

Is gestational weight gain associated with timing of delivery?

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ABSTRACT

Objective: To evaluate whether excessive gestational weight gain (GWG) and change in body mass index (BMI) are associated with delivery timing among women delivering at term (≥ 37 weeks), independent of pre-pregnancy BMI.

Material and Methods: We conducted a retrospective single-center cohort study including 625 singleton pregnancies delivered between April 2022 and April 2025 at Istanbul Okan University Hospital. Pregnancies with major fetal anomalies, pre-existing maternal disease, induced labors, elective caesareans, or multiple gestations were excluded. GWG was classified according to 2009 Institute of Medicine criteria, and Δ BMI was calculated as end-of-pregnancy minus baseline BMI. The primary outcome was delivery at ≥ 41 versus < 41 weeks. Analyses included χ^2 , t-test/Mann-Whitney U, ANOVA, and multivariable logistic regression adjusting for maternal age, parity, pre-pregnancy BMI, smoking, education, and fetal sex.

Results: Mean maternal age was 28.8 ± 5.3 years; 17.4% delivered at ≥ 41 weeks. GWG was above recommendations in 40.2%, within recommendations in 36.0%, and below recommendations in 23.8%. In crude analyses, ≥ 41 -week delivery was more frequent among women above versus within IOM recommendations (21.5% vs. 14.7%, $p=0.036$). Δ BMI was higher in the ≥ 41 -week group (5.83 ± 1.81 vs. 4.99 ± 1.79 kg/m²; $p<0.001$). In adjusted models, GWG categories were not independently associated with ≥ 41 weeks. Compared with normal BMI, underweight (OR 0.18, 95% CI 0.05–0.66) and overweight (OR 0.35, 95% CI 0.16–0.76) women had lower odds. Smoking (OR 2.25, 95% CI 1.12–4.53) increased, while high-school education (vs university) decreased odds (OR 0.18, 95% CI 0.08–0.42).

Conclusion: Excessive GWG was linked to ≥ 41 -week delivery in unadjusted but not adjusted analyses, whereas higher Δ BMI remained associated. Findings underscore the complex role of weight dynamics in late-term pregnancy and support incorporating structured GWG counseling into antenatal care.

Keywords: Delivery timing, gestational weight gain, IOM guidelines, maternal body mass index, prolonged pregnancy.

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INTRODUCTION

Pregnancy extending beyond term has been linked to elevated maternal and neonatal risks, including adverse outcomes such as operative delivery and neurological complications in infants.^[1] Despite research efforts, the mechanisms initiating labor are not completely understood. Nutritional factors and BMI are considered potential influencers via endocrine pathways.^[2] Some studies have even suggested that caloric restriction may induce labor onset.^[3] With a national obesity rate of 23.9% in Türkiye,^[4] maternal BMI has become a critical factor in obstetric outcomes. Higher BMI levels are known to reduce spontaneous labor rates,^[5] whereas underweight women are more likely to deliver prematurely.^[6] Recent findings propose that excessive GWG, apart from pre-pregnancy BMI, may delay labor.^[7] It is important to note that the issue is not merely being overweight at conception but also gaining excessive weight during pregnancy.^[8] Several studies report that both inadequate and excessive GWG are associated with adverse obstetric outcomes.^[9,10] To address these issues, the Institute of Medicine published recommendations in 2009 outlining GWG ranges by BMI category.^[11] Several countries have developed their own versions to better suit local populations, often targeting risks such as small-for-gestational-age (SGA) or large-for-gestational-age (LGA) births.^[12–14] Considering the clinical importance of avoiding prolonged pregnancies, this study explored the role of GWG—a modifiable risk factor—in determining delivery timing among women delivering after 37 weeks. This study aimed to investigate whether excessive gestational weight gain, independent of pre-pregnancy BMI, is associated with the timing of delivery in term pregnancies, using a well-defined Turkish cohort.

MATERIAL AND METHODS

Study Design and Population

This retrospective single-center cohort study was conducted at Istanbul Okan University Hospital. Medical records of women with singleton pregnancies who delivered at or beyond 37 gestational weeks between April 2022 and April 2025 were reviewed. Pregnancies complicated by multiple gestations, deliveries <260 days, major fetal anomalies, pre-existing maternal diseases (e.g., chronic hypertension, diabetes mellitus), induced labors, and elective cesareans were excluded. Prior uterine surgery was also an exclusion criterion. To minimize indication bias related to provider decisions, we excluded induced labors and elective cesarean deliveries; this approach may limit generalizability and could introduce selection bias. Ethical approval was obtained from the Okan University Clinical Research Ethics Committee (Approval No: 190-4, Date: April 14, 2025). Due to the retrospective design, informed consent was waived. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data Collection and Variables

Gestational age was calculated using the last menstrual period and confirmed by first-trimester crown-rump length measurement. Maternal variables included age, parity, pre-pregnancy BMI, smoking status, and educational status (primary, high school,

university). Obstetric data included gestational age at delivery, mode of delivery (vaginal or cesarean), fetal sex, and infant birthweight. BMI change was calculated as the difference between end-of-pregnancy BMI and baseline BMI (kg/m²). Gestational weight gain (GWG) was recorded as total weight gain in kilograms and classified according to the 2009 Institute of Medicine (IOM) guidelines:

- Underweight: 12.7–18.1 kg
- Normal weight: 11.3–15.8 kg
- Overweight: 6.8–11.3 kg
- Obese: 5–9 kg

Pre-pregnancy BMI was categorized as underweight (<18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²), or obese (≥30 kg/m²).

Outcome Measures

The primary outcome was delivery timing, defined as delivery <41 weeks versus ≥41 weeks of gestation. Both categorical GWG (below, within, above IOM criteria) and continuous BMI change values were evaluated in relation to delivery timing.

Statistical Analysis

All analyses were performed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was tested using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range), and categorical variables as counts and percentages.

Comparisons: Independent samples t-test or Mann–Whitney U test was used for two-group comparisons depending on data distribution. Chi-square test was used for categorical variables. One-way ANOVA was performed for comparisons across more than two groups.

Multivariable analysis: Binary logistic regression was applied to identify independent predictors of delivery ≥41 weeks. Adjusted covariates included maternal age, parity, pre-pregnancy BMI category, smoking status, educational status, and fetal sex. Mode of delivery was not included because it lies on the causal pathway and may introduce bias.

Effect size: Cohen's d was calculated to estimate the magnitude of differences in BMI change between groups.

Significance: A p-value <0.05 was considered statistically significant. With the available sample (n=625), a sensitivity analysis indicated 80% power to detect a small between-group difference corresponding to Cohen's d=0.23 at α=0.05.

RESULTS

Participant Characteristics

A total of 625 women met inclusion criteria. The mean maternal age was 28.8±5.3 years (range: 17–44), mean gestational age at delivery was 278.5±8.1 days (~39+6 weeks), and mean birthweight was 3399±398 g. The average gravida was 1.8±1.2, while the parity was 0.7±1.3 (Table 1).

Table 1: Descriptive statistics of maternal and neonatal characteristics (n=625)

Variable	Min	Max	Mean	SD
Age (years)	17	44	28.8	5.31
Gravida	0	10	1.80	1.24
Parity	0	23	0.68	1.32
Abortus	0	6	0.14	0.53
Infant weight (g)	2000	4990	3399.4	397.8
Gestation (days)	257	294	278.5	8.14

SD: Standard deviation. Statistical note: Independent samples t-test or Mann–Whitney U test used depending on distribution; χ^2 test for categorical variables.

Categorical Characteristics

Pre-pregnancy BMI distribution was as follows: 6.9% underweight, 63.2% normal, 22.2% overweight, and 7.7% obese. By the end of pregnancy, 67.2% of women were overweight and 32.8% were obese. According to IOM criteria, 40.2% exceeded recommendations, 36.0% were within recommendations, and 23.8% were below recommendations. Most births were vaginal (84.8%). 17.4% of women delivered at ≥ 41 weeks, 23.5% reported smoking, and 68.6% were university graduates. Fetal sex distribution was balanced (49.4% female vs. 50.6% male) (Table 2).

Association Between IOM Categories and ≥ 41 Weeks Delivery

The proportion of ≥ 41 -week deliveries was significantly higher among women above IOM recommendations compared to those within the recommendations (21.5% vs. 14.7%, χ^2 p=0.036) (Table 3) (Fig. 1).

Multivariable Predictors of ≥ 41 Weeks Delivery

In logistic regression adjusted for maternal age, parity, BMI category, smoking, education, fetal sex, and delivery mode, IOM categories were not independently associated with ≥ 41 -week delivery. Compared with normal BMI, both underweight (OR=0.18, 95% CI: 0.05–0.66, p=0.009) and overweight women (OR=0.35, 95% CI: 0.16–0.76, p=0.008) were less likely to deliver post-term. Cesarean delivery was inversely associated with ≥ 41 weeks (OR=0.13, 95% CI: 0.08–0.21, p<0.001). Smoking increased the odds of ≥ 41 -week delivery more than twofold (OR=2.25, 95% CI: 1.12–4.53, p=0.023). High school education compared to university was associated with a lower likelihood of ≥ 41 -week delivery (OR=0.18, 95% CI: 0.08–0.42, p<0.001). Fetal sex showed no significant association (Table 4).

BMI Change and Delivery Timing

Women delivering at ≥ 41 weeks had a higher BMI change than those delivering earlier (5.83 \pm 1.81 vs. 4.99 \pm 1.79 kg/m²; mean difference 0.83, 95% CI: 0.46–1.20; p<0.001; Cohen's d=0.46) (Table 5).

Table 2: Distribution of categorical maternal and neonatal characteristics

Variable	n (%)
Initial BMI category	
Underweight	43 (6.9)
Normal	395 (63.2)
Overweight	139 (22.2)
Obese	48 (7.7)
Final BMI category	
Overweight	420 (67.2)
Obese	205 (32.8)
IOM category	
Below IOM	149 (23.8)
Within IOM	225 (36.0)
Above IOM	251 (40.2)
Mode of delivery	
Vaginal	530 (84.8)
Cesarean	95 (15.2)
Gestational age	
<41 weeks	516 (82.6)
≥ 41 weeks	109 (17.4)
Smoking	
No	478 (76.5)
Yes	147 (23.5)
Education	
Primary	34 (5.4)
High school	162 (25.9)
University	429 (68.6)
Fetal sex	
Female	309 (49.4)
Male	316 (50.6)

BMI: Body mass index; IOM: Institute of Medicine; Statistical note: χ^2 test used for group comparisons.

Table 3: Association between IOM categories and ≥ 41 weeks deliveries

IOM Category	<41 weeks (n)	≥ 41 weeks (n)	Total
Within IOM	319 (85.3%)	55 (14.7%)	374
Above IOM	197 (78.5%)	54 (21.5%)*	251

* χ^2 test; p=0.036*; IOM: Institute of Medicine.

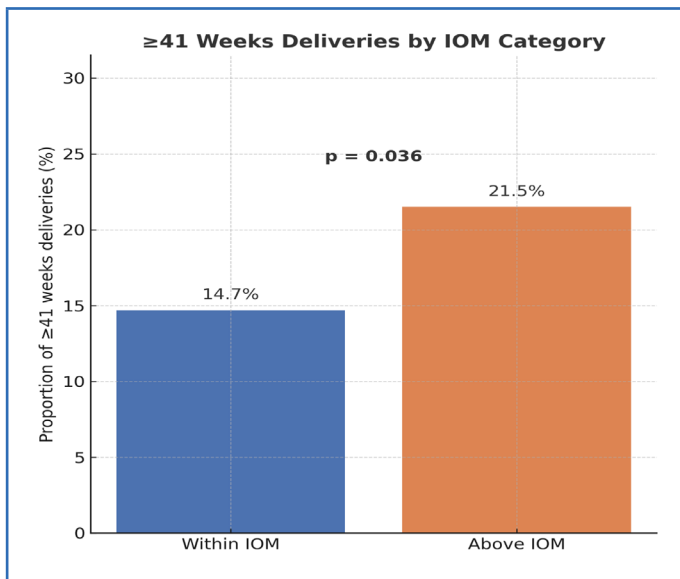


Figure 1: Deliveries at ≥41 weeks were more frequent in women above the IOM gestational weight gain recommendations compared with those within the IOM range (21.5% vs. 14.7%, p=0.036).

Table 4: Logistic regression analysis for predictors of post-term birth (≥41 weeks)

Variable	OR (95% CI)	p
BMI categories		
Underweight vs. Normal	0.18 (0.06–0.53)	0.002*
Overweight vs. Normal	0.35 (0.15–0.82)	0.015*
Obese vs. Normal	0.44 (0.19–1.04)	0.067
IOM weight gain		
Below vs. Within	0.93 (0.47–1.85)	0.845
Above vs. Within	0.99 (0.59–1.67)	0.977
Delivery mode		
Cesarean vs. Vaginal	0.13 (0.06–0.27)	<0.001*
Smoking		
Yes vs. No	2.25 (1.11–4.56)	0.023*
Maternal education		
Primary vs. University	0.18 (0.08–0.43)	<0.001*
High school vs. University	0.57 (0.28–1.16)	0.123
Fetal sex		
Female vs. Male	1.03 (0.61–1.73)	0.902
<41 weeks	109	5.83±1.81

OR: Odds ratio; CI: Confidence interval; IOM: Institute of medicine; BMI: Body mass index. Statistical note: Binary logistic regression. Adjusted covariates: maternal age, parity, pre-pregnancy BMI category, smoking, educational status, and fetal sex. *Statistically significant results are marked with an asterisk (*).

DISCUSSION

Risk factors for prolonged pregnancy include nulliparity, male fetus, prior post-term birth, obesity, and genetic predisposition.^[15] Among these, maternal weight is modifiable. Although obesity raises post-term delivery risk, our study focused on the impact of excessive GWG itself. Caughey et al.^[16] reported that reducing maternal BMI decreases the likelihood of delivering beyond 41 weeks. In our study, 56% of overweight and 52.4% of obese women exceeded IOM-recommended weight gain, compared to 32.5% and 34.1% of underweight and normal-weight participants. These rates surpass the 51% noted by Halloran et al.,^[17] suggesting regional differences in adherence. Victor et al.^[18] emphasized adjusting weight gain standards to reflect local nutrition patterns. Although some studies report a positive association between excessive GWG and prolonged gestation (e.g., Denison et al.^[11]), while others find no association (e.g., Nohr et al.^[19]), our adjusted model showed lower odds of ≥41 weeks among underweight and overweight women compared with normal BMI, and IOM GWG categories were not independently associated. This counterintuitive pattern may reflect selection mechanisms related to the exclusion of induced labors and elective cesareans, center-specific management practices, and residual confounding; therefore, these estimates should be interpreted with caution.^[16,17,19] Emerging evidence suggests that maternal endocrine pathways may underlie the association between excessive gestational weight gain (GWG) and prolonged gestation. Leptin, an adipokine reflecting maternal adiposity, increases during pregnancy and may inhibit uterine contractility via hypothalamic–pituitary modulation and prostaglandin synthesis pathways, potentially delaying labor onset.^[20] Conversely, ghrelin, a hunger-stimulating hormone, declines with advancing gestation and may influence pregnancy duration through its roles in placental angiogenesis and fetal growth regulation.^[21] Additionally, maternal serum leptin has been shown to mediate the relationship between third-trimester weight gain and insulin resistance, pointing to a broader metabolic mechanism linking GWG with gestational prolongation.^[22] Our findings underscore the importance of monitoring GWG by incorporating both absolute weight gain and BMI change in prenatal care. Behavioral interventions during pregnancy—particularly low-intensity programs focusing on diet, physical activity, and self-monitoring—have demonstrated effectiveness in reducing excessive GWG and improving postpartum weight outcomes.^[23] Population-level data further suggests that better GWG management may reduce rates of both preterm and post-term births, highlighting GWG as a modifiable risk factor in perinatal outcomes.^[24] Clinically, this supports integrating structured GWG counseling and lifestyle support into routine antenatal visits to potentially lower the incidence of post-term delivery, induced labor, and related complications.^[24] This retrospective single-center study is subject to unmeasured confounding. Maternal diet and physical activity, socioeconomic indicators, prior history of post-term pregnancy, and departmental induction policies were not recorded. Excluding induced labors and elective cesareans may have introduced selection bias, particularly if women with higher GWG/BMI were delivered before reaching post-term. Gestational BMI categories at term are reported descriptively and are not intended for clinical classification during pregnancy.

Table 5: Comparison of BMI change between women delivering <41 and ≥41 weeks

Delivery timing	n	Mean±SD (kg/m ²)	Mean difference (95% CI)	t (df)	p	Cohen's d
<41 weeks	516	4.99±1.79	Reference	Reference	Reference	Reference
≥41 weeks	109	5.83±1.81	-0.83 (-1.20, -0.46)	-4.38 (623)	<0.001	-0.46

*BMI change was significantly higher in women who delivered ≥41 weeks compared to those who delivered earlier. Statistical note: Independent samples t-test. BMI: Body mass index.

CONCLUSION

In unadjusted analyses, excessive gestational weight gain appeared to be associated with post-term delivery; however, this association did not remain significant after adjustment for confounders. Instead, greater maternal BMI change during pregnancy was independently associated with an increased likelihood of post-term birth, underscoring the importance of monitoring weight dynamics throughout gestation.

Disclosures

Ethics Committee Approval: The study was approved by Okan University Clinical Research Ethics Committee (No: 190-4, Date: 14.04.2025).

Informed Consent: Due to the retrospective design, informed consent was waived.

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