The Relation of Pre-Pregnancy Body Mass Index and Gestational Weight Gain with Neonatal Birth Weight in Baghdad city/ 2023

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Abstract

Background: Pregnancy weight gain is linked to neonatal birth weight and early-life adiposity measures. Elevated weight gain during pregnancy is associated with an increased risk of offspring developing obesity-related diseases in the long term. **Objectives:** The objective of this study is to explore the association between pre-pregnancy BMI, maternal weight gain during pregnancy, and neonate birth weight. **Subjects and methods**: This retrospective cohort study was conducted between January 2023 and January 2024 in Baghdad. The study included data from 360 healthy pregnant women from four primary healthcare centers. Gestational weight gain was computed by subtracting pre-pregnancy weight from maternal weight at the end of pregnancy. Subgroups were established to assess gestational weight gain adequacy, including inadequate, adequate, and excess categories. Gestational age was determined based on the last menstrual cycle or the first ultrasound, and the date of birth. Newborns birth weights and gestational age at birth were analyzed according to WHO growth charts. We defined two groups of abnormal growth: small for gestational age (weight below the 10^{th} percentile) and large for gestational age (weight above the 90^{th} percentile).**Results**: Maternal age was 27.5 ± 5.7 years. Pre-pregnancy BMI was 26.5 kg/m². Gestational weight gain averaged 11.2 kg, with 30.8% inadequate, 36.1% excess, and 33.1% adequate. The majority of neonates were adequate for gestational age (63.3%), while 35.8% were large for gestational age and 0.8% were small for gestational age. Overweight ladies had an OR of 1.77 (95% CI: 1.06, 2.98) with a p-value of 0.030, suggesting a significant increase in the risk of having a large gestational-age baby compared to normal-weight ladies. Similarly, obese women had a substantially higher risk, with an OR of 3.07 (95% CI: 1.73, 5.49) and a highly significant p-value of less than 0.001. **Conclusion:** The current study concludes that the increase in BMI before pregnancy and the presence of excessive weight gain during gestation could potentially function as predictive factors for the birth of neonates who are large for gestational age.

Keywords: Pre-pregnancy BMI; gestational weight gain; neonatal birth weight

Introduction

The condition of having implantations of the results of conception in the uterus or other parts of the body is known as pregnancy. It concludes with a spontaneous abortion or delivery, whichever comes first. . According to the Ministry of Health's statistical annual report for 2022, the rate of maternal mortality in Iraq (excluding the Kurdistan area) is 28 per 100,000 live births. High prenatal body mass index (BMI) is prevalent and raises the risk of a number of harmful disorders for both the mother and her unborn child.

Pre-pregnancy BMI, maternal age, parity, ethnicity, GDM, hypertension, edema, and smoking all have an impact on gestational gain in weight, which varies from woman to woman. . There is strong evidence suggesting that obesity during gestation is connected with major perinatal problems such as gestational diabetes (GDM), pre-eclampsia (PE), and infant mortality. A number of unfavorable pregnancy outcomes have been linked to both overbearing and inadequate gestational weight gain, including macrosomia, cesarean delivery, small for gestational age (SGA), large for gestational age (LGA), preeclampsia, postpartum weight retention, and offspring obesity.

In order to direct clinical practice, the Institute of Medicine (IOM), currently known as the National Academy of Medicine, issued recommendations for gestational weight increase in 1990. . A child's passage into adulthood is impeded by a multitude of negative health outcomes, both immediate and long-term, associated with both high and low birth weights. . Three groups exist for birth weight: normal (birth weight ≥2.5 kg <4.0 kg), low birth weight (birth weight ≉<2.5 kg), and excessively heavy (macrosomia) (birth weight ≥4.0 kg). The infant's life is negatively impacted by the final two circumstances. Researches have demonstrated that anomalous birth weight carries a long-term danger in the form of a high prevalence of adult coronary heart disease and type 2

diabetes, in addition to short-term effects including high infant mortality and childhood growth failure among survivors. . The purpose of this research is to investigate the relationship between the weight of the newborn, the mother's weight gain during conception, and the prior to conception weight.

Subjects and Methods

Study design and settings: This retrospective cohort study was conducted between January 2023 and January 2024 in Baghdad/ Al-karkh. The study encompassed data from four primary healthcare centers: Al-Salhia, Shuhada Al-Utafiyah, Al-Karkh, and Al-Salam.

Ethical and scientific approval for the research was obtained from the Scientific Committee at the Department of Community Medicine, Iraqi Board for Medical Specialization, and from the aforementioned primary health care centres.

The dataset used in this study consisted of valid data from a non-randomly selected sample of 360 healthy pregnant women files. Sampling technique , A non-randomized convenient sampling technique was used. Sample size calculation Prevalence of obesity in women of reproductive age is 38.2% in Iraq . Assuming that 38% of the subjects in the population have the factor of interest, the study would require a sample size of 363 for estimating the expected proportion with 5% absolute precision and 95% confidence.

Inclusion criteria Maternal age between 19 and 37 years who had a singleton birth, Term gestations defined as pregnancies lasting between 37 and 41 weeks, Availability of baseline weight data obtained at 0–15 weeks' gestation, Availability of final weight data obtained within 2 weeks of delivery, Presence of recorded infant weight data, A documented height that enabled the calculation of Body Mass Index (BMI).

Exclusion criteria Participants who met any of the following criteria were excluded from the study the Mothers with chronic diseases and pregnancy

complications, Mothers who reported smoking during pregnancy, Neonates born with birth defects, Missing data for neonates or their mothers.

Data collection : the following data were collected for analysis: Maternal Characteristics: Maternal age, Parity (the number of live births at any gestation or stillbirth after 24 weeks),Educational level , Working status ,Mode of delivery, Consanguinity, Pre-pregnancy weight, Height used to calculate (BMI), The BMI was calculated by dividing the pre-pregnancy weight obtained at the first visit, 0–15 weeks gestation by the square meter of the height.

According to the World Health Organization, BMI for women is categorized into four groups : Underweight (BMI < 18.5 kg/m²) ,Normal weight (BMI 18.5–24.9 kg/m²) ,Overweight (BMI 25.0–29.9 kg/m²) ,Obese (BMI ≥ 30.0 kg/m²). Gestational weight gain was calculated by subtracting pre-pregnancy weight and maternal weight at the end of pregnancy (within 2 weeks of delivery). The recommended Total weight gain during pregnancy was categorized as follows : 12.5–18 kg for underweight mothers, 11.5–16 kg for normal-weight mothers, 7–11.5 kg for overweight mothers, 5–9 kg for obese mothers. Subgroups were created based on gestational weight gain and BMI, including: Inadequate gestational weight gain, Adequate gestational weight gain, Excess gestational weight gain. Neonate Characteristics: Neonatal birth weight and sex of the neonates were obtained from medical records data at the first visit for vaccination. Gestational age was determined based on the last menstrual cycle or the first ultrasound, and the date of birth, Newborns' birth weights and gestational age at birth were analyzed according to WHO growth charts . We defined two groups of abnormal growth: SGA (weight below the 10^{th} percentile) and LGA (weight above the 90^{th} percentile).

Statistical analysis: depending on whether the distribution was normal or skewed, continuous variables were expressed as means and standard deviations or medians with range. Categorical variables were expressed as frequency and percentages.

The One-way ANOVA (for normally distributed variables) and Kruskal-Wallis rank sum test (for non-normally distributed variables) were performed to test the difference between means and medians, respectively. The difference between categorical variables was investigated using Fisher's exact test. Pearson's correlation Coefficient was used to study the correlation between study parameters. in addition, univariate and multivariate logistic regression analysis was utilized to calculate the odds for large for gestational age baby. "Statulator" computer software to used to estate the sample size for the study.A P-value less than 0.05 was considered statistically significant. R software packages (dplyr, gt_summery and ggplot) were used for data processing, visualization, and statistical analysis ("R version 4.3.0, R Foundation for Statistical Computing, Vienna, Austria")

Results

Table 1: description of mother and infant characteristics

Characteristic	No. = 360[1]
Maternal age (years)	27.5 ± 5.7
Education	
Uneducated	10 (2.8%)
Primary	129 (35.8%)
Secondary	117 (32.5%)
College	104 (28.9%)
Occupation	
Housewife	299 (83.1%)
Employee	56 (15.6%)
Student	5 (1.4%)
Pre pregnancy weight (kg)	66.8 ± 12.2
Pre delivery weight (kg)	78.0 ± 12.9
Height (m)	1.6 ± 0.1
Pre pregnancy BMI (kg/m^2)	26.5 ± 4.6

Underweight	10 (2.8%)
Normal Weight	146 (40.6%)
Overweight	125 (34.7%)
Obese	79 (21.9%)
Pre delivery BMI (kg/m^2)	30.9 ± 4.8
Gestational weight gain (kg)	11.2 ± 4.8
Inadequate	111 (30.8%)
Excess	130 (36.1%)
Adequate	119 (33.1%)
Parity	1.0 (1.0 - 6.0)
1	207 (57.5%)
2	83 (23.1%)
3	50 (13.9%)
4	19 (5.3%)
6	1 (0.3%)
Infant sex	
Male	214 (59.4%)
Female	146 (40.6%)
Gestational age (weeks)	38.5 ± 1.0
Birth weight (kg)	3.5 ± 0.6
Adequate for gestational age (AGA)	228 (63.3%)
Large for gestational age (LGA)	129 (35.8%)
Small for gestational age (SGA)	3 (0.8%)
Presence of consanguinity	105 (29.2%)
Delivery method	
Caesarean section	212 (58.9%)
Vaginal delivery	148 (41.1%)
[1]Mean ± SD; n (%); median(range)	

Results in table 2 show the P value between study parameters and pre pregnancy BMI in which statically significant or not significant.

Table 2: study parameters stratified by pre-pregnancy BMI categories.

Characteristic	Underweight, N = 10[1]	Normal Weight, N = 146[1]	Overweight, N = 125[1]	Obese, N = 79[1]	P-value
Maternal age (years)	25.9 ± 3.7	26.1 ± 4.9	27.2 ± 5.6	0.5 ± 6.2	**<0.001**
Education					**0.004**
Uneducated	2 (20.0%)	2 (1.4%)	3 (2.4%)	3 (3.8%)	
Primary	3 (30.0%)	49 (33.6%)	42 (33.6%)	35 (44.3%)	
Secondary	0 (0.0%)	43 (29.5%)	51 (40.8%)	23 (29.1%)	
College	5 (50.0%)	52 (35.6%)	29 (23.2%)	18 (22.8%)	
Occupation					**0.023**
Housewife	8 (80.0%)	14 (78.1%)	113 (90.4%)	64 (81.0%)	
Employee	2 (20.0%)	30 (20.5%)	9 (7.2%)	15 (19.0%)	
Student	0 (0.0%)	2 (1.4%)	3 (2.4%)	0 (0.0%)	
Pre pregnancy weight (kg)	47.3 ± 4.0	57.2 ± 6.0	69.2 ± 6.3	3.2 ± 7.3	**<0.001**
Pre delivery weight (kg)	66.3 ± 10.1	68.6 ± 8.3	80.2 ± 8.3	3.3 ± 9.3	**<0.001**
Height (m)	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	.6 ± 0.0	0.087
Pre delivery BMI (kg/m^2)	24.8 ± 2.7	27.2 ± 2.5	31.7 ± 2.5	7.2 ± 3.4	**<0.001**
Gestational weight gain (kg)	19.0 ± 7.5	11.4 ± 4.6	11.1 ± 5.0	0.1 ± 3.6	**<0.001**
Inadequate	2 (20.0%)	86 (58.9%)	18 (14.4%)	5 (6.3%)	**<0.001**
Excess	4 (40.0%)	26 (17.8%)	58 (46.4%)	42 (53.2%)	
Adequate	4 (40.0%)	34 (23.3%)	49 (39.2%)	32 (40.5%)	
Parity	1.0 (1.0 - 2.0)	1.0 (1.0 -	2.0 (1.0 - 4.0)	.0 (1.0 -	**<0.001**

		4.0)		6.0)	
Infant sex					0.7
Male	6 (60.0%)	35 (58.2%)	79 (63.2%)	44 (55.7%)	
Female	4 (40.0%)	61 (41.8%)	46 (36.8%)	35 (44.3%)	
Gestational age (weeks)	38.9 ± 1.1	38.4 ± 1.0	38.5 ± 1.0	38.5 ± 0.9	0.5
Birth weight (kg)	3.1 ± 0.7	3.3 ± 0.6	3.5 ± 0.5	3.7 ± 0.5	**<0.001**
Adequate for gestational age (AGA)	6 (60.0%)	107 (73.3%)	77 (61.6%)	38 (48.1%)	
Large for gestational age (LGA)	2 (20.0%)	38 (26.0%)	48 (38.4%)	41 (51.9%)	
Small for gestational age (SGA)	2 (20.0%)	1 (0.7%)	0 (0.0%)	0 (0.0%)	
Presence of consanguinity	0 (0.0%)	45 (30.8%)	38 (30.4%)	22 (27.8%)	0.2
Delivery method					>0.9
Caesarean section	5 (50.0%)	87 (59.6%)	74 (59.2%)	46 (58.2%)	
Vaginal delivery	5 (50.0%)	59 (40.4%)	51 (40.8%)	33 (41.8%)	

[1]Mean ± SD; n (%)

[2]One-way ANOVA; Fisher's exact test; Kruskal-Wallis rank sum test

Figure 1 show the correlation coefficient (R) between pre-pregnancy BMI and gestational weight gain was found to be -0.13, with a corresponding p-value of 0.017, indicating a weak negative correlation between these variables. Conversely, the correlation coefficient between pre-pregnancy BMI and birth weight was 0.28, with a highly significant p-value of less than 0.001, suggesting a weak positive correlation between pre-pregnancy BMI and birth weight.

Table 3 overweight individuals exhibited an OR of 1.84 with a p-value of 0.022, suggesting a significant increase in LGA risk compared to normal weight individuals, even after adjustment for maternal age, and gestational weight gain. Similarly, obese individuals maintained a substantially higher risk after adjustment, with an OR of 3.51 and a highly significant p-value of less than 0.001.

Table3: risk of large for gestational age baby after adjustment for maternal age, and gestational weight gain.

Pre-pregnancy BMI	OR[1]	95% CI[1]	P-value[2]
Underweight	0.71	0.10, 2.98	0.7
Normal Weight (reference)	1.00		
Overweight	1.84	1.09, 3.10	**0.022**
Obese	3.51	1.92, 6.53	**<0.001**

[1]OR = Odds Ratio, CI = Confidence Interval

[2]Wald test

[*]Adjusted logit model

Table 4 show women with excess gestational weight gain exhibited an OR of 1.84 and a p-value of 0.021, indicating a significant increase in the risk of delivering an LGA baby compared to those with adequate weight gain.

Table 4: odds ratios for associations between gestational weight gain and neonatal birth weight (LGA).

Gestational weight gain	OR[1]	95% CI[1]	P-value[2]
Inadequate	0.94	0.53, 1.65	0.8
Adequate (reference)	1.00		
Excess	1.84	1.10, 3.11	**0.021**

[1]OR = Odds Ratio, CI = Confidence Interval

[2]Wald test

Discussion

Weight gain during pregnancy has been associated with birth weight and measures of adiposity early in the life of the neonate. Because high birth weight predicts BMI later in life . High birth weight may also increase the risk for other diseases later in life, including asthma, atopy, and cancer . During pregnancy, insulin resistance develops in the mother to shunt vital nutrients to the growing fetus. Excessive weight or weight gain during pregnancy exaggerates this normal process by further increasing insulin resistance and possibly also by altering other maternal hormones that regulate placental nutrient transporters. The resulting excessive rate of nutrient transfer stimulates fetal insulin secretion, overgrowth, and increased adiposity .In this study involving 360 pregnant women, it was observed that 36.1% (N=130) exhibited excess weight gain during pregnancy while 30.8% (N=111) experienced inadequate gestational weight gain. The mean weight gain was determined to be 11.2 ± 4.8 Kg. These findings align with similar studies; for instance, Marano *etal.,* conducted a descriptive study in Brazil in 2012, revealing that 35.6% had excess weight gain and 35.8% had inadequate weight gain. Similarly, Santos *etal.,* reported in 2012 that 45.5% had excessive gestational weight gain, closely mirroring the percentage of weight gain observed in this current study.However, a notable departure from these trends was evident in a cross-sectional study conducted by Lutfi *etal.,* in Iraq in 2023, which reported a considerably higher prevalence of excessive weight gain during pregnancy. In this Iraqi study, a striking 73% of the participants were noted to have gained excessive weight, with 11% experiencing insufficient weight gain during pregnancy. The elevated prevalence observed may not accurately reflect the genuine frequency of excess weight gain during pregnancy in Iraq, primarily due to their relatively small sample size of 114 participants.

The current study demonstrated a significant association between pre-pregnancy BMI categorized as overweight or obese and excessive weight gain during pregnancy ($p < 0.001$). This aligns with prior research conducted in Indonesia by Aji et al. in 2022, which similarly found that women identified as overweight or obese before pregnancy had a substantially higher likelihood of experiencing excessive gestational weight gain ($p = 0.011$).The current study showed that being overweight or obese before pregnancy could potentially pose a risk for delivering a large gestational-age baby. The odds ratio (OR) for an overweight group was calculated as 1.84 (P-value = 0.022). Furthermore, the study indicates a more pronounced risk for delivering a large gestational age baby among those classified as obese, with an OR of 3.51 (P-value <0.001), this significant association was obtained after adjustment for maternal age and gestational weight gain. Therefore, pre-pregnancy BMI in the range of overweight or obese is an independent predictor of LGA baby. Similarly, Wang *etal.,* conducted a prospective study in China in 2020, indicating that overweight or obese women had a 1.9-fold higher risk of delivering neonates classified as large for gestational age (OR = 1.9) Yu *etal.,* through a meta-analysis of 45 studies in 2013, affirmed that pre-pregnancy overweight or obesity significantly increased the risk of giving birth to neonates classified as large for gestational age (LGA) (OR, 1.53 and OR, 2.08). Furthermore, a cross-sectional study in Iran by Mohammad *etal.,* in 2023 concluded that a high mean pre-pregnancy BMI is significantly associated with increased birth weight. Additionally, obesity is often linked to chronic low-grade inflammation, which can impact placental function and nutrient transfer to the fetus.

The inflammatory milieu may affect the placenta's ability to regulate growth factors and nutrients, potentially leading to an environment conducive to larger fetal size . Moreover, obesity is commonly associated with conditions like gestational diabetes, which further amplifies the risk of delivering LGA neonates.

Insulin resistance, a hallmark of obesity, can contribute to gestational diabetes, and both conditions independently increase the likelihood of fetal overgrowth .In the present study, it was demonstrated that excessive gestational weight gain (GWG) serves as a potential predictor for delivering a large-for-gestational-age (LGA) baby, with an odds ratio (OR) of 1.84 (P-value = 0.021). This observation aligns consistently with the findings of various other studies. Ferraro et al. conducted a study in 2012, revealing that surpassing GWG guidelines was associated with elevated rates of LGA (OR 2.86). This association was also corroborated by Wang *etal.*, 2020 and Aji *etal.*,2022.

Conclusion

The current study concludes that the increase in BMI before pregnancy and the presence of excessive weight gain during gestation could potentially function as predictive factors for the birth of neonates who are large for gestational age. monitoring and managing pre-pregnancy weight, as well as ensuring appropriate gestational weight gain, could be crucial in identifying and addressing the risk of delivering larger-than-average babies.

Educational interventions aimed at promoting healthy pre-pregnancy lifestyles and providing guidance on optimal weight gain during pregnancy.

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