BMJ Open

Development and evaluation of percentile distribution of body weight by gestational week as a tool for gestational weight management: a retrospective study based on hospital routine data

Yi Zhang,[1] Liping Wang,[2] Chuanmin Yin,[3] Kai Mu,[1] Dayan Niu,[1] Weili Yan[1]

[1]Department of Clinical Epidemiology, Children's Hospital of Fudan University, Shanghai, China
[2]Maternal and Infant Health Center, International Peace Maternity & Child Health Hospital of China Welfare Institute, Shanghai, China
[3]Nutrition Department, Obstetrics and Gynecology Hospital of Fudan University, Shanghai, China

Correspondence to
Dr Weili Yan;
yanwl@fudan.edu.cn

ABSTRACT

Objectives This study aimed to construct and validate smoothed gestational weight centile curves based on preconception weight status for Chinese pregnant women.

Design A retrospective study based on hospital routine data

Setting Hospital prenatal care.

Population A cohort of pregnant Chinese women with preconception and gestational body weights without maternal or neonatal complications (sample 1, n=2992), and a non-selective independent sample (sample 2, n=7420), were selected from hospital routine data for curve construction and validation.

Study design Smoothed body weight centile curves for each gestational week were constructed using the LMS method in sample 1. Validation in sample 2 included analysis of agreement between predicted weight at the 38th week and observed values using the Bland–Altman Index. Predictions were also compared with international curves.

Results Smoothed centile curves of gestational weight for the three preconception body mass index groups showed a similar non-linear increasing trend. The differences between predicted body weights and observed values were 0.66±1.58 kg, 0.14±1.61 kg and −0.54±2.06 kg in the underweight, normal weight and overweight groups, respectively. Bland-Altman Index values were 5.2%, 5.6% and 4.7% in the underweight, normal weight and overweight groups, respectively, with limits of agreement of −2.4~3.8 kg, −3.0~3.3 kg and −4.4~3.4 kg, respectively. These limits of agreement were narrower than those of available international curves.

Conclusion Body weight percentiles for gestational weeks 0–42 were proposed for underweight, normal weight or overweight Chinese women. These curves could constitute a useful tool for individualised gestational weight management by predicting body weight at a later gestation phase.

INTRODUCTION

Promoting healthy gestational weight gain (GWG) is important for preventing obstetric and perinatal morbidity. Low weight gain during pregnancy is associated with intra-uterine growth retardation, low birth weight and future risk of metabolic diseases.[1–3] Meanwhile, excessive weight gain is related to maternal and fetal complications during pregnancy[4–6] as well as adverse events later in life,[7 8] such as childhood obesity, type 1 diabetes and hypertension. Although recommendations for GWG management are used in antenatal care for monitoring pregnancy weight, the optimal GWG remains controversial.[9]

The recommendations of the Institute of Medicine (IOM)[10] for gestational weight management in pregnancies with different weight statuses are well known worldwide; however, the reference population mainly included western individuals, with the WHO body mass index (BMI) classification[10] used for defining the preconception weight status. Studies have suggested that IOM recommendations might not be suitable for Chinese

Strengths and limitations of this study

► The proposed smoothed percentile curves of gestational weight covered the entire gestation period, from 0 to 42 weeks for the Chinese population by three preconception weight statuses.
► Two independent study samples were used to increase reliability of our findings, one for curve development and the other for validation.
► In the validation analysis, we described how to apply the proposed curves for individualised weight management by computing individualised ideal body weight goals for later gestation weeks based on their weight before or during early gestation.
► The sample size was large in the normal weight group, however, it was relatively limited in the underweight and overweight groups.

pregnancies.[11 12] One reason is the difference between the Chinese BMI classification ($24\,kg/m^2$ and $28\,kg/m^2$ for overweight and obesity, respectively) and the preconception weight status in the WHO classification. Another reason is the racial difference in weight gain, as demonstrated in recently published international GWG reference curves constructed by the International Fetal and Newborn Growth Consortium for the 21st Century (INTER-GROWTH-21) Project. The latter study found higher GWG in Chinese subjects compared with other racial groups.[13]

Meanwhile, strong associations of early weight gain with adverse pregnancy outcomes have been reported,[14 15] even with excessive adipose body composition in mid-childhood.[16] Recommendations for total GWG and weekly rate of weight gain in the second and third trimesters were proposed by IOM; however, recommendations for early gestation were not stressed.[10] The recent standards generated by the INTERGROWTH-21 project only alert clinicians regarding GWG changes within 14–42 weeks, but not for earlier stage of gestation in normal weight women. The importance of early pregnancy weight management was highlighted[13] and deserves more attention.

Above all, weight management during pregnancy is of great importance to maternal and child health. However, there are no unified weight management standards during pregnancy for Chinese women, especially describing the optimal weekly rate of weight gain. Therefore, this study used longitudinal data from pregnancies without maternal or fetal complications to generate centile body weight curves, from 0-42 gestational weeks, for Chinese pregnant women in three weight groups with preconception weight status. With such curves, each individual could compute the optimal weight for any gestational week based on current weight, which can be adopted as personal ideal targets for gestational weight management. In addition, the algorithm was validated in a separate sample. We expect the generated curves to serve as a useful tool for individualised weight management during pregnancy.

MATERIALS AND METHODS

A retrospective cohort of healthy pregnancies was assembled from the electronic medical records of the Obstetrics and Gynecology Hospital of Fudan University, Shanghai, in 2011, to generate the centile curves (derivation cohort).

An independent sample of pregnancies (n=7420) from the International Peace Maternity and Child Health Hospital of the China Welfare Institute (validation cohort) was used to validate the generated centile curves. Clinical data from first antenatal visit to delivery were abstracted. Preconception body weights were not available. No subjects were excluded (pregnancies with adverse maternal or neonatal complications were included).

WHO recommends GWG charts to use longitudinal data in a selected population with low prevalence of maternal and fetal complications, including anthropometric measures before and during pregnancy.[17] Considering the WHO recommendations and improved

representativeness of curves, inclusion criteria in this study comprised Han ethnicity, singleton conception, availability of preconception weight records and healthy pregnancy. Healthy pregnancy was defined by the following criteria: (1) Fasting glucose at first antenatal visit below 5.6 mmol/L. (2) Pregnancy without adverse maternal complications such as pregnancy-induced hypertension or gestational diabetes mellitus (GDM). (3) Pregnancy without neonatal complications, such as fetal growth restriction, fetal distress, low birth weight (<2500 g), preterm, macrosomia, or Apgar scores below 9 at 1 min or 5 min. The participants' characteristics, perinatal data and neonatal outcomes, including birth weight, height, gestational age and clinical diagnosis, were obtained from the hospital's electronic medical records.

Self-reported preconception weights and heights in obstetric records were used to calculate preconception BMI values. Based on the Chinese BMI classification,[18] participants were classified into the underweight (preconception BMI<$18.5\,kg/m^2$), normal weight (preconception BMI≥$18.5\,kg/m^2$ and <$24\,kg/m^2$) and overweight (preconception BMI≥$24\,kg/m^2$) groups. Gestational age was determined by the last menstruation at the time of registration, and corrected by first trimester ultrasonography examination if the difference exceeded 5 days. Serial anthropometric measurements were carried out on calibrated scales at each antenatal care.

Hypertension in pregnancy was defined as diastolic blood pressure over 90 mm Hg or systolic blood pressure over 140 mm Hg after 20 weeks of pregnancy in women who had a normal blood pressure at the onset of pregnancy. Low birth weight was defined as birth weight under 2500 g, and macrosomia as a birth weight over 4000 g. The mother's weight at term was recorded. GWG was obtained by subtracting the weight at delivery from that recorded preconception, and categorised as insufficient, appropriate and excessive, according to the currently used IOM recommendations for the underweight, normal weight and overweight groups.[10] GWG represented the difference from first antenatal care to delivery, and was evaluated according to the IOM recommendations in the derivation cohort.

DATA ANALYSIS

A significance level of α=0.05 was used for all tests. Descriptive statistical analysis was performed with Stata V.11 (StataCorp, College Station, Texas, USA). Continuous variables were analysed by t-test, and categorical variables by the χ^2 test.

Smoothed centile curves of gestational weight by gestational age were generated based on the derivation cohort for the underweight, normal weight and overweight groups by the the lambda, mu, sigma (LMS) method.[19] The LMS method assumes the Box–Cox power transformation to normalise the data at each age to independent positive values; L, M and S values are cubic splines with knots at each distinct age (t), and were fitted by the maximum penalised likelihood method to create three

smooth curves: L(t) Box–Cox power transformation, M(t) median and S(t) coefficient of variation. LMSchartmaker (Pro V.1.35, 2006; Cole and Green[20]) was employed to create smoothed 5th, 10th, 25th, 50th, 75th, 90th and 95th centile curves, respectively. We then used the worm plot for residual analysis and determining the goodness of fit, to build a preliminary model. The worm plot shape indicated that the data were similar to the assumed underlying distribution.

Centiles curves at a given gestational week were obtained as:

$C100\alpha(t) = M(t)(1 + L(t)S(t)Z\alpha)^{1/L(t)}$ (Formula 1)

$$Z_\alpha = \frac{(C100\alpha(t)/M(t))^L - 1}{L(t) \times S(t)} \text{ (Formula 2)}$$

where Zα is the SD of the whole sample, and C100α (t) is the corresponding percentile.

The validation cohort was used to assess the constructed percentile curves. First, individual preconception BMI classification was defined based on the observed body weight at early gestation. Z-scores were calculated for body weight at the 16th, 20th and 24th weeks, respectively, based on overall gestational weight curves (online supplementary S-table 1), and their average was defined

as Z_1-score to compute preconception weight by Formula 1. Each subject was classified into the underweight, normal weight or overweight group based on the estimated preconception weight. Second, the corresponding centile curves and LMS parameters were used to compute body weight for the 38th week. Third, we compared body weights for the 38th week between actual and predicted values by Student's *t*-test. The Bland-Altman plot[21] was used to examine agreement between actual and predicted weights in the three groups, separately. In the four scatter plots generated, the x-axis represented the mean of paired measurements recorded with two weights, while the y-axis reflected the difference between actual and predicted weights, also known as the bias. The results were interpreted by the Bland-Altman Index,[21] defined as percentage of the difference between predicted and actual weights falling beyond the limit of agreement (LOA). LOA was defined as bias ±1.96*precision, where precision was the SD of the bias. A Bland-Altman Index value of less than 5% indicated good agreement between actual and predicted weights values. We also performed simple linear correlation analysis to assess consistency.

Table 1 Demographics and characteristics of derivation cohort and validation cohort

Characteristics	Derivation cohort				Validation cohort
	With preconception weight	Without preconception weight	Difference	P values	
Age, years, mean	28.5 (2.9)	28.6 (3.3)	–0.1	0.256	29.4 (3.3)
Preconception weight, kg mean (SD)	53.9 (7.2)	–	–	–	
Height, cm, mean (SDs)	162.6 (4.7)	162.3 (4.7)	0.3	0.039	162.1 (5.0)
Preconception BMI, kg/m^2, mean (SD)	20.4 (2.4)	–	–	–	
BMI at the first antenatal visit, kg/m^2, mean (SD)	20.5 (2.6)	21.4 (2.7)	0.9	<0.001	22.5 (2.9)
Gestational age at the first antenatal visit, weeks, mean (SD)	17.0 (2.2)	16.0 (2.1)	1	<0.001	24.9 (4.5)
Gestational age at delivery, weeks	39.2 (1.1)	39.1 (1.1)	0.1	0.016	38.6 (1.5)
Baby birth weight, g, mean (SD)	3323(330)	3326.2 (325)	–3.25	0.729	3324.3 (452)
Macrosomia n (%)	525/8657 (6.1)	–	–	–	365/5394 (6.7)
Weight at the first antenatal visit, kg	57.7 (8.0)	56.6 (8.0)	1.1	0.005	59.3 (8.4)
Weight delivery, kg, mean (SD)	70.7 (8.6)	70.8 (8.7)	–0.1	0.748	70.0 (8.9)
Gestational weight gain (kg), mean (SD)					
<18.5	12.9 (5.0)	14.7 (4.6)	1.6	<0.001	–
18.5–24	13.1 (3.9)	14.4 (3.9)	1.3	<0.001	–
≥24	11.7 (3.7)	12.9 (4.2)	1.2	<0.001	–
GWG exceeded the IOM recommendations, n (%)			–	–	–
<18.5 kg/m^2	67/666 (10.0)	39/245 (15.9)	–	–	–
18.5–24 kg/m^2	538/2109 (25.5)	517/1535 (33.7)	–	–	–
≥24 kg/m^2	97/217 (44.7)	162/317 (51.1)	–	–	–

GWG obtained by subtracting the body weight at first antenatal visit from the weight at delivery.
BMI, body mass index; GWG, gestational weight gain; IOM, Institute of medicine.

Recently, the INTERGROWTH-21 project proposed an international GWG reference curve for normal weight women based on data from eight counties, including China.[13] The preconception BMI of the reference study sample ranged from 18.5 kg/m^2 to 24.9 kg/m^2. To verify the obtained centile distribution curves, a subgroup sample from the validation cohort (with available body weight for the 24th and 38th weeks, and the same preconception BMI) was selected for assessment at the 38th week for gestational weight, comparing prediction between the INTERGROWTH-21 reference curve and current data by the Bland-Altman method.

Patient and public involvement

This study is a retrospective data analysis based on routine electronic medical records from two hospitals and was approved by two institutional ethics committees. The extracted data set for analysis did not include patients' personal information. Patients were not involved in the design, recruitment or any measurements of the study. No dissemination of result to patients is planned.

RESULTS

Description of the derivation cohort

There were 10 685 pregnancies in the study derivation cohort. Of these, 5258 pregnancies with no available preconception weights were excluded; 2420 pregnancies were further excluded for adverse maternal complications; 15 pregnancies with adverse neonatal complications were also excluded. Finally, 2992 healthy pregnancies remained for data analysis, including 666, 2109 and 217 pregnancies in the underweight, normal weight and overweight groups, respectively.

As shown in table 1, selection of a study derivation cohort for constructing gestational weight curves may bring bias. Some characteristics of mothers and neonates in the selected healthy pregnancies with available preconception weights differed from those without preconception weights; these differences were statistically significant but with limited clinical significance. The excluded subjects comprised 20.7% with GDM, 7.6% with diagnosed diabetes before gestation, 2.8% with fasting plasma glucose ≥5.1 mmol/L during pregnancy, 5.3% with premature newborns, 3.2% with low birthweight neonates, 6.1% with macrosomia, 1.8% with small for gestational age and 10.4% with fetal distress. GWG from first antenatal care to delivery exceeded the recommended GWG, defined by the IOM recommendations as 10.0%, 25.5% and 44.7% for underweight, normal weight and overweight individuals, respectively, in the derivation cohort.

Gestational weight centile curves

Figure 1 depicts centile curves of gestational weight by gestational age (0–42 weeks) for the underweight, normal weight and overweight groups, respectively. The three sets of curves were similar in shape, but different in percentile weight levels. The 5th, 50th and 90th percentiles of GWG from 0 to 42 weeks for the three groups are presented in table 2. Weight gains determined at the 38th week based on median curves were 15.6 kg, 16.1 kg and 14.6 kg for the underweight, normal weight and overweight groups, respectively, with highest and lowest values in the normal weight and overweight groups, respectively. In the normal weight group, the 10th, 50th and 90th percentiles of body weight at the onset of pregnancy were 48.6 kg, 54.4 kg and 61.4 kg, becoming 55.4 kg, 62.4 kg and 70.9 kg at the 24th week, and 62.5 kg, 70.5 kg and 79.8 kg at the 38th week, respectively. The 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles of gestational weight for gestational weeks 0 to 42 are shown in online supplementary S-table 2–4; L, M and S parameters by gestation week (0 to 42) are presented for the underweight, normal weight and overweight groups, as well as all subjects in online supplementary S-table 1.
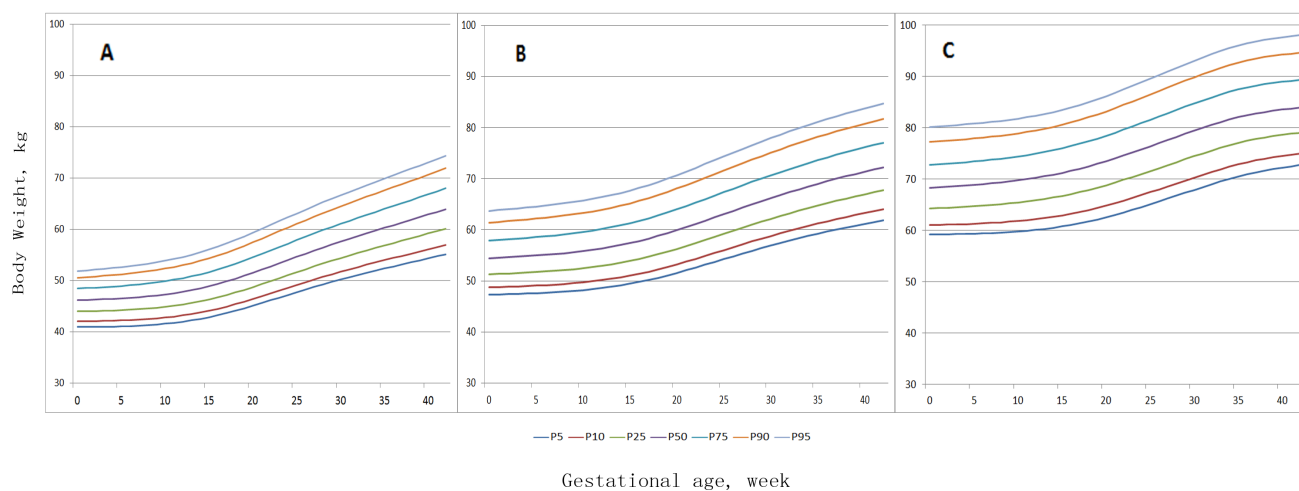

Figure 1 Gestational weight centile curves for underweight (A), normal weight (B) and overweight (C) pregnancies.

Table 2 Percentiles of gestational weight gain (GWG) by gestational age (week) for pregnant women with different preconception weight status

Gestation age, week	Underweight(kg) BMI<18.5 kg/m²			Normal weight(kg) BMI=18.5 kg/m²–23.9 kg/m²			Overweight (kg) BMI≥24 kg/m²		
	P5	P50	P95	P5	P50	P95	P5	P50	P95
0	40.9	46.2	51.9	47.3	54.4	63.7	59.0	69.3	84.7
1	41.0	46.2	52.0	47.3	54.5	63.8	59.2	69.5	85.0
2	41.0	46.3	52.1	47.4	54.6	64.0	59.4	69.8	85.4
3	41.0	46.4	52.3	47.4	54.7	64.2	59.6	70.0	85.7
4	41.0	46.5	52.5	47.5	54.8	64.3	59.7	70.3	86.0
5	41.1	46.5	52.6	47.6	55.0	64.5	59.9	70.5	86.3
6	41.1	46.6	52.8	47.7	55.1	64.7	60.1	70.8	86.6
7	41.2	46.8	53.0	47.8	55.2	64.9	60.2	71.0	86.9
8	41.3	46.9	53.3	47.9	55.4	65.2	60.4	71.3	87.2
9	41.4	47.1	53.6	48.0	55.6	65.4	60.6	71.5	87.4
10	41.6	47.3	53.9	48.2	55.8	65.7	60.8	71.8	87.7
11	41.8	47.5	54.2	48.4	56.1	66.0	60.9	72.0	87.9
12	42.0	47.8	54.6	48.6	56.3	66.4	61.1	72.2	88.2
13	42.3	48.1	55.0	48.8	56.7	66.8	61.3	72.5	88.4
14	42.5	48.5	55.5	49.1	57.0	67.2	61.5	72.7	88.7
15	42.9	48.9	56.0	49.4	57.4	67.7	61.7	73.0	88.9
16	43.3	49.4	56.6	49.8	57.8	68.2	61.9	73.3	89.2
17	43.7	49.8	57.2	50.2	58.3	68.8	62.2	73.6	89.5
18	44.1	50.4	57.9	50.6	58.8	69.4	62.5	74.0	89.8
19	44.6	50.9	58.6	51.1	59.3	70.0	62.8	74.4	90.2
20	45.1	51.5	59.3	51.6	59.9	70.7	63.2	74.8	90.6
21	45.6	52.1	60.1	52.1	60.5	71.4	63.6	75.3	91.1
22	46.1	52.8	60.8	52.6	61.1	72.1	64.0	75.8	91.6
23	46.7	53.4	61.6	53.1	61.8	72.9	64.5	76.3	92.1
24	47.2	54.0	62.3	53.7	62.4	73.6	65.0	76.9	92.7
25	47.7	54.6	63.1	54.2	63.1	74.4	65.5	77.5	93.3
26	48.3	55.3	63.8	54.8	63.7	75.1	66.1	78.0	93.8
27	48.8	55.9	64.6	55.3	64.4	75.8	66.6	78.6	94.4
28	49.3	56.4	65.3	55.9	65.0	76.6	67.1	79.1	95.0
29	49.8	57.0	66.0	56.4	65.6	77.3	67.6	79.6	95.5
30	50.2	57.6	66.6	56.9	66.2	77.9	68.1	80.2	96.0
31	50.7	58.1	67.3	57.4	66.8	78.6	68.6	80.7	96.5
32	51.1	58.7	68.0	57.9	67.4	79.3	69.1	81.2	97.1
33	51.5	59.2	68.6	58.4	67.9	79.9	69.6	81.7	97.6
34	51.9	59.7	69.2	58.8	68.5	80.5	70.1	82.2	98.1
35	52.4	60.3	69.9	59.3	69.0	81.1	70.6	82.6	98.5
36	52.8	60.8	70.5	59.7	69.5	81.7	71.1	83.1	99.0
37	53.2	61.3	71.2	60.1	70.0	82.2	71.5	83.5	99.4
38	53.6	61.8	71.8	60.5	70.5	82.8	71.9	83.9	99.7
39	54.0	62.4	72.4	60.8	70.9	83.3	72.3	84.2	100.0
40	54.3	62.9	73.1	61.2	71.4	83.8	72.6	84.5	100.3
41	54.7	63.4	73.7	61.5	71.8	84.2	73.0	84.8	100.6

Continued

Table 2 Continued

| Gestation age, week | Underweight(kg) | | | Normal weight(kg) | | | Overweight (kg) | | |
| | BMI<18.5 kg/m^2 | | | BMI=18.5 kg/m^2–23.9 kg/m^2 | | | BMI≥24 kg/m^2 | | |
	P5	P50	P95	P5	P50	P95	P5	P50	P95
42	55.1	63.9	74.4	61.9	72.2	84.7	73.3	85.1	100.8
GWG (0–42), kg	14.2	17.7	22.5	14.6	17.8	21.0	14.3	15.9	16.1
GWG (0–40), kg	13.4	16.7	21.2	13.9	17.0	20.1	13.6	15.2	15.6
GWG(0–38), kg	12.6	15.6	19.9	13.2	16.1	19.1	12.9	14.6	15.0

Validation of the curves

Overall, the predicted weights were close to the actual ones observed. The differences were reduced in the underweight and normal weight groups compared with the overweight group (0.66±1.58 kg, 0.14±1.61 kg and −0.54±2.06 kg, respectively; all p<0.001). The actual weights were well correlated with the predicted values in all three groups (correlation coefficients of 0.92, 0.96 and 0.95 for underweight, normal weight and overweight individuals, respectively; all p<0.001). Bland-Altman Index values were 5.2%, 5.6% and 4.7%, respectively, for the underweight, normal weight and overweight groups, indicating that nearly 5% of subjects had gestational weights beyond 95% CIs of predicted weights at the 38th week (figure 2 and online supplementary S-table 1).

Comparison with the INTERGROWTH-21 gestational weight curve

A subgroup sample with normal preconception body weights (n=2302, preconception BMI=18.5 kg/m^2– 24.99 kg/m^2) from the validation cohort was selected for comparison. The actual body weight at 38th week was 70.7±6.3 kg. Meanwhile, the predicted body weights based on centile curves proposed by the current study and INTERGROWTH-21[13] were very similar (70.7±6.1 kg

and 69.7±7.1 kg, respectively). Bland-Altman Index values were 4.7% and 4.0%, respectively; however, narrower limits of agreement were obtained from the current study (LOA$_{current\ study}$, −3.9~3.9 vs LOA$_{INTERGROWTH-21}$, −7~5) (figure 3).

DISCUSSION

Based on longitudinal body weight records of a group of healthy pregnancies without maternal or neonatal complications during gestation as the derivation cohort, we constructed the first gestational weight centile curves of the three preconception BMI categories over the entire pregnancy in Chinese women. The proposed gestational weight centile curves were validated in an independent sample and showed good agreement between predicted and actual body weights for an upcoming gestational week, especially in pregnancies with normal preconception BMIs. The performance in predicting the body weight for a later gestational week was also improved compared with using newly published international curves.

Maternal GWG management is a key component of prenatal care. A centile curve based on pregnant Chinese women may be helpful for weight management in the
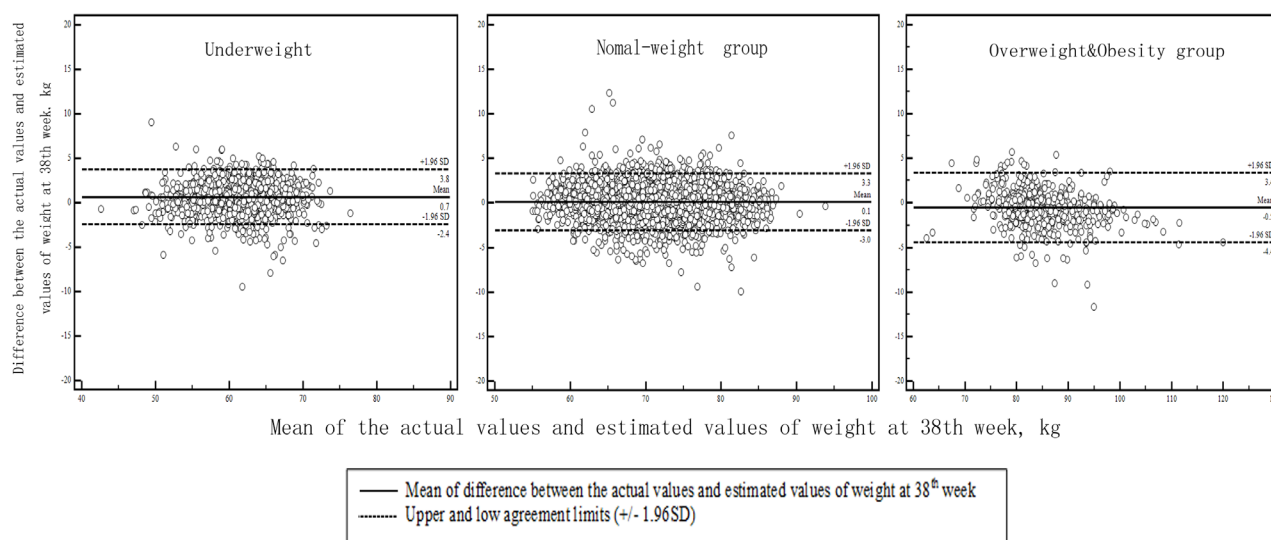

Figure 2 Bland-Altman plot assessing the agreement between the actual values and predicted values of body weight at the 38th week for three groups of pregnancies with different preconception weight status.
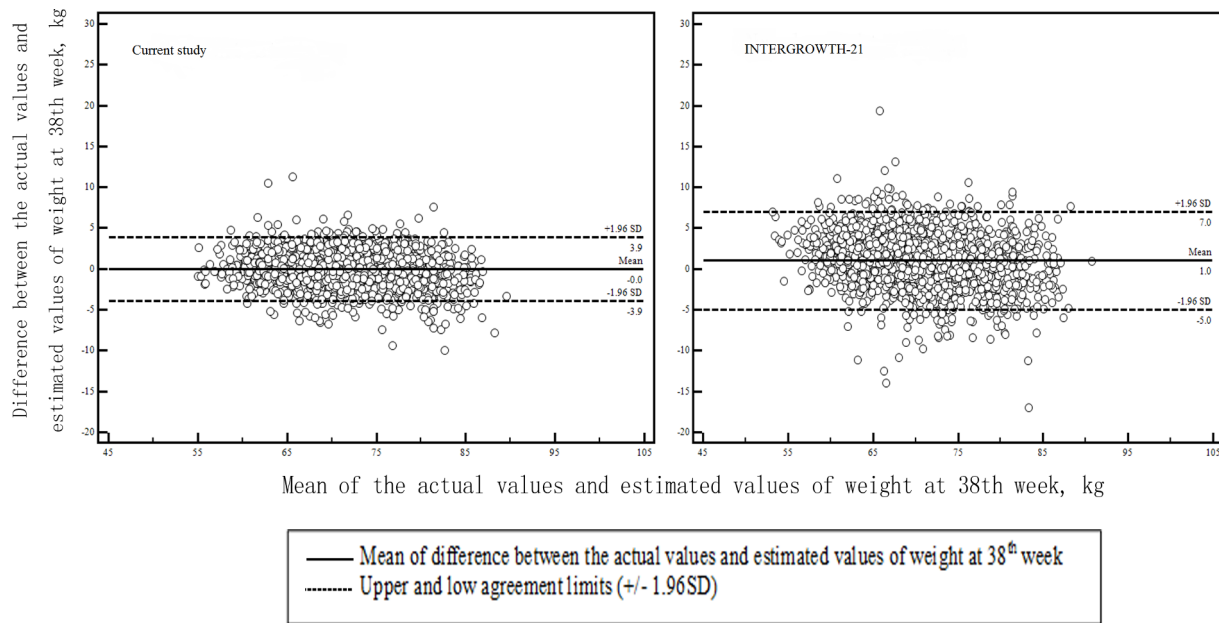
Figure 3 Bland-Altman plot assessing the agreement between actual values and predicted values of body weight at the 38th week by using reference curves of gestational weight gain (GWG) proposed by the current study and INTERGROWTH-21 (n=2302 from the validation cohort).

pregnant population of China. Recommendations for GWG were first established by IOM in 1990 and amended in 2009 for the three pregnant weight statuses, when faced with the increasing prevalence of obesity, elevated age of pregnant women and new knowledge about pregnancy.[10 22 23] Studies using the IOM recommendations in Chinese pregnancies demonstrated that excessive weight gain in pregnant Chinese women is a serious problem.[24 25] In the INTERGROWTH-21 project, healthy pregnant Chinese women (accounting for 10% of the sample size) showed significantly higher GWG compared with other ethnic groups.[13] Therefore, gestational weight management for Chinese women needs race-specific recommendations that may allow for greater GWG.

The current study proposed smoothed centile curves of gestational weight for pregnant Chinese women with three merits. First, three sets of centile curves provided an optimal weight for any future gestational week based on the individual's current or preconception weight, specifically for underweight, overweight and obese pregnancies, who are not included in recent international GWG curves.[13] Second, the three sets of curves covering early stage of gestation, make individualised weight gain recommendations for early gestation possible. Eun-Hee Cho found that excessive weight gain in early pregnancy is a significant risk factor for multiple adverse pregnancy outcomes among Korean women, who are similar to Chinese women in terms of racial background.[26] Other studies have reported that excessive weight gain in early pregnancy increases the incidence of impaired glucose tolerance[27] and GDM,[28] as well as the birth weight of the offspring.[29] The three curves recommended a weekly rate of GWG, at weeks 0 to 42, and could help manage gestational weight in the entire pregnancy period. Finally, the algorithm generated based on

curves was able to predict the weight at any given gestational week accurately. The difference between predicted and actual weights was smallest for normal weight pregnancies, followed by the underweight and overweight/obese groups. By selecting a subsample from the validation cohort in the current study with the same BMI range as INTERGROWTH-21 subjects, predicted body weights at the 38th week obtained by curves from this study were consistent with the actual weights, but with increased precision compared with INTERGROWTH-21 references. Compared with two previous studies based on Singaporean[11] and Chinese[12] populations, the current study was superior in methodology.

Gynaecologists, obstetricians and pregnant women undertaking individualised weight management can apply the gestational weight centile curves proposed in this study. Based on the preconception weight status or the weight during early gestation, the proposed algorithm could help individual pregnant women estimate the recommended body weight for subsequent gestational weeks.

Several limitations should be considered in the interpretation of these results. First, preconception weights and heights were self-reported by patients, indicating a possible recall bias. Second, selection criteria for healthy pregnancy were based on characteristics from clinical records, and blood indicators such as glycosylated haemoglobin and insulin, were not available. Third, the sample size was limited, especially for the underweight and overweight groups. Fourth, the representativeness of the current study is limited since the derivation cohort was from a single hospital. Future perspective studies with larger sample sizes and broader representativeness are expected to improve the proposed curves.

CONCLUSIONS

We proposed and validated the first gestational weight centile curves by gestational week for pregnant Chinese women with different preconception weight statuses. The generated curves could serve as a useful tool for individualised gestational weight management. The curves for women with normal weights before pregnancy yielded more accurate predictability for subsequent gestational weeks; those of underweight and overweight pregnant women need improvement in future studies with larger sample sizes.

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