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Original Article

Effect of pre-pregnancy body mass index and gestational weight gain on perinatal outcomes

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Abstract: Objective: To analyze the effects of pre-pregnancy body mass index (BMI) and gestational weight gain (GWG) and their relationship with adverse perinatal outcomes in pregnant Chinese women. Methods: A retrospective cohort study of 3531 single pregnant women who received prenatal examinations and gave birth in the First Affiliated Hospital of Jinan University from December 2018 to June 2020 was conducted on the influence of pre-pregnancy BMI and gestational weight gain on perinatal outcomes. Results: Pre-pregnancy overweight and obese women had a higher risk of gestational diabetes mellitus (GDM), gestational hypertension, macrosomia, cesarean section and neonatal asphyxia than pre-pregnancy underweight and normal weight women (P<0.05). Inadequate GWG women were more likely to have GDM, preterm delivery and low birth weight infants than the women who were classified as having recommended and excessive GWG (P<0.05). Excessive GWG women had higher risk of cesarean section, gestational hypertension and macrosomia than the women who were classified as inadequate GWG and within the recommended GWG (P<0.05). Conclusions: Different pre-pregnancy BMI and GWG had different effects on pregnancy outcomes. Controlling pre-pregnancy BMI and GWG within a recommended range can effectively reduce the morbidity of maternal and infant outcomes and improve the perinatal outcomes.

Keywords: Obesity, pre-pregnancy body mass index, gestational weight gain, cesarean section, macrosomia, perinatal outcomes

Introduction

With the changes of modern lifestyle, the proportion of women who are overweight and obese among women of childbearing age is gradually increasing, pre-pregnancy excess weight and obesity are closely related to pregnancy outcomes including pregnancy complications and delivery methods. Being overweight or obese is related to a poor diet, not enough exercise and other habits. The unhealthy habits of overweight or obese pregnant women before pregnancy may be inherent to pregnancy, especially when they have not received guidance on the importance of a healthy pregnancy body and quality management in early pregnancy, which affects the control of the body weight during pregnancy.

A large number of studies have confirmed that pre-pregnancy maternal obesity and excessive GWG affect the short-term and future health of the mothers and babies. Short-term effects include GMD, gestational hypertension, eclampsia, premature birth, stillbirth, macrosomia, cesarean section, and congenital malformations, etc. [1-4]. Long-term adverse effects include maternal and child obesity, which increases the risk of type 2 diabetes, hypertension, and other metabolic syndromes [5-7]. Inadequate GWG can lead to fetal organ development, fetal growth restriction and low birth weight, miscarriage, and premature delivery, etc. Therefore, it is conducive to a good perinatal outcome to control pre-pregnancy BMI and gestational weight gain.

A pregnant women's GWG is related to pre-pregnancy BMI, diet, exercise, socio-demography, social psychology and behavior, as well as exposure to environmental pollutants, body inflammatory factors, and genetic factors, etc.; all of which are the result of multiple factors. Therefore, comprehensive measures should be

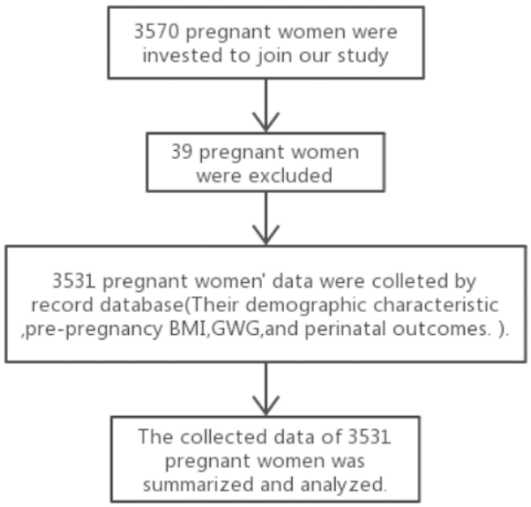

Figure 1. Study flow.

taken to prevent and control unreasonable GWG. Diet and exercise are the key factors for weight management during pregnancy. Public health intervention can be actively carried out for pregnant women with high risk factors, providing health education and dietary guidance before and during pregnancy, and promoting a reasonable diet and healthy exercise for pregnant women.

Methods and methods

Design and participants

A cluster sampling method was adopted, where 3531 singleton pregnant women who received prenatal examinations and delivered in the First Affiliated Hospital of Jinan University from December 2018 to June 2020 were selected as the research subjects. All of the pregnant women had no acute or chronic diseases, were without heart, liver and kidney issues, no chronic hypertension, or diabetes before pregnancy, and no dietary restrictions. Maternal information, such as maternal age, pre-pregnancy weight, last measured weight before delivery, gestational age, gestational history, pregnancy complications, delivery mode, pregnancy outcomes, and newborn weight, etc. were recorded by professional nurses. All of the mothers with 3531 singleton pregnancies were the research subjects, and the inclusion criteria were as follows: (1) At least 18 years old; (2) Single pregnant women. Exclusion criteria: (1) Twin or multiple pregnancies; (2) Patients with severe physical disorders and neuropsychiatric disorders; (3) Test results showed that the fetus had obvious malformations in the abdomen. **Figure 1** is our study flowchart and it shows every step of our study.

Measures

Height and pre-pregnancy weight were used to calculate the pre-pregnancy BMI. According to the Chinese adult BMI classification, the enrolled pregnant women were classified into four categories, 21.1% (744) of the pregnant women were categorized as being pre-pregnancy underweight (BMI<18.5 kg/m^2), 65.8% (2323) were categorized as pre-pregnancy normal weight (18.5 kg/m^2≤BMI<24.0 kg/m^2), 10.4% (368) were categorized as pre-pregnancy overweight (24.0 kg/m^2≤BMI<28.0 kg/m^2) and 2.7% (96) were categorized as pre-pregnancy obese (BMI≥28.0 kg/m^2). Gestational weight gain (GWG) was based on the 2009 IOM (Institute of Medicine) guidelines: namely pre-pregnancy underweight women were recommended to gain 12.5-18.0 kg weight, pre-pregnancy normal weight women were recommended to gain 11.5-16.0 kg, pre-pregnancy overweight women were recommended to gain 7-11.5 kg, and pre-pregnancy obese women were recommended to gain 5-9 kg. Below was classified in the guidelines as inadequate GWG, within the guidelines was the recommended GWG, and above the guidelines was excessive GWG. In this study, 25.3% (892) of the pregnant women were classified as having inadequate GWG, 41.0% (1448) were classified as having the recommended GWG and 33.7% (1191) were classified as having excessive GWG. We compared the incidence of preterm delivery (<37 weeks of gestation), GDM, gestational hypertension, vaginitis in pregnancy, cesarean section, macrosomia (>4000 g), low birth weight infant (<2500 g), postpartum anemia, postpartum hemorrhage, premature rupture of membranes, polyhydramnios, oligohydramnios, pregnancy with hypothyroidism, fetal distress, neonatal asphyxia, infant admission to the NICU within 24 h, intrahepatic cholestasis in pregnancy (ICP), placenta previa between pre-pregnancy BMI and the gestational weight gain categories.

Statistical analysis

SPSS23.0 was used for statistical analysis, categorical data were presented as frequency and percentage, and differences in proportions

were examined using the Chi-square test. The multivariate logistic regression models was used to investigate potential contributory factors, binary regression logistic regression models were used to calculate the odds ratios (OR) and 95% confidence intervals (CI). *P* value <0.05 was considered as statistically significant.

Result

The different groups of characteristics of pregnant women and gestational weight gain

The average age of the 3531 pregnant women was (30.14±4.51) years, 18.0% were advanced in maternal age (AMA); the average gestational age was (39.02±3.09) weeks. A total of 52.8% of the pregnant women were primiparas, and 69% had normal labor. The majority of the pregnant women had a college education or above (86.2%). Most of them were working during their pregnancy (80.6%). A total of 35.0% of the pregnant women had an abortion history and 17.8% had a cesarean section history. A total of 7.8% of pregnant women were hepatitis B carriers, 5.1% had vicia faba, 5.6% had thalassemia, 0.4% had Rh-negative blood and 0.1% had systemic lupus erythematosus. The average pre-pregnancy BMI of the 512 pregnant women was (20.75±3.09) kg/m^2, and the average GWG was (14.01±5.56) kg. The GWG of the women with different pre-pregnancy BMIs were statistically significant differents (P<0.05). Most of the pre-pregnancy underweight and normal women were classified as being in the recommended GWG (58.6% and 38.6%), most of the pre-pregnancy overweight and obese women classified as having excessive GWG (63.0% and 85.8%). Pregnant women under the age of 20 were more likely to be underweight, pregnant women between the age of 20 and 34 were more likely to be obese, pregnant women older than 35 years had a higher risk of being overweight than the younger group. A total of 80.6% of the pregnant women had a job, and most of them had normal weight before pregnancy. Most primiparous women were underweight before pregnancy, and most of the multiparous women were overweight before pregnancy. Pregnant women with a history of abortions and cesarean section were mainly overweight and obese before pregnancy. Most pregnant women had a college/university education or above (86.2%), they mainly gained suitable weight during pregnancy, and the more likely they had more knowledge and skill about pregnancy and childbirth. There results were significant (P<0.05). The details are shown in **Table 1**.

Perinatal outcomes in different categories of pre-pregnancy BMI

The incidence of GDM, gestational hypertension, cesarean section, macrosomia and neonatal asphyxia among the four categories of the pregnant women were statistically significant (P<0.05). After controlling for the effects of occupation, education level, parity, maternal age at delivery, past marital and fertile history, past medical history; compared with pre-pregnancy normal weight women, being underweight in the pre-pregnancy period (BMI<18.5 kg/m^2) was a risk factor for preterm delivery (aOR=1.51, 95% CI: 0.81-3.03) and ICP (aOR=1.96, 95% CI: 1.07-3.60). Being pre-pregnancy overweight and obese (BMI≥24 kg/m^2 and BMI≥28 kg/m^2) were risk factors for GDM (aOR=1.50, 95% CI: 1.17-1.91) and (aOR=2.52, 95% CI: 1.64-3.85), gestational hypertension (aOR=2.33, 95% CI: 1.38-3.91) and (aOR=8.42, 95% CI: 4.58-15.48), cesarean delivery (aOR=1.45, 95% CI: 1.12-1.90) and (aOR=2.56, 95% CI: 1.61-4.07), macrosomia (aOR=2.79, 95% CI: 1.81-4.32) and (aOR=4.14, 95% CI: 2.10-8.17), neonatal asphyxia (aOR=3.31, 95% CI: 1.22-8.98) and (aOR=4.33, 95% CI: 0.94-19.90). The details are shown in **Table 2**.

Perinatal outcomes in different categories of GWG

The incidence of GMD, gestational hypertension, cesarean section, macrosomia, low birth weight infants, and preterm delivery among the three categories of the pregnant women were statistically significant (P<0.05). After controlling for the effects of maternal age, education level, parity, compared with the recommended GWG women, insufficient GWG was a risk factor for preterm delivery (aOR=1.64, 95% CI: 1.44-2.91), GDM (aOR=1.65, 95% CI: 1.53-3.79), and low birth weight infants (aOR=1.52, 95% CI: 1.36-3.76). Excessive GWG was a risk factor for gestational hypertension (aOR=2.18, 95% CI: 1.38-3.44), cesarean delivery (aOR=1.66, 95% CI: 1.38-2.01), and macrosomia (aOR=4.12, 95% CI: 2.64-6.42). The details are shown in **Table 3**.

Table 1. Distribution of participants according to clinical characteristics and pre-pregnancy BMI

Characteristics		Prevalence N (%)	Underweight (n=744)	Normal weight (n=2323)	Overweight (n=368)	Obese (n=96)	*P* value
Age	<20	287 (8.1)	105 (14.1)	154 (6.6)	22 (6.0)	6 (6.3)	<0.001
	20-34	2610 (73.9)	578 (77.7)	1711 (73.7)	247 (67.1)	74 (77.1)	
	≥35	634 (18.0)	61 (8.2)	458 (19.7)	99 (26.9)	16 (16.7)	
Occupation	Employee	2847 (80.6)	575 (77.3)	1910 (82.2)	290 (78.8)	72 (75.0)	0.008
	Unemployed	684 (19.4)	169 (22.7)	413 (17.8)	78 (21.2)	24 (25)	
Education level	High school or below	487 (13.8)	107 (14.4)	304 (13.1)	62 (16.8)	14 (14.6)	0.248
	College or above	3044 (86.2)	637 (85.6)	2019 (86.9)	306 (83.2)	82 (85.4)	
Parity	Primipara	1863 (52.8)	482 (64.8)	1196 (51.5)	140 (38.0)	45 (46.9)	<0.001
	Multipara	1668 (47.2)	262 (35.2)	1127 (48.5)	228 (62.0)	51 (53.1)	
Abortions	0	2295 (65.0)	528 (71.0)	1492 (64.2)	219 (59.5)	56 (58.3)	<0.001
	≥1	1236 (35.0)	216 (29.0)	831 (35.8)	140 (40.5)	40 (41.7)	
Caesarean	0	2901 (82.2)	662 (89.0)	1898 (81.7)	266 (72.3)	75 (78.1)	<0.001
	≥1	630 (17.8)	82 (11.0)	425 (18.3)	102 (27.7)	21 (21.9)	
HBV carrier	Yes	276 (7.8)	40 (5.4)	204 (8.8)	26 (7.1)	6 (6.3)	0.021
	No	3255 (92.2)	704 (94.6)	2119 (91.2)	342 (92.9)	90 (93.8)	
Favism	Yes	3351 (94.9)	703 (94.5)	2207 (95.0)	349 (94.8)	92 (95.8)	0.942
	No	180 (5.1)	41 (5.5)	116 (5.0)	19 (5.2)	4 (4.2)	
Thalassemia	Yes	3334 (94.4)	702 (94.4)	2192 (94.4)	349 (94.8)	91 (94.8)	0.983
	No	197 (5.6)	42 (5.6)	131 (5.6)	19 (5.2)	5 (5.2)	
Systemic lupus erythematosus	Yes	4 (0.1)	2 (0.3)	2 (0.1)	-	-	0.454
	No	3527 (99.9)	742 (99.7)	2321 (99.9)	368 (100.0)	96 (100.0)	
Rh-negative Blood type	Yes	15 (0.4)	2 (0.3)	11 (0.5)	1 (0.3)	1 (1.0)	0.248
	No	3516 (99.6)	742 (99.7)	2312 (99.5)	367 (99.7)	95 (99.0)	
GWG	Below IOM guidelines	892 (25.3)	216 (29.0)	608 (26.2)	56 (15.2)	12 (12.5)	<0.001
	Within IOM guidelines	1448 (41.0)	378 (50.7)	936 (40.3)	114 (31.0)	20 (20.8)	
	Above IOM guidelines	1191 (33.7)	150 (20.3)	779 (33.5)	198 (53.8)	64 (66.7)	

Conclusion

Pre-pregnancy excess weight and obesity and excessive gestational weight gain are serious issues in Western countries. The United States was the first to pay attention to the problem of excessive weight gain in pregnant women. In 1990, 41.5% of pregnant women were classified as having excessive GWG [8]. An investigation from 2012 to 2013 showed that the incidence of excessive GWG was about 38.2%-54.7% [9] and in 2017 it was 47% [4], showing an upward trend. In Australia, nearly two-thirds (62.8%) of the adult women are overweight or obese, and almost half of child-bearing women's body mass index (BMI) is ≥25 kg/m^2 [10, 11]. A recent prospective cohort study in China showed that being underweight in the pre-pregnancy period was 13.20%, while being overweight and obese was 14.70%, with insufficient GWG occuring 24.45% and excessive GWG happened 34.06% of the time. The results of similar study in other regions showed that the rates of being pre-pregnancy underweight in the above-mentioned regions was about 12.12%-23.94%, and the rates of pre-pregnancy overweight and obese women were about 11.08%-24.48%; while the incidence of not enough GWG was about 13.51%-28.88%, and the incidence of excessive GWG was about 25.81%-30.91% [12-15]. The results of this survey reported that the percentage of being pre-pregnancy underweight was 22.1%, while overweight and obese women were 10.4% and 2.7% respecitively, and the incidence of insufficient and excessive GWG were 25.3% and 33.7% respectively, which were similar to the results of other studies in China.

The increased body fat during pregnancy is necessary to promote the growth and development of the infants. Fat in the buttocks, back and thighs play an important role during the late pregnancy and lactation [16]. Many pregnant women pay great attention to nutritional boosts during the perinatal period, but excessive weight gain during pregnancy will lead to increased morbidity with newborns and pregnant women, and will also cause the continued obesity of mothers. Pre-pregnancy obesity and excessive GWG are related to childhood obesity, this effect will extend to adulthood and

Table 2. The relationship between pre-pregnancy BMI and perinatal outcomes

Perinatal outcomes	Underweight (n=744)	Normal weight (n=2323)	Overweight (n=368)	Obese (n=96)	*P*	Underweight vs. normal weight aOR (95% CI)	Overweight vs. normal weight aOR (95% CI)	Obese vs. normal weight aOR (95% CI)
Preterm delivery	22 (3.0)	111 (4.8)	25 (6.8)	5 (5.2)	0.062	1.51 (0.81-3.03)	1.42 (0.90-2.23)	1.075 (0.43-2.71)
GDM	106 (14.2)	532 (22.9)	118 (32.1)	40 (41.7)	0.001	0.69 (0.55-0.874)	1.50 (1.12-1.91)	2.52 (1.64-3.85)
Gestational hypertension	5 (0.7)	57 (2.5)	21 (5.7)	16 (16.7)	0.001	0.30 (0.12-0.75)	2.33 (1.38-3.92)	8.42 (4.6-15.48)
Vaginitis in pregnancy	52 (7.0)	142 (6.1)	28 (7.6)	6 (6.3)	0.569	1.07 (0.76-1.49)	1.37 (0.89-2.10)	1.06 (0.46-2.48)
Premature rupture of membranes	168 (22.6)	509 (21.9)	61 (16.6)	12 (12.5)	0.069	0.99 (0.81-1.22)	0.76 (0.57-1.02)	0.53 (0.28-0.97)
Polyhydramnios	21 (2.8)	82 (3.5)	11 (3.0)	-	0.915	0.83 (0.51-1.37)	0.85 (0.45-1.61)	1.03 (0.97-1.09)
Oligohydramnios	31 (4.2)	87 (3.7)	13 (3.5)	7 (7.3)	0.337	0.96 (0.62-1.47)	1.02 (0.56-1.86)	2.09 (0.93-4.68)
Cesarean section	157 (21.1)	735 (31.6)	154 (41.8)	48 (50.0)	0.001	0.66 (0.53-0.82)	1.45 (1.12-1.90)	2.56 (1.61-4.07)
Postpartum anemia	97 (13.0)	305 (13.1)	43 (11.7)	6 (6.3)	0.236	0.99 (0.77-1.27)	0.86 (0.61-1.21)	0.45 (0.19-1.03)
Postpartum hemorrhage	28 (3.8)	99 (4.3)	18 (4.9)	8 (8.3)	0.221	0.98 (0.63-1.52)	1.30 (0.79-2.15)	2.07 (0.97-4.40)
Pregnancy with hypothyroidism	32 (4.3)	144 (6.2)	18 (4.9)	4 (4.2)	0.390	0.76 (0.51-1.13)	0.76 (0.46-1.26)	0.68 (0.25-1.88)
Fetal distress	47 (6.3)	158 (6.8)	19 (5.3)	8 (8.3)	0.486	0.80 (0.57-1.13)	0.88 (0.53-1.44)	1.37 (0.64-2.93)
Neonatal asphyxia	4 (0.5)	12 (0.5)	6 (1.6)	2 (2.1)	0.034	1.01 (0.32-3.22)	3.31 (1.22-8.98)	4.33 (0.944-19.90)
NICU admission	133 (17.9)	473 (20.4)	86 (23.4)	23 (24.0)	0.013	0.80 (0.65-1.00)	1.31 (1.00-1.71)	1.28 (0.79-2.08)
Macrosomia	7 (0.9)	73 (3.1)	32 (8.7)	11 (11.5)	0.001	0.36 (0.16-0.78)	2.79 (1.81-4.32)	4.14 (2.10-8.17)
Low birth weight	28 (3.8)	96 (4.1)	22 (6.0)	3 (3.1)	0.276	0.89 (0.58-1.39)	1.48 (0.91-2.40)	0.75 (0.23-2.41)
Placenta previa	7 (0.9)	20 (0.9)	2 (0.5)	2 (2.1)	0.282	1.91 (0.76-4.79)	0.51 (0.12-2.24)	2.23 (0.49-10.14)
ICP	18 (2.4)	31 (1.3)	8 (2.2)	2 (2.1)	0.138	1.96 (1.07-3.60)	1.74 (0.79-3.84)	1.72 (0.40-7.37)

Table 3. The relationship between GWG and perinatal outcomes

Perinatal outcomes	Inadequate GWG (n=892)	Recommended GWG (n=1448)	Excessive GWG (n=1191)	*P*	Inadequate GWG VS. recommended GWG	Excessive GWG VS. recommended GWG
					Adjusted OR (95% CI)	Adjusted OR (95% CI)
Preterm delivery	63 (7.1)	65 (4.5)	35 (2.9)	0.001	1.64 (1.44-2.91)	0.64 (0.42-0.98)
GDM	273 (30.6)	325 (22.4)	198 (16.6)	0.001	1.65 (1.53-3.79)	0.71 (0.58-0.86)
Gestational hypertension	17 (1.9)	21 (2.1)	51 (4.3)	0.001	1.12 (0.62-2.05)	2.18 (1.38-3.44)
Vaginitis in pregnancy	52 (5.8)	100 (6.9)	76 (6.4)	0.610	1.19 (0.84-1.69)	0.91 (0.68-1.24)
Premature rupture of membranes	194 (21.7)	319 (22.0)	237 (19.9)	0.355	1.03 (0.84-1.27)	0.87 (0.72-1.05)
Polyhydramnios	27 (3.0)	54 (3.7)	33 (2.8)	0.344	1.27 (0.79-2.05)	0.74 (0.47-1.15)
Oligohydramnios	32 (3.6)	52 (3.6)	54 (4.5)	0.493	0.97 (0.61-1.52)	1.28 (0.86-1.90)
Cesarean section	218 (24.4)	427 (29.5)	449 (37.7)	0.001	1.21 (0.97-1.51)	1.66 (1.38-2.01)
Postpartum anemia	101 (11.3)	200 (13.8)	150 (12.6)	0.186	1.26 (0.97-1.63)	0.89 (0.71-1.12)
Postpartum hemorrhage	29 (3.3)	67 (4.6)	59 (5.0)	0.073	1.53 (0.98-2.39)	1.21 (0.78-1.61)
Pregnancy with hypothyroidism	40 (4.5)	76 (5.2)	82 (6.9)	0.052	1.16 (0.78-1.73)	1.34 (0.97-1.85)
Fetal distress	55 (6.2)	101 (7.0)	76 (6.4)	0.772	1,10 (0.77-1.54)	0.90 (0.66-1.24)
Neonatal asphyxia	7 (0.8)	13 (0.9)	11 (0.9)	0.663	0.69 (0.26-1.80)	0.96 (0.36-2.60)
NICU admission	176 (19.7)	307 (21.2)	232 (19.5)	0.621	1.06 (0.86-1.31)	0.91 (0.75-1.11)
Macrosomia	11 (1.2)	27 (1.9)	85 (7.1)	0.001	1.47 (0.72-2.99)	4.12 (2.64-6.42)
Low birth weight	65 (7.3)	57 (3.9)	27 (2.3)	0.001	1.52 (1.36-3.76)	0.59 (0.37-0.94)
Placenta previa	7 (0.8)	13 (0.9)	11 (0.9)	0.865	1.30 (0.51-3.34)	0.96 (0.36-2.60)
ICP	13 (1.5)	32 (2.2)	14 (1.2)	0.110	1.61 (0.84-3.10)	0.53 (0.28-1.00)

will increase the risk of type 2 diabetes and cardiovascular disease in the offspring [6], thereby increasing the socioeconomic burden and the waste of medical resources. Considering each country's cultural background, ethnicity, regional dietary characteristics, socioeconomic conditions and medical service conditions, formulating appropriate pre-pregnancy BMIs and gestational weight gain is an important measure to balance fetal nutrition and reduce adverse perinatal outcomes.

The complex interactions between physical, psychological and social behaviors influence women's weight gain during the perinatal period. Female organs and hormones go through great changes, and women will have the pain of childbirth and the burden of parenting, thus they are easy to experience anxiety, depression and other bad emotions, and they may appear to be overeating or loose the appetite, which will affect the management of pregnancy weight. Additionally, being influenced by the traditional concepts, some pregnant women will take in more high-calorie and high-fat food during the perinatal period. Family incomes, marital status, education level, age, multiple births, smoking during pregnancy, diet and physical exercise also have an influence on weight gain. Other demographic characteristics, such as local residents, marital status, birth history, socio-economic status, smoking during pregnancy, receiving check-ups and delivery in a public hospital, will also affect the pre-pregnancy BMI [17]. The results of this study showed that pregnant women with a higher education level and older age have suitable weight gain during pregnancy. The number of pregnancies and deliveries is higher in pre-pregnancy overweight and obese women, and their history of abortion and cesarean section is relatively abundant.

The International Federation of Gynecology and Obstetrics (FIGO) recommends that weight management during adolescence, pre-pregnancy and pregnancy, is an important way to achieve women's lifelong health. Overweight and obese women should optimize their weight before pregnancy, with changes to a poor diet and lifestyle, and increase their physical exercise [18], with considerations for bariatric surgery if necessary. Like ordinary obese people, there are also social stereotypes about overweight and obese pregnant women, such as laziness, and low self-control. Obese pregnant women say that they are faced with discrimination and prejudice in the hospital, feeling shamed and have psychological burden, which may increase the risk of psychological disorders [19]. The American College of Obstetricians and Gynecologists (ACOG) issued the NO.600 committee opinion "Ethical Issues in the Diagnosis and Treatment of Obese Women" in June 2014. Medical staff should treat obese women equally and fairly, and avoid blaming patients for obesity, actively understanding the causes of obesity in patients and providing effective diagnosis and treatment [20]. Medical staff should pay more attention to weight management during pregnancy, and formulate a personalized weight gain plan, according to women's pre-pregnancy BMI and gestational age, combing with dietitians to give reasonable dietary recommendations, and encourage pregnant women to have regularl aerobic exercise and strength training, to improve cardiopulmonary function and reduce the risk of postpartum obesity and related diseases.

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Disclosure of conflict of interest

None.

Abbreviations

BMI, body mass index; GWG, gestational weight gain; GDM, gestational diabetes mellitus; ACOG, American College of Obstetricians and Gynecologists; FIGO, International Federation of Gynecology and Obstetrics; ICP, intrahepatic cholestasis in pregnancy; NICU, neonatal intensive care unit; HBV, hepatitis B virus; AMA, advanced maternal age; IOM, Institute of Medicine.

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