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Original Research Article

Prevalence and factors linked to inappropriate gestational weight gain: a cross-sectional study at Hung Vuong hospital

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ABSTRACT

Background: Gestational weight gain (GWG) serves as an indirect indicator of the nutritional and energy supply status for both mother and fetus throughout pregnancy. However, excessive GWG beyond recommended levels increases the risk of hypertensive disorders of pregnancy (HDP), gestational diabetes mellitus (GDM), macrosomia, and cesarean delivery, while inadequate GWG heightens the risk of fetal growth restriction and preterm birth. This study aimed to determine the proportion of pregnant women with inappropriate GWG according to the 2009 Institute of Medicine (IOM) recommendations, identify associated factors, and evaluate the relationships between GWG and pregnancy outcomes.
Methods: A cross-sectional study was conducted on singleton pregnant women managed from the first trimester until delivery at Hung Vuong Hospital, with data collected within 7 days postpartum. The study period spanned from April 2023 to May 2023.
Results: A total of 354 singleton pregnant women, who received regular prenatal care from the first trimester and delivered at Hung Vuong Hospital, were analyzed. The rate of inappropriate GWG was 58.8%. Three factors were identified as influencing inappropriate GWG: pre-pregnancy body mass index (BMI), history of preterm birth, and parity. Additionally, three associations were found between GWG and pregnancy outcomes: GDM, macrosomia, and newborn length greater than the 90th percentile.
Conclusions: The prevalence of inappropriate GWG was notably high (>50%). Pre-pregnancy BMI exhibited a strong association with GWG. Furthermore, a history of parity and preterm birth was linked to the risk of inappropriate GWG. Women with excessive GWG had an increased risk of macrosomia, while those with inadequate GWG faced a higher risk of GDM and a reduced likelihood of newborns with length exceeding the 90th percentile.

Keywords: Pregnant women, Gestational weight gain, Pre-pregnancy BMI

INTRODUCTION

Gestational weight gain (GWG) reflects the nutritional and energy provision for the mother and fetus during pregnancy.[1] Effective management of GWG is critical, as it not only mitigates short-term adverse outcomes for both mother and child but also supports long-term neonatal development.[2] In 2009, the Institute of Medicine (IOM) issued GWG recommendations tailored to different pre-pregnancy body mass index (BMI) categories, based on the World Health Organization's classification.[3] International studies demonstrate low adherence (<50%) to IOM gestational weight gain (GWG) recommendations, with pre-pregnancy BMI significantly influencing patterns: underweight women tend toward inadequate GWG, while overweight/obese women show excessive GWG.[4-8] GWG deviations correlate with adverse outcomes (gestational diabetes mellitus- GDM, hypertensive disorders, large for gestational age/small for gestational age- LGA/SGA).[8] However, most evidence

derives from Western populations with distinct epidemiological characteristics. Asian women exhibit higher body fat percentages at equivalent BMIs and greater metabolic risks, prompting the Asian Diabetes Association to establish lower BMI cutoffs.[9-11] Limited southeast Asian data, particularly from Vietnam, highlights the need for population-specific research using Asian-adapted guidelines to optimize maternal-fetal outcomes through tailored nutritional interventions. A 2014 study by Dao Cao Nguyen Anh at Gia Dinh People's Hospital, involving 490 cases, reported that 62.3% of women achieved GWG within the recommended range, while 20.8% and 16.9% exhibited inadequate and excessive GWG, respectively.[12] The study noted that women with a low pre-pregnancy BMI tended to gain less than recommended, whereas those with overweight or obese BMI were prone to excessive GWG, confirming associations between inappropriate GWG and adverse maternal and neonatal outcomes. Hung Vuong Hospital, a major maternity center, manages over 12,000 prenatal visits and 30,000 deliveries annually. However, no prior studies have investigated inappropriate GWG or its influencing factors and impacts on adverse pregnancy outcomes at this facility. Research on GWG aligned with 2009 IOM recommendations is thus essential to inform clinical strategies for managing high-risk pregnancies. Such findings could enhance health education efforts to reduce inappropriate GWG and establish personalized weight management protocols to improve pregnancy outcomes.

Objectives

Primary

To determine the proportion of singleton pregnant women at Hung Vuong Hospital with inappropriate GWG according to 2009 IOM recommendations.

Secondary

To identify factors associated with inappropriate GWG and examine association between GWG and maternal/fetal outcomes.

METHODS

It was a cross-sectional study.

Study population and setting

Singleton pregnant women monitored and delivered at Hung Vuong Hospital from April 2023 to May 2023.

Inclusion criteria

Singleton pregnant women receiving prenatal care at Hung Vuong Hospital from the first trimester, with complete screening tests (aneuploidy screening, fetal anomaly ultrasound, 75 gm glucose tolerance test) and delivery within 7 days of hospital admission.

Exclusion criteria

Pregnancy termination before 37 weeks, fetal anomalies, or pre-existing maternal diabetes.

Sample size estimation

Using the descriptive study formula:

$$n = \frac{Z^2_{(1-a/2)} \times p \times (1-p)}{d^2}$$

Based on Sun et al, the proportion of singleton pregnant women with inadequate GWG was 24.8%, and excessive GWG was 33.9%.[13] With p=24.8%- n=286.6; with p=33.9%- n=344.3. Thus, the minimum sample size was set at 345 cases.

Sampling and data collection

All eligible singleton pregnant women attending the outpatient clinic (department B) at Hung Vuong Hospital from April to September 2023 were included.

Statistical analysis

Descriptive statistics, odd ratios (OR), 95% confidence intervals (CI), and p values were calculated to assess associations.

RESULTS

A total of 354 singleton pregnant women were included. Table 1 presents the epidemiological characteristics of the study population.

Table 1: Epidemiological characteristics of study participants.

Characteristic	Frequency (n=354)	Percentage
Age (years)		
<35	296	83.6
≥35	58	16.4
Ethnicity		
Kinh	342	96.6
Hoa	5	1.4
Other	7	2.0
Occupation		
Office worker	131	37.0
Factory worker	93	26.3
Housewife	68	19.2
Business/trade	37	10.5
Other	25	7.0
Residence		
Ho Chi Minh City	135	38.1
Other provinces	219	61.9

Table 2: Multivariate analysis of inadequate GWG and related factors.

Characteristic	Inadequate GWG n=100 (%)	Adequate GWG n=254 (%)	aOR	95% CI	P value
BMI					
Underweight	23 (23.0)	27 (10.6)	1.92	1.02-3.62	0.043
Normal	63 (63.0)	143 (56.3)	1		
Overweight	8 (8.0)	60 (23.6)	0.30	0.13-0.66	0.003
Obese	6 (6.0)	24 (9.5)	0.57	0.22-1.47	0.248

Table 3: Multivariate analysis of excessive GWG and related factors.

Characteristic	Excessive GWG n=108 (%)	Non-excessive GWG n=246 (%)	aOR	95% CI	P value
Parity					
Nulliparous	62 (57.4)	119 (48.4)	1		
1 prior birth	36 (33.3)	103 (41.9)	0.39	0.21-0.71	0.002
≥2 prior births	10 (9.3)	24 (9.8)	0.35	0.14-0.87	0.023
Preterm history					
No	102 (94.4)	241 (98.0)	1		0.017
Yes	6 (5.6)	5 (2.0)	5.30	1.34-20.92	
BMI					
Underweight	3 (2.8)	47 (19.1)	0.21	0.06-0.73	0.014
Normal	43 (39.8)	163 (66.3)	1		
Overweight	43 (39.8)	25 (10.1)	8.31	4.37-15.78	0.000
Obese	19 (17.6)	11 (4.5)	7.57	3.21-17.85	0.000

Table 4: Multivariate analysis of GWG and maternal outcomes.

Outcome	Yes (%)	No (%)	aOR	95% CI	P value
GDM					
Adequate GWG	28 (19.2)	118 (80.8)	1		
Inadequate GWG	32 (32.0)	68 (68.0)	2.03	1.10 -3.75	0.024
Excessive GWG	19 (17.6)	89 (82.4)	0.75	0.36-1.54	0.426
Hypertension					
Adequate GWG	3 (2.1)	143 (97.9)	1		
Inadequate	1 (1.0)	99 (99.0)	0.57	0.06-5.93	0.637
Excessive	10 (9.3)	98 (90.7)	4.20	0.85-20.71	0.078
Cesarean					
Adequate GWG	62 (42.5)	84 (57.5)	1		
Inadequate GWG	38 (38.0)	62 (62.0)	0.87	0.48-1.58	0.636
Excessive GWG	58 (53.7)	50 (46.3)	1.52	0.83-2.80	0.176

Table 5: Multivariate analysis of GWG and neonatal outcomes.

Outcomes	Yes (%)	No (%)	aOR	95% CI	P value
Macrosomia					
Adequate GWG	6 (4.1)	140 (95.9)	1		
Inadequate GWG	2 (2.0)	98 (98.0)	0.52	0.10-2.79	0.447
Excessive GWG	14 (13.0)	94 (87.0)	3.94	1.25-12.44	0.019
Length>90th percentile					
Adequate GWG	16 (11.0)	130 (89.0)	1		
Inadequate GWG	2 (2.0)	98 (98.0)	0.15	0.03-0.70	0.016
Excessive GWG	12 (11.1)	96 (88.9)	0.93	0.36-2.37	0.873

The mean age of the study population was 29.94±4.95, with the following breakdown by weight gain groups: recommended weight gain group: 30.10±4.83, below recommended weight gain group: 30.26±4.70, above

recommended weight gain group: 29.44±5.33. The youngest participant in our study was 19 years old, while the oldest was 45 years old. The majority of the study population (83.6%) were under 35 years of age, whereas the ≥35-year-old group accounted for a minority (16.4%). Besides, 96.6% of the study participants were Kinh (the majority ethnic group in Vietnam). The remaining 3.4% comprised Hoa (Chinese-Vietnamese, 1.4%) and other ethnic minorities (2.0%). More than one-third (37.0%) of the participants were office workers, 26.3% were factory workers/industrial laborers. Homemakers, business/small traders, and other occupations accounted for 19.2%, 10.5%, and 7.0%, respectively. The majority (61.9%) lived in other provinces across Vietnam, 38.1% of the participants resided in Ho Chi Minh City.

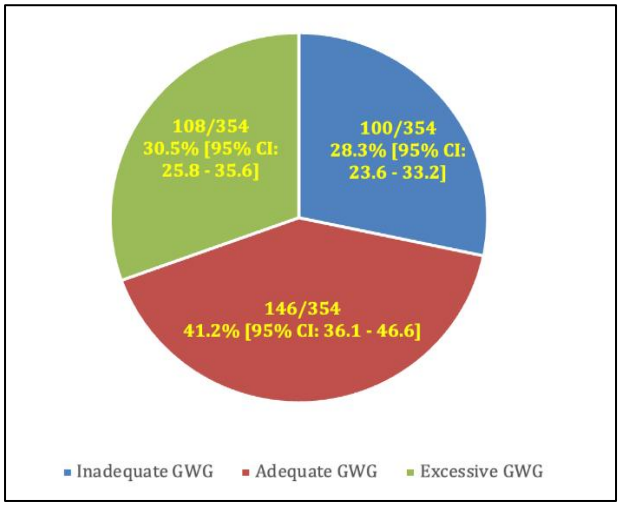

Table 1: Relative risk of abnormal Doppler indices with adverse perinatal outcome.

The proportion of study participants with inappropriate gestational weight gain according to 2009 IOM recommendations was 58.8% (95% CI=53.4-63.9). This included 28.3% (95% CI=23.6-33.2) of pregnant women with inadequate GWG and 30.5% (95% CI=25.8-35.6) with excessive GWG. Only 41.2% (95% CI=36.1-46.6) of pregnant women had GWG within the recommended range.

Underweight group had 1.92 times higher odds of inadequate GWG compared to the normal BMI group (aOR=1.92, 95% CI=1.02-3.62, p=0.043). While overweight group showed 70% lower odds of inadequate GWG versus the normal BMI group (aOR=0.30, 95% CI=0.13-0.66, p=0.003). In contrast, no significant association was found between pre-pregnancy obesity and inadequate GWG (p=0.248; 95% CI for aOR included 1).

Multivariable analysis revealed three independent predictors of excessive gestational weight gain (GWG). Multiparous women demonstrated significantly lower odds, with those having one prior birth showing 61% reduced odds (aOR=0.39, 95%CI=0.21-0.71, p=0.002) and those with ≥2 births showing 65% reduction (aOR=0.35, 95%CI=0.14-0.87, p=0.023) compared to nulliparous women. Conversely, women with preterm birth history had 5.30-fold higher odds of excessive GWG (aOR=5.30, 95%CI=1.34-20.92, p=0.017). Pre-pregnancy BMI showed particularly strong associations: overweight and obese women had 8.31-fold (95%CI=4.37-15.78) and 7.57-fold (95%CI=3.21-17.85) higher odds respectively (both p<0.001), while underweight women showed a 79% risk reduction (aOR=0.21, 95%CI=0.06-0.73, p=0.014) compared to normal BMI women.

After performing multivariable regression analysis to control for confounding and interacting factors while assessing the relationship between GWG and maternal/fetal outcomes, we observed that inadequate GWG group had 2.03 times higher odds of GDM compared to adequate GWG group (aOR=2.03, 95% CI=1.10-3.75, p=0.024), 0.15 times the odds (85% reduction) of infants with length >90th percentile (aOR=0.15, 95% CI=0.03-0.70, p=0.016). Besides, excessive GWG group had 3.94 times higher odds of LGA infants (aOR=3.94, 95% CI=1.25-12.44, p=0.019). The results also showed that no significant associations between GWG and those outcomes (hypertensive disorders of pregnancy, preterm birth, small for gestational age infants, neonatal length <10th percentile, Apgar scores <7 at 1 or 5 minutes, neonatal intensive care unit admission) (p=0.873; 95% CI included 1).

DISCUSSION

Gestational weight gain according to 2009 IOM recommendations

Our study employed the Asian Diabetes Association's (2000) BMI classification system, aligning with Sun et al and Wie, while contrasting with Dao who used WHO Asian criteria with a higher obesity cutoff (≥27.5 kg/m^2) while majority of other studies applying standard WHO classifications.[3,5-8,12-15] The majority of participants across studies, including ours (58.2%), Wie (64%), and Sun (72.3%), fell within the normal BMI range. However, our cohort showed distinct patterns: lower underweight prevalence (14.1% versus Dao's 21.6%) but higher overweight (19.2% versus 11.8%) and obesity rates (8.5% versus 1.7%), likely attributable to our urban focus (HCMC region), stricter prenatal monitoring, and lower BMI thresholds. Regional comparisons revealed consistent underweight prevalence (14.1% in our study versus 8.1-18.2% in other Asian studies), while overweight/obesity rates varied significantly (our 19.2%/8.5% versus Wie's 11.7%/8.8% and WHO-classification studies' 7.7-23.9%/1.2-10.8%). These disparities reflect methodological differences (55% of variance), temporal obesity trends (our 2023 data showing 1.8 times higher overweight rates than pre-2010 studies), and socioeconomic factors- exemplified by He's Singaporean cohort (23.9% overweight, 10.8% obese) underscoring development-related impacts.[5] The choice of BMI classification system particularly influenced obesity

prevalence, with Asian Diabetes criteria identifying 2.3 times more cases than WHO Asian standards in comparable populations.[3,7,8,14,15]

Our study found 58.8% of pregnant women had gestational weight gain (GWG) outside the 2009 IOM recommendations, comprising 28.3% with inadequate and 30.5% with excessive GWG, while 41.2% achieved recommended GWG. These findings align closely with Asian studies using comparable BMI classifications: Sun reported 58.7% non-adherent GWG and Wie 57.3%.[6,13] However, our cohort showed higher rates of inadequate GWG (28.3% versus 24.8% and 21.7%, respectively) but lower excessive GWG (30.5% versus 33.9% and 35.6%). This discrepancy may reflect temporal differences- Wie's 2000-2007 predated IOM guideline implementation at our clinical site. Notably, Dao reported substantially lower non-adherent GWG (37.7% overall: 20.8% inadequate, 16.9% excessive).[12] Stratified analysis revealed consistently higher non-adherence across all BMI categories in our study (52.0% versus 38.7% underweight; 51.5% versus 35.2% normal weight; 75.0% versus 46.6% overweight; 80.0% versus 62.5% obese), potentially attributable to their exclusion of chronic conditions (e.g., pre-existing diabetes, hypertensive disorders) known to influence GWG patterns. Among studies using WHO BMI criteria, non-adherence rates showed wider variation: comparable in He (59.3%) and Jiang (57%), but significantly higher in Li (63.2%), Asvanarunat (65.1%), and Enomoto (70.9%)- likely reflecting inconsistent application of IOM guidelines and BMI classification systems at those research sites during their study periods.[3,5,7,14,15]

Gestational weight gain and related factors

In our study, normal-weight women exhibited below-recommended (30.6%) and above-recommended (20.9%) gestational weight gain (GWG), while underweight women showed higher below-recommended GWG (46.0%) and lower above-recommended GWG (6.0%). Overweight/obese women predominantly had above-recommended GWG (63.2% and 63.3%, respectively). Multivariate analysis identified pre-pregnancy BMI as the sole predictor of below-recommended GWG, with underweight women having 1.92-fold higher odds (aOR=1.92, 95% CI=1.02-3.62, p=0.043) and overweight women 70% lower odds (aOR=0.30, 95% CI=0.13-0.66, p=0.003) versus normal BMI. Conversely, overweight/obese women had 8.31-fold (95% CI=4.37-15.78, p<0.001) and 7.57-fold (95% CI=3.21-17.85, p<0.001) higher odds of excessive GWG, while underweight women showed 79% reduced odds (aOR=0.21, 95% CI=0.06–0.73, p=0.014). These findings align with He, who reported similar BMI-dependent trends.[5] Additional predictors of excessive GWG included multiparity (61-65% lower odds vs nulliparas) and preterm birth history (5.30-fold higher odds). While consistent with Asian studies (Dao, Wie), our novel identification of parity and preterm history as contributors highlights the need for personalized GWG monitoring, particularly in high-risk groups.[6,12]

Association between gestational weight gain and maternal/fetal outcomes

Univariate analysis initially identified associations between gestational weight gain (GWG) and multiple outcomes (GDM, HDP, preterm birth, LGA, neonatal length >90th percentile). However, multivariate analysis controlling for confounders revealed only three significant relationships: (1) below-recommended GWG showed 2.03-fold higher GDM odds (aOR=2.03, 95% CI=1.10-3.75, p=0.024), potentially reflecting dietary interventions post-GDM diagnosis altering GWG patterns. (2) Above-recommended GWG was associated with 3.94-fold higher LGA risk (aOR=3.94, 95%CI=1.25-12.44, p=0.019).[3] Below-recommended GWG demonstrated 85% lower odds of neonates with length >90th percentile (aOR=0.15, 95% CI=0.03-0.70, p=0.016). Our cross-sectional design precluded causal inferences, and GDM cases were limited to 24-28 weeks' diagnosis. These findings align with Sun regarding LGA (OR=1.89) but contrast with Dao who reported GWG associations with cesarean delivery (aOR=2.2) and neonatal outcomes (Apgar<7: aOR=11.16) without controlling for key covariates.[12,13] While Li supported our GDM/LGA findings, they additionally reported GWG-HDP associations (aOR=2.55), possibly confounded by edema-induced weight measurement bias.[7] Heterogeneity across studies likely reflects differences in BMI stratification, clinical practices, and diagnostic criteria. Notably, hypertensive disorders and fetal growth restriction showed no GWG association, suggesting their pathogenesis depends more on vascular/placental factors than nutritional influences.

This cross-sectional study at Hung Vuong Hospital assessed gestational weight gain patterns but has inherent limitations. While suitable for prevalence estimates, the design cannot establish causality. The sample represents urban women with consistent prenatal care (middle-to-upper socioeconomic status), limiting generalizability. Retrospective weight data (measured before 14 weeks) may misclassify pre-pregnancy BMI and GWG categories. Unmeasured confounders (diet, exercise, clinical interventions) and modest sample size restricted deeper subgroup analyses. Outcomes were evaluated only until delivery, excluding postpartum maternal health and long-term neonatal outcomes. These factors should be considered when interpreting the associations between BMI, GWG, and pregnancy outcomes.

CONCLUSION

The rate of inappropriate GWG according to 2009 IOM recommendations among singleton pregnant women was 58.8% in our study (28.3% inadequate GWG, 30.5% excessive GWG). Pre-pregnancy BMI, parity, and preterm birth history were significantly associated with inappropriate GWG. Inadequate GWG increased GDM

risk, excessive GWG heightened macrosomia risk, and inadequate GWG reduced the likelihood of newborn length >90th percentile. This high rate of inappropriate GWG highlights the need for improved weight management protocols. The findings provide baseline data for developing targeted nutrition/exercise interventions and assessing the benefits of optimal weight gain on maternal-fetal outcomes.

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