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Original Article

Correlation analysis of body mass index and age in early pregnancy with pregnancy related complications and neonatal weight

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Abstract: Objective: To explore the relationship between pregnancy related complications and neonatal weight with body mass index (BMI) and maternal age in early pregnancy. Methods: Related information about 2,070 cases of primipara with single birth delivered in the obstetrics department of our hospital was analyzed. These above subjects were grouped according to their BMI and age. Relationship between pregnancy related complications and neonatal weight with BMI and mother's age in early pregnancy was further investigated. Results: BMI increased less in the overweight group than in the normal group and low weight group during pregnancy ($P<0.05$). The overweight and obese group had a higher incidence of gestational hypertension and diabetes mellitus in early pregnancy than the normal group ($P<0.05$). Besides, the average neonatal weight of the obese group was higher than that of the normal group ($P<0.05$). The incidence of gestational diabetes mellitus in the senior age group was higher than that in the younger age group ($P<0.05$). Logistic regression showed that being overweight, obese and older age were all risk factors related to pregnancy complications and low birth weight. Conclusion: Pregnancy related complications and outcomes are closely related to BMI and mother's age in early pregnancy.

Keywords: BMI, childbearing age, pregnancy related complications, neonatal weight

Introduction

Studies have shown that body mass index (BMI) before pregnancy is closely related to both pregnancy complications (hypertension, diabetes mellitus) and neonatal related complications. In addition, productive weight control during pregnancy and childbearing at younger age are of great significance in optimizing perinatal outcomes [1-3]. In recent years, with social progress and the implementation of the two children policy in China, more and more people choose late marriage and late childbearing, resulting in the postponement of childbearing [4]. Some studies have found that the metabolic rate was decreased, and the incidence of adverse outcomes of mother and fetus were increased with increasing age of pregnant women. Being aged over 45 years old and abnormal BMI of pregnant women before pregnancy may lead to adverse outcomes of both mother and fetus [5, 6]. Many previous studies have also explored the influence of BMI before pregnancy and age on pregnancy complications and outcomes, but most of them are only regional studies with differences [7, 8]. Therefore, our present study analyzed the data of 2,070 pregnant women with single child pregnancies in a coastal city of southern China, aiming to explore the influence of BMI in early pregnancy and age on pregnancy related complications and neonatal weight.

Materials and methods

Research subjects

A retrospective analysis was made of 2,070 cases of parturients who completed antenatal examination regularly and gave birth between January 2016 and September 30, 2018 in the obstetric clinic of The First Affiliated Hospital of Fujian Medical University. Inclusion Criteria: 1. singleton pregnancy; 2. primipara; 3. complete

prenatal examination. Exclusion criteria: 1. parturient with previous diabetes history and hypertension; 2. parturient received abortion or induced labor due to various reasons; 3. parturient with pre pregnancy immune system diseases; 4. parturient with severe liver and kidney dysfunction before pregnancy; 5. parturient with birth defects; 6. parturient with incomplete clinical data.

Informed consent is not necessary because this retrospective study uses patient data anonymously. The research has been approved by the Ethics Committee of The First Affiliated Hospital of Fujian Medical University.

Methods

The following information of the parturient was collected through their previous medical records: age, height, weight (in 8- and 39-week gestational age), delivery related data (including gestational week and delivery mode) and the occurrence of gestational hypertension and diabetes. Information of the corresponding neonates (including the weight, asphyxia and premature rupture of membranes) was also collected.

Grouping criteria and principles

Weight grouping [9]: The parturients fell into four groups according to their BMI before pregnancy as following: low weight group (BMI< 18.5 kg/m^2), normal group (BMI between 18.5-24.9 kg/m^2), overweight group (BMI between 25-30 kg/m^2) and obese group (BMI≥30 kg/m^2).

Age grouping includes the lower age group (<24 years old), mid age group (24 to 35 years old), and the older age group (≥35 years old).

Diagnosis of pregnancy hypertension: Systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg measured at least twice in the same arm.

Diagnosis of gestational diabetes mellitus (according to the relevant diagnostic standards of fasting blood glucose measurement and oral glucose tolerance test) refers to the latest edition of scientific definition standard of Obstetrics and Gynecology [10, 11].

Weight grouping of the neonates acts in accordance with the following principles: Neonates less than 2.5 kg are identified as low weight infants and more than 4.0 kg are macrosomia [12].

Outcome measures

We aimed to investigate the correlation between pregnancy related complications such as gestational hypertension and diabetes and the neonatal weight with the weight and age of parturients in early pregnancy.

Statistical analysis

SPSS 22.0 software was employed to analyze the data of these research subjects. The measurement data were expressed by mean ± SD, and the comparison between groups was conducted by t-test or one-way ANOVA of independent samples. The enumeration data were expressed in n (%), and chi square test was used for comparison between groups. Two factor Logistic regression analysis was used to detect the risk factors of pregnancy related complications and low birth weight infants. The variables were assigned according to the classification variables and were screened by the step forwards (Ward) method, with 0.05 as the inclusion standard, and 0.10 as the exclusion standard. Relative risk is expressed by the adjusted odds ratio (OR value). Bilateral test was used for analysis. The difference was considered as statistically significant with $P<0.05$.

Results

General data of the research subjects

In our selected subjects, the proportion of the parturient in low weight group, normal group, overweight group and obese group is 18.79% (389 cases), 67.00% (1,387 cases), 12.03% (249 cases) and 2.18% (45 cases), respectively. Among them, the cases of parturient in the lower age group, mid age group and older age group are 187, 1551 and 332, respectively. Statistics indicated that the average age of the subjects was 29.7 ± 4.6 years old, average height was 160.6 ± 4.6 cm, the average BMI during pregnancy was increased by 5.41 ± 1.58 kg/m^2 and the average neonatal weight was 3.23 ± 0.53 kg. As shown in **Figures 1** and **2**.

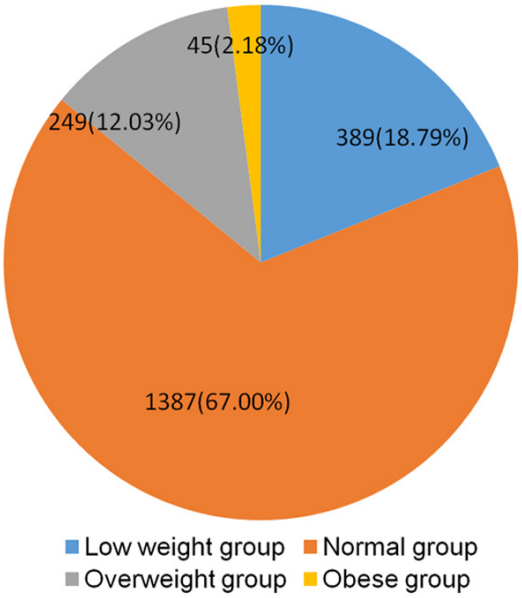

Figure 1. Composition of parturients in low weight group, normal group, overweight group and obese group of this study.

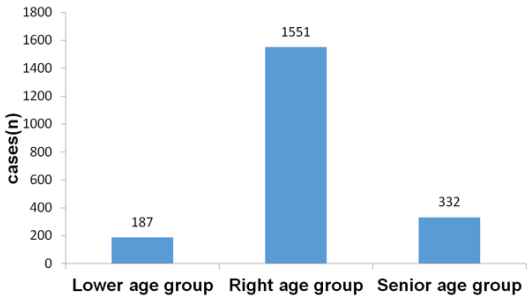

Figure 2. Age grouping of the parturients in our study.

Comparison of BMI growth, weight gain and age of pregnant women with different BMI in early pregnancy

The results showed that the average age of the low weight group was the lowest, lower than that of normal group (t=5.550, P<0.001), and the average age of overweight group was the highest, significantly higher than that of normal group (t=4.020, P<0.001). At the same time, no significant difference existed in height among groups (t=3.176, P=0.520). Mean value of BMI increase during pregnancy in the overweight group and obese group was lower than that in normal group with statistically significant differences (t=4.653, P<0.001; t=2.632, P<0.01). Meanwhile, the low weight group had higher increased mean value of BMI during pregnancy than the normal group (t=4.843, P<0.001). The weight gain during pregnancy of the overweight group was much less than that of the normal group with statistically significant differences (t=5.137, P<0.001). In addition, weight gain of the obese group was also lower than the normal group but with no statistically significant differences (t=1.697, P=0.090). As shown in **Table 1**.

Comparison of neonatal outcomes in different BMI groups in early pregnancy

Average neonatal weight and the proportion of low weight infants in the obese group and overweight group were both higher than those in normal group (P<0.01). Besides, average neonatal weight in the low weight group was obviously lower than that of the normal group (P<0.01). In addition, the percentage of macrosomia in low body group was lower than that in normal group (P<0.05). There was no significant difference in the percentage of low birth weight infants in each group. As shown in **Table 2**.

Comparison of pregnancy complications of parturients in different BMI groups in early pregnancy

Our study analyzed the relationship between different BMI and pregnancy related complications. The results showed that no significant difference existed in the incidence of gestational hypertension and diabetes between the low weight group and the normal group. The incidence of gestational hypertension and diabetes in the obese group and overweight group was higher than that in normal group (P< 0.05). What is more, is that the obese group had a significantly higher incidence than the overweight group (P<0.05). As shown in **Table 3**.

Pregnancy complications, neonatal weight and neonatal status of singleton pregnancy in different age groups

Senior age group had higher incidence of gestational diabetes mellitus than the other two groups (P<0.05). No significant difference in the incidence of gestational hypertension and average neonatal weight was found among these three groups (P>0.05). Besides, average neonatal weight among the three groups also had no statistically significant difference (P=

Table 1. General materials of singleton pregnancy in different BMI groups in early pregnancy

Groups	BMI (kg/m^2) in Early pregnancy	Age (year)	Height (cm)	BMI increase (kg/m^2)	Weight gain (kg)
Low weight group (n=389)	17.18 ± 1.33	28.4 ± 4.3***	160.9 ± 4.8	5.81 ± 1.48***	14.99 ± 3.87***
Normal group (n=1,387)	20.86 ± 1.58	29.8 ± 4.6	160.6 ± 4.6	5.45 ± 1.56	13.86 ± 4.12
Overweight group (n=249)	25.40 ± 1.15	31.1 ± 4.6***	160.4 ± 4.5	4.90 ± 1.53***	12.55 ± 3.92***
Obese group (n=45)	30.50 ± 2.93	30.7 ± 5.4	160.7 ± 4.9	5.04 ± 2.46**	12.20 ± 5.38

Note: Compared with the normal group, **P<0.01, ***P<0.001. BMI: body mass index.

Table 2. Comparison of neonatal weight in different BMI groups in early pregnancy

Groups	Cases	Neonatal weight (kg)	Percentage of low weight infants (n, %)	Percentage of macrosomia (n, %)
Low weight group	389	3.16 ± 0.41**	13 (3.34)	10 (2.57)*
Normal group	1,387	3.28 ± 0.44	40 (2.88)	72 (5.19)
Overweight group	249	3.43 ± 0.50**	8 (3.21)	31 (12.45)**
Obese group	45	3.57 ± 0.70**	3 (6.67)	10 (22.22)**

Note: Compared with the normal group, *P<0.05, **P<0.01. BMI: body mass index.

Table 3. Analysis of pregnancy complications and BMI in early pregnancy

Groups	Cases	Percentage of gestational hypertension (n, %)	Percentage of gestational diabetes mellitus (n, %)
Low weight group	389	9 (2.31%)	32 (8.23%)
Normal group	1,387	27 (1.95%)	142 (10.24%)
Overweight group	249	10 (4.02%)*	49 (19.68%)*
Obese group	45	5 (11.11%)*,#	20 (44.44%)*,#

Note: Compared with the overweight group, #P<0.05; compared with the normal group, *P<0.05. BMI: body mass index.

0.980). Percentage of macrosomia and low weight infants in the senior age group is higher than the other two groups (P<0.05) and no significant difference exists between the other two groups (P>0.05). As shown in **Table 4**.

The relationship between BMI in early pregnancy and age with pregnancy complications and pregnancy outcome

After BMI in early pregnancy and age were embedded, related pregnancy complications and the neonatal weight were analyzed by two factor Logistic regression analysis. The results showed that the risk of gestational diabetes mellitus (OR: overweight group: 2.0, obese group: 7.1) and hypertension (OR: overweight group: 2.5, obese group: 5.1) increased with increasing BMI in early pregnancy. Besides, the incidence of gestational diabetes mellitus and macrosomia (OR: Senior age group: 2.6, OR: Senior age group: 1.8) also increased with age. As shown in **Tables 5**-**8**.

Discussion

With the increasing implementation of eugenics, female BMI, is an important indicator to evaluate the nutritional status of women before and during pregnancy, and it is also considered as the main indicator to evaluate women's health and the first monitoring indicator for pregnant women [13, 14]. Many studies have pointed out that being underweight during pregnancy will lead to the birth of low weight infants, but excessively high BMI would lead to the occurrence of macrosomia [15]. At the same time, too much weight gain during pregnancy will not only increase the incidence of adverse pregnancy outcomes, but also induce general postpartum obesity in infants and pregnant women [16]. In this study, we found that the incidence of gestational hypertension, diabetes and macrosomia in the overweight group was significantly higher than that in the normal group. Besides, the obese group had a higher incidence of gestational hypertension and diabetes than the overweight group. What is more, excessively increased BMI was found to elevate the incidence of gestational diabetes. In addition, the average neonatal weight of the normal group was lower than that of the obese group and the over-

Table 4. Comparison of pregnancy complications and neonatal outcomes in different age groups

Groups	Cases	Neonatal weight (kg)	Percentage of low weight infants (n, %)	Percentage of gestational hypertension (n, %)	Percentage of gestational diabetes mellitus (n, %)	Percentage of macrosomia (n, %)
Lower age group	187	3.25 ± 4.03	6 (3.21%)	3 (1.60%)	6 (3.21%)	6 (3.21%)
Mid age group	1551	3.27 ± 4.45	42 (2.71%)	35 (2.26%)	159 (10.25%)	88 (5.67%)
Older age group	332	3.32 ± 5.27	16 (4.82%)[a]	13 (3.92%)	78 (23.49%)[a]	29 (8.73%)[a]

Note: Compared with the other two groups (Lower age group and Right age group), [a]P<0.05.

Table 5. The results of Logistic regression analysis on risk factors of gestational diabetes mellitus

Risk factors	Regression coefficient	OR value	95% CI	*P* value
Overweight	0.693	2.0	1.4-2.9	0.000
Obesity	1.960	7.1	3.8-13.3	0.000
Older age	0.955	2.6	1.9-3.5	0.000

Note: OR: odds ratio; CI: confidence interval.

Table 6. The results of Logistic regression analysis on risk factors of gestational hypertension

Risk factors	Regression coefficient	OR value	95% CI	*P* value
Overweight	0.916	2.5	1.6-3.9	0.000
Obesity	1.629	5.1	2.4-10.7	0.000

Note: OR: odds ratio; CI: confidence interval.

Table 7. The results of Logistic regression analysis on risk factors of macrosomia

Risk factors	Regression coefficient	OR value	95% CI	*P* value
Low weight	0.182	1.2	0.6-2.3	0.527
Overweight	0.095	1.1	0.5-2.3	0.853
Obesity	0.833	2.3	0.7-7.9	0.173
Lower age	0.182	1.2	0.5-2.8	0.602
Older age	0.588	1.8	1.0-3.3	0.046

Note: OR: odds ratio; CI: confidence interval.

Table 8. The results of Logistic regression analysis on risk factors of low weight infants

Risk factors	Regression coefficient	OR Value	95% CI	*P* Value
Low weight	0.182	1.2	0.6-2.8	0.534
Overweight	0.693	2.0	0.9-4.2	0.853
Obesity	1.808	6.1	2.2-16.7	0.000
Older age	0.530	1.7	0.9-3.2	0.123

Note: OR: odds ratio; CI: confidence interval.

weight group but was higher than that of the low weight group. Beyond this, no significant difference existed in the rate of low weight infants among each group. This is different from previous research conclusions which pointed out that the proportion of low weight infants was more easily induced by low weight pregnant women. Our results may also be related to the normal weight gain of low weight pregnant women in our study [17]. Because of the general implementation of weight management and related education in our obstetric clinic, weight management in pregnancy has been commonly recognized. In this study, the average weight gain of low and normal weight pregnant women met the requirements of world pregnancy management. The weight gain of the obese and overweight group was obvious, but was also in line with the latest relevant research conclusions. This situation also needs further efforts of obstetricians and pregnant women in the future [18].

Previous studies have found that the age of pregnant women (more than 40 years old) could increase the incidence of gestational hypertension and diabetes [19, 20]. Similarly, our study also pointed out that the incidence of gestational diabetes in pregnant women over 35 years old was higher than that in mid age group. However, there was no difference in birth weight among different age groups. In addition, the percentages of macrosomia and low weight neonates in the older group were higher than those in the other two groups. These results indicated that the incidence of adverse outcomes of mother and fetus in mothers aged over 35 increased with increasing age in southern China. Besides, there was no significant increase in the

incidence of pregnancy complications in the mothers younger than 24 years old in the low age group, which may be related to the age grouping, and similar reports have also been reported before [21].

Results of two factor Logistic regression analysis further showed that increased BMI before pregnancy was an independent risk factor for gestational diabetes, hypertension and low birth weight. In addition, older age is also an independent risk factor for gestational diabetes mellitus and macrosomia, which supports the previous conclusion that old age and weight gain would increase the incidence of pregnancy related complications and adverse outcomes [22].

To sum up, there is a certain correlation between pregnancy related complications and outcomes with BMI in early pregnancy and the age. Thus, we should pay attention to the popularization of the knowledge about controlling the weight before pregnancy. At the same time, we suggest that women should have children at a younger age, preferably at the age of 25-35. However, this study is a single center and regional study, which still needs more multi regional combined study to further confirm our conclusion. In addition, other adverse pregnancy outcomes are also our future research interests.

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Disclosure of conflict of interest

None.

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