Gestational weight gain advice to optimize infant birth weight in Japan: A quantile regression analysis of the Japanese nationwide perinatal database, 2013–2017

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Abstract

Objective: The optimal range of gestational weight gain (GWG) was recently raised in Japan. Considering that the effect of GWG on birth weight varies by quantile, this study performed hypothetical experiments to determine effective GWG advice to reduce small-for-gestational-age (SGA) infants while limiting the increase in large-for-gestational-age (LGA) infants. Design: Retrospective cohort study. Setting: The Japanese Society of Obstetrics and Gynecology nationwide perinatal database, 2013–2017. Population: A cohort of 354,401 primiparous singleton pregnancies. Methods: The association between GWG and birth weight for gestational age was analyzed using a quantile regression model. Based on the results, we estimated how hypothetical strategies targeting women of inadequate or excessive GWG might influence the proportions of SGA and LGA compared with a body mass index (BMI)-based uniform strategy. Main outcome measure: Birth weight for gestational age. Results: The estimated proportions of SGA and LGA in the study population were 9.33 and 11.13, respectively, whereas those in the BMI-based uniform strategy, which assumed a 3-kg increase in GWG for women with BMI < 25 kg/m², were 7.26 (95% confidence interval: 7.15–7.36) and 14.51 (14.37–14.66). By contrast, assuming a 3-kg increase and a 3-kg decrease in women with inadequate and excessive GWG, the estimated proportions of SGA and LGA were 8.42 (8.31–8.54) and 11.50 (11.37–11.62), respectively. Conclusions: When providing GWG advice, not only increasing GWG according to prepregnancy BMI, but also determining GWG adequacy and decreasing it when excessive GWG is observed, may be effective for optimizing birth outcomes.
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Funding information

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KEYWORDS

birth weight for gestational age, gestational weight gain, large-for-gestational-age, quantile regression analysis, small-for-gestational-age

1 | INTRODUCTION

Gestational weight gain (GWG) is a potentially modifiable factor that can prevent the occurrence of adverse maternal and infant outcomes, including small-for-gestational-age (SGA) and large-for-gestational-age (LGA) (1,2). Japan is a country with one of the lowest birth weights in the world (3). One of the reasons for this is thought to be the high prevalence of women classified as underweight and strict weight management of GWG (3–5). As a result, in 2021, the Japanese Society of Obstetrics and Gynecology (JSOG) raised the GWG target levels. The guidance now advises women classified as underweight (i.e., prepregnancy body mass index [BMI] < 18.5 kg/m²) to gain 12–15 kg (versus 9–12 kg previously), normal weight (i.e., 18.5 ≤ BMI < 25) to gain 10–13 kg (versus 7–12 kg), overweight (i.e., 25 ≤ BMI < 30) to gain 7–10 kg (versus no official recommendation), and obese (i.e., BMI ≥ 30) to gain ≥ 5 kg (versus no official recommendation).
by 40 weeks of gestation. Furthermore, GWG growth charts containing both the upper and lower limits of GWG by gestational age were recently developed to meet this new GWG guidance (6). However, the effectiveness of using these charts for reducing the proportion of SGA without increasing that of LGA in the population has yet to be verified.

Generally, GWG advice is given based on the optimal range according to prepregnancy BMI. However, the effect size of GWG on birth weight varies greatly by birth-weight quantiles; the impact of GWG on birth weight is much larger in the 90th than in the 10th birth-weight percentile (7,8). In other words, the conventional guidance of increasing GWG according to BMI will inevitably lead to an increase in LGA. It would be useful in real-world clinical practice to know how the estimated proportions of SGA and LGA would change when giving GWG advice based solely on prepregnancy BMI and when given based solely on GWG adequacy using the GWG growth charts.

Given this background, the objectives of the present study were, first, to determine the effect of GWG at different percentiles of birth-weight distribution by quantile regression analysis using a nationwide perinatal database, and second, to compare the SGA and LGA percentage change estimates in hypothetical experiments between a uniform GWG increase according to prepregnancy BMI and GWG changes based on GWG adequacy.

2 | METHODS

2.1 | Data source and study population

We used data from January 2013 to December 2017 of the JSOG perinatal database (9). This database consists of a nationwide registry that contains clinical information on all births after 22 weeks of gestation at registered participating obstetric facilities. Over the study period, a total of 1,128,073 births, including 6654 stillbirths, were recorded in the database, corresponding to 22.7% of all births in Japan published as national statistics (10).

Figure S1 shows the study design. First, singleton pregnancies (91.3% of the initial data) were selected by excluding multiple pregnancies, stillbirths, cases with congenital malformation, and maternal deaths. Then, pregnancies with a gestational age < 28 or > 41 weeks and multiparas were excluded. Subjects were also excluded when any of the following data were missing or implausible: maternal age, parity, prepregnancy weight, weight upon delivery, height, gestational age, smoking status, use of assisted reproductive technology (ART), infant sex, or birth weight. Maternal height < 50 cm or > 272 cm and maternal weight < 3 kg or > 200 kg were considered implausible. Subsequently, women with outlying height data (values outside ± 3 standard deviations [SD], equivalent to > 175.7 or < 141 cm), and weight data (outside ± 3 SD, equivalent to > 81.3 or < 24.7 kg) were excluded. Finally, a total of 354,401 primipara singleton pregnancies (31.4% of initial data) were eligible for analysis. For the sensitivity analysis with lower-risk pregnancies, 240,535 pregnancies (21.3% of the initial data) were further selected by excluding cases involving hypertensive disorders of pregnancy (HDP), diabetes mellitus (DM), autoimmune disease, ART, and smoking.

2.2 | Ethics approval

This study was approved by the Research Ethics Review Committee at Tokyo Medical and Dental University (No. M2019-226, 2019/11/22) and the Clinical Research Management and Review Committee of the Japan Society of Obstetrics and Gynecology (No. 100, 2020/7/27). All methods were performed in accordance with the relevant guidelines and regulations of the institutions. Informed consent was obtained from patients for the use of their data, which were collected during routine clinical practice for medical research purposes.

2.3 | Gestational weight gain at 40 weeks

GWG was calculated as the difference between maternal weight at 40 weeks of gestation and prepregnancy weight. In other cases when the mother did not deliver at 40 weeks, a predicted value of GWG at 40 weeks was calculated from the rate of weight gain as described previously (8,11). The rate of weight gain was
calculated for each woman based on a simple linear regression model for the relationship between gestational week and gestational weight.

2.4 | Adequacy of GWG by prepregnancy BMI

The recommended GWG ranges at 40 weeks are 12–15, 10–13, 7–10, and ≤ 5 kg for women classified as underweight, normal weight, overweight, and obese, respectively (6). The recommended GWG ranges at each week of gestation for each BMI category were based on the GWG growth charts published by Morisaki et al. (6). We classified the subjects whose GWG was within the appropriate range specific to the corresponding BMI as adequate, below the range as inadequate, and above the range as excessive. This classification was not applied to the obese group because no lower limit was set.

2.5 | Concordance of GWG adequacy over the gestational period

In clinical practice, guidance on weight gain during gestation is often provided in the second trimester; however, it is unclear to what extent the GWG adequacy assessed before 40 weeks using GWG growth charts is concordant with the GWG adequacy determined at 40 weeks. To overcome this challenge, we investigated the concordance of GWG adequacy from 15 to 40 weeks using weight gain data over the gestational period from a subsample of 859 women in a single-center pregnancy cohort (8). The details are described in the supporting information.

2.6 | Outcome measure

The birth weight for gestational age (BWGA) Z-scores and percentiles were calculated using Japanese neonatal anthropometric charts, which are specific to gestational age, infant sex, and parity (12). SGA and LGA infants were defined as having a BWGA below the 10th and above the 90th percentile, respectively.

2.7 | Statistical analysis

Descriptive statistics for the variables were presented as the mean [SD] or median and interquartile range for continuous variables, and n and percentage for categorical variables.

Multivariate quantile regression was used to analyze the effect of GWG on BWGA Z-scores at different quantiles of the distribution. The covariates were continuous variables such as maternal age, height, prepregnancy BMI (log-transformed because of the skewness of the BMI distribution), and dichotomous categorical variables such as smoking status during pregnancy, HDP, DM, autoimmune disease, and ART. Continuous variables were scaled to have a zero mean and unit variance by Z-score transformation to compare effect sizes across the investigated characteristics. Dichotomous categorical variables were coded as 0 (absence) or 1 (presence). The potential modifying effect of BMI on the GWG-BWGA association was accounted for by including the interaction of BMI and GWG in the model. Classical ordinary least squares linear regression models were also fitted with the same variables for comparison. For the sensitivity analysis, we repeated the multivariable quantile regression analysis, excluding women with HDP, DM, autoimmune disease, ART, and smoking during pregnancy.

We estimated the effects of hypothetical GWG change experiments using coefficient estimates from the quantile regression models. A detailed description of the quantile-based calculations is available in Supporting Methods 2. We calculated 95% confidence intervals with the bootstrap method (iterations of bootstrap resampling = 2000).

R software (version 4.2.3) was used for the statistical analyses. Quantile regression models were fitted using the quantreg R package (version 5.95) (13).

3 | RESULTS

3.1 | Population characteristics

Table 1 shows the population characteristics. Table S1 shows the classifications according to GWG adequacy by prepregnancy BMI category. Approximately 20% of the women were underweight and about 50% showed
inadequate GWG.

3.2 | Unequal effects of GWG on BWGA across quantiles

Figure 1 shows the coefficient estimates for GWG and covariates on BWGA across quantiles obtained by multivariable quantile regression analysis. As a reference, Tables S2 and S3 show the results of the conventional univariable and multivariable linear regression analyses. The effect of GWG on BWGA was small (0.21) in the smaller quantile, whereas it was large (0.25) in the 90th quantile. Similarly, BMI, DM, and ART had positive effects with larger effects in the 90th than in the 10th quantile. By contrast, HDP had a strong negative effect on BWGA, which was stronger in the 10th quantile. To varying degrees, autoimmune disease and smoking had negative effects, with a stronger effect in the 10th than in the 90th quantile.

A sensitivity analysis confirmed that differences in GWG effects across BWGA quantiles could be detected even in the population excluding women with HDP, DM, autoimmune disease, ART, and smoking (Figure S2).

3.3 | Hypothetical experiment to investigate the effects of uniform GWG increases on the proportions of SGA and LGA

In the present study population, the proportions (%) of SGA and LGA were 9.33 and 11.13, respectively (Table 2a). Among multiple factors, GWG is a modifiable factor that can reduce the proportions of SGA and LGA. Following general guidance, BWGA Z-scores were predicted using a quantile regression model, assuming a uniform 3-kg increase in GWG at 40 weeks for underweight and normal weight subjects. This hypothetical experiment 1 led to a 2.07% decrease in SGA, but a 3.38% increase in LGA (Table 2b).

3.4 | Hypothetical experiments to investigate the effects of GWG changes based on GWG adequacy on the proportions of SGA and LGA

A hypothetical experiment to examine the increase or decrease in GWG based on GWG adequacy assumes that GWG adequacy does not change much over gestational weeks. Therefore, we used gestational weight data of subpopulations to determine the concordance of GWG adequacy from 15 to 40 weeks and that at 40 weeks (Figure 2). The results revealed that many (> 70%) of those with inadequate GWG at 40 weeks had inadequate GWG from 15 weeks of gestation. In addition, more than half of the women who had excessive GWG at 40 weeks showed excessive GWG from at least 28 weeks of gestation.

Next, the following three hypothetical experiments were conducted: one involving a 3-kg GWG increase in women with inadequate GWG regardless of underweight, normal weight, or overweight (hypothetical experiment 2); one involving a 3-kg GWG decrease in women with excessive GWG regardless of underweight, normal weight, or overweight (hypothetical experiment 3); and one involving a 3-kg GWG increase in women with adequate GWG and a 3-kg GWG decrease in women with excessive GWG regardless of underweight, normal weight, or overweight (hypothetical experiment 4) (Table 2c–e). Hypothetical experiment 4 resulted in a 0.91% decrease in SGA and only a 0.37% increase in LGA (Table 2e).

4 | DISCUSSION

4.1 | Main findings

Based on the results of the quantile regression models using a large nationwide perinatal database in Japan, we investigated what strategy regarding GWG would be effective in decreasing SGA while not substantially increasing LGA. The results revealed that the strategy of uniformly increasing GWG according to prepregnancy BMI decreased SGA by 2.1%, but increased LGA by 3.4%, more than 1.5 times the rate. By contrast, the strategy of increasing GWG in the inadequate group and decreasing GWG in the excessive group reduced SGA while only increasing LGA by less than half that rate. Sub-analyses were also performed, and showed that GWG adequacy remained concordant through mid-to-late gestation in most women.

4.2 | Interpretation
GWG has unequal effects on birth weight by quantile. A previous study that conducted a quantile regression analysis reported that an uniform reduction in GWG was effective for reducing the risk of macrosomia (7). This strategy may be effective in countries plagued with obesity. By contrast, in Japan, low birth weight is more problematic, as it is characterized by a high proportion of lean women and a significantly lower GWG compared with other countries (3,6). While the optimal GWG range according to BMI was recently raised to address this issue, the present results suggest that a uniform 3-kg GWG increase among underweight and normal weight women may unintentionally increase the proportion of LGA by 3.4%. This large increment was not surprising because the GWG regression coefficient was abruptly elevated in the higher BWGA quantile (Figure 1). This finding supports the importance of recognizing the unequal effects of GWG across birth-weight quantile distributions.

In our quantile regression model, several factors previously reported to be associated with birth weight were included for adjustment (Figure 1). Among the covariates (14–17) that reduced birth weight, HDP and smoking showed a stronger effect in the lowest quantile. Among the covariates (7,17–20) that increased birth weight, prepregnancy BMI, DM, and ART showed apparent unequal effects on BWGA. A higher regression coefficient for ART was observed in the upper tail of the BWGA distribution; this can be explained by the fact that more than 90% of pregnancies with ART that result in live births are via frozen–thawed embryo transfer, which is known to be associated with an increased risk of LGA (21). The interaction term between prepregnancy BMI and GWG was negative and constant across BWGA distributions, indicating that the regression coefficient for GWG gradually decreases as BMI increases, regardless of the BWGA distribution. However, in both cases of low and high BMI, the regression coefficient for GWG rose sharply in the higher BWGA quartiles.

For GWG management in clinical practice, it is important to assess whether weight gain is within the adequate range throughout pregnancy. Using the recently developed GWG charts, the present study first analyzed whether the adequacy of GWG is concordant through 15–40 weeks of gestation (Figure 2). The results showed that 70% of women with inadequate GWG at 40 weeks had already been assessed as inadequate as early as 20 weeks, regardless of prepregnancy BMI. More than 60% of women with excessive GWG at 40 weeks were concordantly assessed as excessive at 30 weeks. It has been reported that weight gain in mid-to-late gestation is associated with an increased risk of low birth weight and/or macrosomia (1). Therefore, it was considered reasonable to conduct hypothetical experiments to evaluate the strategies in which GWG increased or decreased according to GWG adequacy.

In the hypothetical experiments, the effects of 3-kg increases on BWGA in the case of inadequate GWG and 3-kg decreases in the case of excessive GWG were compared, both alone and in combination (Table 2). To the best of our knowledge, no such approach leveraging the latest GWG charts has been reported. The value of 3 kg is not important because it may be difficult to change the weight by 3 kg. More importantly, due to the inequality of the GWG effect, simply advising women with an inadequate GWG to increase their GWG will inevitably lead to an increase in LGA. The present study clearly demonstrated the importance of recommending both an increase in GWG to women with inadequate GWG and a decrease in GWG to women with excessive GWG.

4.3 | Strengths and limitations

The main strength of the present study is the large study size, which comprised nationwide data with detailed information about maternal and neonatal characteristics. The large sample size made it possible to estimate the effects of multiple maternal factors, including GWG, at various BWGA distribution quantiles. Due to the fact that nationwide data were used, the risk of selection bias was also avoided. The second strength of this study is that it was performed shortly after new GWG guidelines were published. Dissemination of the present results might help prevent clinicians from focusing only on the increased GWG target. An increase in LGA may be unintentionally brought if attention is paid only to the increase in GWG according to pre-pregnancy BMI, adhering to the new guidance. Third, we used a unique approach of evaluating the effect of hypothetical strategies. The advantage of taking such an approach is that it allows us to judge whether a strategy is good or bad without having to conduct real-world trials.
However, this study also has a few limitations. Because the amount of weight gain was increased by 3 kg in the new Japanese guidance, the hypothetical weight change in the intervention was analyzed as 3 kg, but there was no specific rationale for this value. In reality, it may be difficult to manage a 3 kg weight gain or loss throughout the entire gestation period. However, even if the 3-kg value itself were different, the unequal GWG effect across birth-weight distributions would still be the same; therefore, we nevertheless conclude that focusing solely on raising GWG would not ultimately change the trend of increasing LGA. Further research is therefore necessary to verify how the SGA and LGA rates will change as a result of the weight control in the new guidelines.

5 | CONCLUSION

Although raising the GWG target was an important step for optimizing birth weight in Japan, it is not sufficient. Our quantile regression analysis revealed the importance of using the newly developed GWG standard charts to assess GWG adequacy and recommending weight gain when inadequate and weight loss when excessive.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Lead author NS participated in the study design, conducted the analysis, wrote the original manuscript, and created the tables and figures. RH prepared and curated the data set and edited the manuscript. NM acted as the supervisory author and assisted with editing the manuscript.

ETHICS APPROVAL

This study was approved by the Research Ethics Review Committee at Tokyo Medical and Dental University (No. M2019-226, 2019/11/22) and the Clinical Research Management and Review Committee of the Japan Society of Obstetrics and Gynecology (No. 100, 2020/7/27). All methods were performed in accordance with the relevant guidelines and regulations of the institutions. Informed consent was obtained from the patients for the use of the data collected during routine clinical practice for medical research purposes.

FUNDING INFORMATION

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REFERENCES


<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean [SD] or Median (IQR)</th>
<th>n (%)</th>
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</thead>
<tbody>
<tr>
<td>Prepregnancy BMI (kg/m²)</td>
<td>20.4 (18.8, 22.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean [SD] or Median (IQR)</td>
<td>n (%)</td>
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<tr>
<td>----------------------</td>
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</tr>
<tr>
<td>GWG (kg/40 weeks)</td>
<td>10.4 [3.9]</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>158.3 [5.4]</td>
<td></td>
</tr>
<tr>
<td>Age (year)</td>
<td>31.4 [5.7]</td>
<td></td>
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<tr>
<td>Fetal sex (male)</td>
<td></td>
<td>184,040 (51.9)</td>
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<tr>
<td>ART</td>
<td></td>
<td>60,850 (17.2)</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td>23,029 (6.5)</td>
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<tr>
<td>HDP</td>
<td></td>
<td>24,336 (6.9)</td>
</tr>
<tr>
<td>GDM</td>
<td></td>
<td>18,305 (5.2)</td>
</tr>
<tr>
<td>Overt DM (Type 1)</td>
<td></td>
<td>853 (0.2)</td>
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<tr>
<td>Overt DM (Type 2)</td>
<td></td>
<td>1,123 (0.3)</td>
</tr>
<tr>
<td>Autoimmune disease</td>
<td></td>
<td>3,375 (1.0)</td>
</tr>
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</table>

Abbreviations: SD, standard deviation; IQR, interquartile range; BMI, body mass index; GWG, gestational weight gain; ART, assisted reproductive technology; HDP, hypertensive disorders of pregnancy; GDM, gestational diabetes mellitus; DM, diabetes mellitus.

**TABLE 2.** Effects of different hypothetical strategies on the proportions of SGA and LGA.

<table>
<thead>
<tr>
<th></th>
<th>SGA (%)</th>
<th>LGA (%)</th>
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<tbody>
<tr>
<td>(a) Observed data (current status)</td>
<td></td>
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<tr>
<td>Underweight</td>
<td>2.33</td>
<td>1.32</td>
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<tr>
<td>Normal weight</td>
<td>6.35</td>
<td>8.43</td>
</tr>
<tr>
<td>Overweight/obese</td>
<td>0.65</td>
<td>1.38</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9.33</strong></td>
<td><strong>11.13</strong></td>
</tr>
<tr>
<td>(b) Estimates in hypothetical experiment 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>1.76 (1.70-1.81)</td>
<td>1.89 (1.83-1.95)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>4.85 (4.76-4.93)</td>
<td>11.24 (11.11-11.37)</td>
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<tr>
<td>Overweight/obese</td>
<td>0.65 (0.62-0.68)</td>
<td>1.38 (1.34-1.43)</td>
</tr>
<tr>
<td>(c) Estimates in hypothetical experiment 2</td>
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<tr>
<td>Underweight</td>
<td>1.89 (1.83-1.94)</td>
<td>1.62 (1.56-1.66)</td>
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<tr>
<td>Normal weight</td>
<td>5.53 (5.43-5.62)</td>
<td>9.43 (9.30-9.55)</td>
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<tr>
<td>Overweight/obese</td>
<td>0.61 (0.58-0.64)</td>
<td>1.47 (1.42-1.52)</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>8.02 (7.91-8.13)</strong></td>
<td><strong>12.51 (12.37-12.64)</strong></td>
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<tr>
<td>(d) Estimates in hypothetical experiment 3</td>
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<tr>
<td>Underweight</td>
<td>2.39 (2.33-2.46)</td>
<td>1.23 (1.18-1.27)</td>
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<tr>
<td>Normal weight</td>
<td>6.67 (6.57-6.77)</td>
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<td>Overweight/obese</td>
<td>0.68 (0.65-0.72)</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>9.74 (9.62-9.86)</strong></td>
<td><strong>10.12 (10.00-10.24)</strong></td>
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<tr>
<td>(e) Estimates in hypothetical experiment 4</td>
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<tr>
<td>Underweight</td>
<td>1.94 (1.88-2.00)</td>
<td>1.53 (1.48-1.57)</td>
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<tr>
<td>Normal weight</td>
<td>5.84 (5.75-5.94)</td>
<td>8.61 (8.50-8.72)</td>
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<tr>
<td>Overweight/obese</td>
<td>0.64 (0.61-0.67)</td>
<td>1.36 (1.31-1.41)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8.42 (8.31-8.54)</strong></td>
<td><strong>11.50 (11.37-11.62)</strong></td>
</tr>
</tbody>
</table>

Hypothetical experiment 1: uniform 3-kg GWG increase in underweight and normal weight women.

Hypothetical experiment 2: only a 3-kg GWG increase in underweight, normal weight, and overweight women with inadequate GWG.
Hypothetical experiment 3: only a 3-kg GWG decrease in underweight, normal weight, and overweight women with excessive GWG.

Hypothetical experiment 4: a 3-kg GWG increase in underweight, normal weight, and overweight women with inadequate GWG and a 3-kg GWG decrease in underweight, normal weight, and overweight women with excessive GWG.

**FIGURE 1** Effect of maternal factors, including gestational weight gain (GWG) on birth weight for gestational age (BWGA) across BWGA quantiles.

The black dots and gray bands indicate the coefficient estimates at each quantile and 95% confidence interval (CI), respectively. The red and blue solid and dashed lines indicate the OLS coefficients and their 95% CIs, respectively, which were obtained using conventional multivariable linear regression analysis. The red and blue codes show the positive and negative effects. The OLS coefficient value is shown at the top of each graph. The interval of the gray horizontal lines is 0.04. Coefficients of continuous variables refer to a change in outcome in response to a change of 1 standard deviation equivalent. Diabetes mellitus includes gestational diabetes mellitus and overt diabetes mellitus (Type 1 and Type 2). OLS, ordinary least squares; BMI, body mass index; ART, assisted reproductive technology; HDP, hypertensive disorders of pregnancy.

**FIGURE 2** Concordance of gestational weight gain (GWG) adequacy across gestational weeks.

Proportion of GWG adequacy at each week of pregnancy among groups classified by GWG adequacy at 40

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weeks. The solid line and gray band indicate the regression line and 95% confidence interval. The top, middle, and bottom panels indicate underweight, normal weight, and overweight women, respectively, and the left, middle, and right panels indicate inadequate, adequate, and excessive GWG at 40 weeks, respectively. The number and percentage of subjects comprising each panel are shown in Table S5. The panels on the left show that > 70% of women with inadequate GWG at 40 weeks showed inadequate GWG from mid-gestation. The panels on the right show that most women with excessive GWG at 40 weeks showed excessive GWG from around 28 weeks of gestation.
Inadequate GWG at 40 weeks

Adequate GWG at 40 weeks

Excessive GWG at 40 weeks

Underweight
Normal weight
Overweight

Proportion

Week