family violence were not evaluated in this study and may be playing an important role in gestational weight gain. In addition, illicit drug use was not considered in the analysis, while cigarette and alcohol use were limited to the third trimester of pregnancy. Finally, the distribution of Oklahoma PRAMS women by race suggests a characteristically high percentage of Native Americans, limiting generalization to other geographical areas of the United States.

In conclusion, with the exception of older mothers who are likely more prone to have experienced battering, deficient and excessive gestational weight gains were not related to experiences with physical violence by an intimate partner prior to delivery. More definitive prospective cohort studies are needed to establish whether other forms of violence, including emotional and sexual abuse, can affect gestational weight gain, and whether gestational weight gain can mediate the effect of physical, sexual and emotional abuse on pregnancy, labor and delivery outcomes.

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**Table 1**  
 Socio-demographic and health characteristics by physical violence around the time of pregnancy

	Physical abuse Before pregnancy		Physical abuse During pregnancy		Physical abuse before and/or during pregnancy	
	% Yes (SE)	OR (95% CI)	% Yes (SE)	OR (95% CI)	% Yes (SE)	OR (95% CI)
<b>Age (years)</b>						
20–24	8.4 (0.7)	1.83* (1.13–2.96)	6.3 (0.6)	3.02* (1.57–5.81)	10.1 (0.8)	2.20* (1.38–3.53)
25–29	4.1 (0.5)	0.86 (0.52–1.44)	2.9 (0.4)	1.34 (0.67–2.68)	5.1 (0.6)	1.05 (0.64–1.73)
30–34	2.4 (0.5)	0.49* (0.27–0.90)	1.5 (0.4)	0.67 (0.30–1.48)	2.9 (0.5)	0.61 (0.34–1.07)
35	4.8 (1.0)	1.00	2.2 (0.7)	1.00	4.8 (1.0)	1.00
<b>Race</b>						
White	5.2 (0.4)	1.00	3.7 (0.3)	1.00	6.2 (0.4)	1.00
Black	7.3 (1.4)	1.42 (0.92–2.19)	5.9 (1.3)	1.65* (1.02–2.65)	9.7 (1.6)	1.62* (1.10–2.38)
Native American	6.2 (1.2)	1.21 (0.79–1.85)	2.9 (0.8)	0.80 (0.46–1.42)	6.9 (1.2)	1.13 (0.76–1.68)
Asian	1.6 (1.2)	0.29 (0.062–1.36)	3.0 (1.8)	0.81 (0.24–2.73)	3.0 (1.8)	0.47 (0.14–1.57)
<b>Marital status</b>						
Married	3.0 (0.3)	1.00	2.0 (0.3)	1.00	3.5 (0.3)	1.00
Unmarried	10.8 (0.9)	3.90* (2.90–5.10)	7.8 (0.8)	4.08* (2.96–5.63)	13.2 (0.9)	4.19* (3.27–5.39)
<b>Education</b>						
< 12 years	9.1 (1.2)	1.00	5.0 (0.9)	1.00	10.6 (1.3)	1.00
12 years	6.8 (0.7)	0.73 (0.52–1.04)	4.8 (0.6)	0.95 (0.62–1.46)	8.0 (0.7)	0.73 (0.53–1.00)
> 12 years	3.1 (0.4)	0.32* (0.22–0.46)	2.6 (0.3)	0.49* (0.32–0.77)	3.9 (0.4)	0.34* (0.24–0.47)
<b>Parity</b>						
0	4.8 (0.6)	1.00	3.7 (0.5)	1.00	6.1 (0.6)	1.00
1	4.8 (0.6)	0.99 (0.69–1.40)	3.4 (0.5)	0.92 (0.62–1.36)	5.9 (0.6)	0.97 (0.71–1.32)
2	6.1 (0.8)	1.29 (0.89–1.88)	4.5 (0.7)	1.19 (0.78–1.84)	7.2 (0.8)	1.20 (0.86–1.69)
3 or more	7.7 (1.2)	1.66* (1.10–2.49)	3.7 (0.8)	0.99 (0.59–1.66)	8.3 (1.2)	1.40 (0.96–2.06)
<b>Trimester of prenatal care initiation</b>						
1 <sup>st</sup>	4.8 (0.4)	1.00	3.3 (0.3)	1.00	5.8 (0.4)	1.00
2 <sup>nd</sup>	8.7 (1.3)	1.91 (1.33–2.74)	6.9 (1.2)	2.18 (1.45–3.27)	10.5 (1.4)	1.90 (1.37–2.65)
3 <sup>rd</sup>	14.9 (5.3)	3.52 (1.55–8.03)	11.5 (4.9)	3.83 (1.45–3.27)	14.9 (5.3)	2.87 (1.26–6.51)

	Physical abuse Before pregnancy	Physical abuse During pregnancy	Physical abuse before and/or during pregnancy
None	9.7 (4.7)	2.14 (0.74–6.20)	5.3 (3.6)
<b>Stressful events during pregnancy</b>			
None	0.5 (0.2)	1.00	0.4 (0.2)
1	1.3 (0.4)	2.94 (1.02–8.47)	0.9 (0.3)
2	2.6 (0.6)	5.86 (2.15–16.02)	1.7 (0.5)
3 or more	12.9 (0.9)	32.9* (13.08–82.70)	9.2 (0.8)
<b>Pregnancy complications</b>			
None	3.7 (0.4)	1.00	2.8 (0.4)
Any	6.8 (0.5)	1.92* (1.43–2.58)	4.6 (0.4)
<b>Smoking in last 3 months of pregnancy</b>			
Yes	15.9 (1.9)	4.12* (2.98–5.69)	9.7 (1.6)
No	4.4 (0.3)	1.00	3.2 (0.3)
<b>Alcohol in last 3 months of pregnancy</b>			
Yes	11.5 (3.7)	2.32* (1.12–4.81)	8.0 (3.4)
No	5.3 (0.3)	1.00	3.7 (0.3)
<b>Pregnancy intention</b>			
Unintended	8.4 (0.7)	3.12* (2.34–4.16)	5.8 (0.5)
Intended	2.9 (0.3)	1.00	2.1 (0.3)
<b>Pre-pregnancy BMI (kg/m<sup>2</sup>)</b>			
Underweight (< 19.8)	6.9 (1.1)	1.24 (0.85–1.83)	6.2 (1.1)
Normal (19.8–26.0)	5.7 (0.5)	1.00	3.5 (0.4)
Overweight (26.1–29.0)	4.8 (0.9)	0.84 (0.54–1.31)	2.5 (0.6)
Obese (29.1+)	4.8 (0.7)	0.84 (0.59–1.19)	3.7 (0.6)

BMI=body mass index; CI = Confidence Interval; COR = Crude Odds Ratio; SE=Standard error;

\* p<0.05 for null hypothesis that Loge(OR)=0 based on univariate logistic regression model.

Table 2

Socio-demographic and health characteristics by adequacy of pregnancy weight gain

	Adequacy of pregnancy weight gain					
	Less than adequate level		Adequate level		Above adequate level	
	% Yes (SE)	COR (95% CI)	% Yes (SE)	COR (95% CI)	% Yes (SE)	COR (95% CI)
<b>Age (years)</b>						
20–24	28.2 (1.2)	0.95 (0.74–1.23)	36.9 (1.3)	Ref.	34.9 (1.2)	1.62* (1.24–2.12)
25–29	27.4 (1.2)	0.89 (0.69–1.15)	38.4 (1.3)	Ref.	34.2 (1.3)	1.52* (1.16–1.99)
30–34	28.0 (1.5)	0.84 (0.64–1.10)	41.7 (1.6)	Ref.	30.3 (1.5)	1.24* (0.93–1.65)
35	33.5 (2.3)	1.00	41.9 (2.4)	Ref.	24.6 (2.1)	1.00
<b>Race</b>						
White	27.3 (0.8)	1.00	39.4 (0.8)	Ref.	33.3 (0.8)	1.00
Black	33.6 (2.6)	1.31 (0.99–1.72)	37.2 (2.7)	Ref.	29.2 (2.6)	0.93 (0.69–1.24)
Native American	29.6 (2.3)	1.15 (0.89–1.49)	36.9 (2.4)	Ref.	33.5 (2.4)	1.07 (0.84–1.37)
Asian	43.6 (5.4)	1.88* (1.14–3.09)	33.5 (5.2)	Ref.	22.9 (4.5)	0.81 (0.45–1.45)
<b>Marital status</b>						
Married	28.0 (0.8)	1.00	40.8 (0.9)	Ref.	31.2 (0.8)	1.00
Unmarried	29.2 (1.4)	1.24* (1.04–1.47)	34.4 (1.4)	Ref.	36.3 (1.5)	1.38* (1.17–1.62)
<b>Education</b>						
< 12 years	37.4 (2.1)	1.00	34.3 (2.1)	Ref.	28.4 (2.0)	1.00
12 years	29.0 (1.2)	0.69* (0.55–0.88)	38.2 (1.2)	Ref.	32.8 (1.2)	1.04 (0.81–1.33)
> 12 years	25.4 (0.9)	0.57* (0.45–0.72)	40.6 (1.0)	Ref.	34.0 (1.0)	1.03 (0.79–1.29)
<b>Parity</b>						
0	22.4 (1.1)	1.00	37.4 (1.3)	Ref.	40.1 (1.3)	1.00
1	28.6 (1.2)	1.16 (0.96–1.39)	41.4 (1.3)	Ref.	30.0 (1.2)	0.68 (0.57–0.80)
2	34.4 (1.7)	1.58* (1.28–1.94)	36.6 (1.7)	Ref.	28.9 (1.6)	0.74 (0.60–0.91)
3 or more	35.4 (2.2)	1.51* (1.17–1.93)	39.3 (2.2)	Ref.	25.3 (1.9)	0.60 (0.47–0.77)
<b>Trimester of prenatal care initiation</b>						
1 <sup>st</sup>	27.4 (0.7)	1.00	39.9 (0.8)	Ref.	32.7 (0.8)	1.00
2 <sup>nd</sup>	31.0 (2.2)	1.32* (1.04–1.68)	34.3 (2.2)	Ref.	34.7 (2.3)	1.23 (0.98–1.56)

	Adequacy of pregnancy weight gain		
	Less than adequate level	Adequate level	Above adequate level
3 <sup>rd</sup>	43.1 (7.9)	34.1 (7.6)	22.9 (6.9)
None	62.4 (7.6)	16.9 (5.5)	20.7 (6.4)
	1.84 (0.89–3.78)	Ref.	0.82 (0.34–1.95)
	5.4* (2.41–12.04)	Ref.	1.50 (0.98–1.56)
<b>Stressful events during pregnancy</b>			
None	28.6 (1.4)	40.9 (1.6)	30.4 (1.4)
1	27.5 (1.4)	40.2 (1.5)	32.3 (1.5)
2	26.4 (1.6)	40.9 (1.8)	32.7 (1.7)
3 or more	28.6 (1.2)	36.9 (1.3)	34.6 (1.3)
	1.00	Ref.	1.26* (1.04–1.53)
	0.98 (0.79–1.21)	Ref.	1.08 (0.88–1.33)
	0.93 (0.73–1.17)	Ref.	1.08 (0.86–1.34)
	1.11 (0.91–1.36)	Ref.	1.26* (1.04–1.53)
<b>Pregnancy complications</b>			
None	26.3 (1.0)	39.1 (1.1)	34.6 (1.1)
Any	29.9 (0.9)	38.6 (0.9)	31.4 (0.9)
	1.15 (0.99–1.34)	Ref.	0.92 (0.79–1.11)
<b>Smoking in last 3 months of pregnancy</b>			
Yes	30.3 (2.4)	34.2 (2.5)	35.5 (2.5)
No	28.2 (0.7)	39.3 (0.8)	32.5 (0.8)
	1.00	Ref.	1.00
	1.24 (0.95–1.61)	Ref.	1.26 (0.97–1.63)
<b>Alcohol in last 3 months of pregnancy</b>			
Yes	40.7 (5.7)	30.9 (5.2)	28.5 (5.0)
No	28.1 (0.7)	38.9 (0.8)	32.9 (0.7)
	1.00	Ref.	1.00
	1.82* (1.07–3.13)	Ref.	1.09 (0.62–1.93)
<b>Pregnancy intention</b>			
Unintended	29.5 (1.1)	35.8 (1.1)	34.7 (1.1)
Intended	27.2 (0.9)	41.6 (1.0)	31.2 (0.9)
	1.00	Ref.	1.00
	1.26* (1.09–1.47)	Ref.	1.29* (1.12–1.49)
<b>Pre-pregnancy BMI (kg/m<sup>2</sup>)</b>			
Underweight (< 19.8)	30.6 (1.9)	33.5 (2.0)	35.9 (2.1)
Normal (19.8–26.0)	28.6 (0.9)	31.3 (1.0)	40.2 (1.1)
Overweight (26.1–29.0)	17.2 (1.6)	22.8 (1.8)	59.9 (2.0)
Obese (29.1+)	33.0 (1.5)	66.9 (1.5)	--
	0.54 (0.46–0.64)	Ref.	--
	1.00 (0.79–1.27)	Ref.	0.84 (0.66–1.05)
	1.00	Ref.	1.00
	0.83 (0.62–1.09)	Ref.	2.05* (1.63–2.57)

BMI=Body Mass Index; CI = Confidence Interval; COR = Crude Odds Ratio; SE=Standard error;

\* p<0.05 for null hypothesis that Loge(OR)=0 based on univariate logistic regression model.

**Table 3**

Univariate and multivariate logistic models for the effect of physical violence around the time of pregnancy on adequacy of gestational weight gain

	Less than adequate level Vs. Adequate level		Above adequate level Vs. Adequate level	
<b>Model I – univariate</b>				
<b>Physical abuse before and/or during pregnancy</b>	<b>COR</b>	<b>95% CI</b>	<b>COR</b>	<b>95% CI</b>
Yes	1.14	0.83–1.57	1.46	1.09–1.96
No	Ref.	--	Ref.	--
<b>Model II – multivariate</b>				
<b>Physical abuse before and/or during pregnancy</b>	<b>AOR</b>	<b>95% CI</b>	<b>AOR</b>	<b>95% CI</b>
Yes	0.99	0.69–1.40	1.28	0.93–1.76
No	Ref.	--	Ref.	--
<b>Age (years)</b>				
20–24	Ref.	--	Ref.	--
25–29	1.04	0.85–1.27	0.97	0.81–1.17
30–34	1.07	0.85–1.34	0.83	0.67–1.03
35	1.16	0.88–1.53	0.65	0.49–0.86
<b>Marital status</b>				
Married	Ref.	--	Ref.	--
Unmarried	1.02	0.83–1.25	1.28 <sup>**</sup>	1.05–1.54
<b>Education</b>				
< 12 years	Ref.	--	Ref.	--
12 years	0.73 <sup>**</sup>	0.56–0.94	1.23	0.94–1.61
> 12 years	0.62 <sup>**</sup>	0.48–0.81	1.44 <sup>**</sup>	1.09–1.89
<b>Pregnancy intention</b>				
Unintended	1.22 <sup>**</sup>	1.04–1.45	1.16	0.99–1.37
Intended	Ref.	--	Ref.	--
<b>Stressful life events</b>				
None	Ref.	--	Ref.	--
1	0.95	0.76–1.18	1.02	0.83–1.26
2	0.86	0.67–1.09	0.99	0.79–1.25
3 or more	0.95	0.76–1.19	1.04	0.84–1.29
<b>Smoking in last 3 months of pregnancy</b>				
Yes	1.09	0.82–1.46	1.23	0.93–1.64
No	Ref.	--	Ref.	--
<b>Alcohol in last 3 months of pregnancy</b>				
Yes	1.78 <sup>**</sup>	1.02–3.09	1.11	0.63–1.96
No	Ref.	--	Ref.	--
<b>Gestational age (weeks)</b>	0.92 <sup>**</sup>	0.90–0.95	1.04 <sup>**</sup>	1.01–1.08

AOR = Adjusted Odds Ratio; CI = Confidence Interval; COR=Crude Odds Ratio.

\* p<0.05 for null hypothesis that Loge(OR)=0 based on univariate logistic regression model.

\*\*  
p<0.05 for null hypothesis that  $\text{Loge}(\text{OR})=0$  based on multivariate logistic regression model.

**Table 4**

Multivariate logistic model for the effect of physical violence around the time of pregnancy on adequacy of gestational weight gain stratified by age group<sup>\*</sup>

	Age group (years)			
	20–24	25–29	30–34	35
<b>Above adequate level Vs. Adequate level<sup>a</sup></b>	N=2569	N=2327	N=1564	N=865
<i>Physical abuse before and/or during pregnancy</i>				
Yes	1.09 (0.67–1.79)	0.79 (0.39–1.58)	0.45 (0.17–1.18)	7.54 <sup>**</sup> (1.63–34.89)
No	Ref.	--	Ref.	--
<b>Less than adequate level Vs. Adequate level<sup>b</sup></b>	N=2465	N=2202	N=1454	N=724
<i>Physical abuse before and/or during pregnancy</i>				
Yes	1.24 (0.79–1.94)	1.34 (0.74–2.41)	0.56 (0.22–1.45)	8.76 <sup>**</sup> (2.18–35.15)
No	Ref.	--	Ref.	--

<sup>a</sup>Multivariate logistic model adjusted for marital status, education, pregnancy intention, stressful life events, smoking in the last 3 months of pregnancy, alcohol in the last three months of pregnancy and gestational age.

<sup>b</sup>Multivariate logistic model adjusted for marital status, education, pregnancy intention, stressful life events, smoking in the last 3 months of pregnancy, alcohol in the last three months of pregnancy and gestational age.

\* p<0.05 for null hypothesis that gamma=0 (interaction term gamma between age group and IPV) in a separate multivariate logistic regression model in which main effect of age group is added.

\*\* p<0.05 for null hypothesis that Loge(OR)=0 based on multivariate logistic regression model.