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Role of Maternal Nutrition in the Health Outcomes of Mothers and Their Children: A Retrospective Analysis

Authors' Contribution:

Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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Background:

Low nutrition status of mothers plays an important role in increasing the prevalence of poor pregnancy outcomes. Poor pregnancy outcomes are the most common in the Guangzhou region of China. The objective of the study was to evaluate the role of maternal nutrition in the improvement of health outcomes for mothers and their children in the Guangzhou region of China.

Material/Methods:

In this study, pregnancy medical records of women were analyzed. Data related to questionnaires which had been provided during hospital stays for nutritional consumption were gathered. Demographic characteristics and health outcomes of mothers and their children were recorded. Correlations of health outcomes with maternal nutrition were tested with respect to Z-scores at 95% confidence level.

Results:

Based on the health outcomes of mothers and their children, the study divided participants into 2 groups. The first group was mothers and their children with good health outcomes (live births with weighing ≥ 2.5 kg; the GHO group, $n=130$) and the second group was mothers and their children with poor health outcomes (miscarriage or premature birth with weighing less than 2.5 kg; the PHO group, $n=70$). These results showed positive correlation between financial status of the mother (salaried, $P<0.001$), maternal body mass index ($P=0.001$), maternal nutrition ($P<0.001$), maternal education (in years, $P<0.001$), and maternal age ($P=0.004$) with health outcomes of mothers and their children.

Conclusions:

The financial status of the mother, maternal nutrition, maternal age, and maternal education were the key determinants for predicting health outcomes of mothers and their children.

MeSH Keywords:


Child • Educational Status • Maternal Age • Maternal Health Services • Public Health Administration

Abbreviations:

STROBE – the strengthening the reporting of observational studies in epidemiology; **BMI** – body mass index

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Background

Although health sectors in PR China actively provide grassroots maternal health services [1], a mother with low nutrition status is one of the key determinants of poor pregnancy outcomes and is responsible for morbidity and mortality of mothers and their children in rural and urban areas of PR China [2]. As per the National Nutrition Survey of the Chinese National Nutrition and Health Surveillance, poor pregnancy outcomes are the most common in PR China where the low nutritional status of mothers and children plays an important role in increasing the prevalence of poor outcomes [3]. The importance of maternal nutritional in the Chengdu region of China has been well studied and it was found that maternal nutritional played an important role in improving the health of mothers and their children and offers healthy growth in newborn infants [2]. Therefore, the role of maternal nutrient in the development of pregnancy in expectant mothers and their children in other regions of PR China cannot be neglected. Also, maternal nutritional intervention is a cost-effective approach to improve the health of mothers and their children in PR China [4].

Generally, the financial circumstances of families play an important role in predicting the nutritional status of the families, including their children's health status. Thus, the increased financial status of women can help provide spending money toward the ideal nutritional requirement of their families including their children [3]. Therefore, the employment of women can improve the health of their children as well as their own health. It has been seen that the unemployment status of women results in the poor health of children as well as their mothers in the northwestern rural region of the PR China [5].

In addition to the financial condition of women in the Qinghai and Gansu provinces of PR China, the role of education targeted to mothers on the importance of nutrition has also been shown to be helpful in improving the health of women and their children [5]. Poor pregnancy outcomes are the most common in the Guangzhou region of China and the role of maternal nutrition in the improvement of health outcomes for mothers and their children in the Guangzhou region of China has not been evaluated specifically in Chinese pregnant women.

The objective of the study was to evaluate the role of maternal nutrition in the improvement of health outcomes for mothers and their children in the Guangzhou region of China.

Material and Methods

Ethical consideration and consent to participate

The protocol (2016A020215054/CL/11/18 dated November 14, 2018) was approved by the First Affiliated Hospital of Sun Yat-sen University review board. Each participating woman, who had data included in this study was contacted and written informed consent was provided regarding publication of the study data in all formats (hard and/or electronic) irrespective of time and language. The study adhered to the law of China, the 2008 Declaration of Helsinki (Chinese version), and the STROBE (strengthening the reporting of observational studies in epidemiology) statement.

Inclusion criteria

Mothers who had children 5 days to 18 months of age and who provided consent to participate were included in this study.

Exclusion criteria

Mothers who had children younger than 5 days old and older than 18 months of age were excluded from the study. Health outcomes of babies younger than 5 days old were not considered appropriate for the evaluation of the effects of maternal education, maternal financial status, and maternal salaries. Health outcomes of babies older than 18 months of age were not considered appropriate for the evaluate of the effects of maternal nutrition and maternal age. In addition, mothers who did not provided consent to participate were excluded from the study.

Data collections regarding questionnaires

The pregnancy medical records of women included in the study were reviewed. At the time of admission, a questionnaire had been provided to each enrolled patient to gather data related to nutritional consumption, demographic characteristics, and health outcomes of the mothers and their children (after delivery). The assigned questionnaires collected data regarding age, height, weight, other demographic variables, clinical characteristic, years of education, income (annually), smoking status, body mass index (BMI), the occurrence of nutritional consumption, the type of dietary supplements, daily intake of calories, protein, fat, fiber, carbohydrates, total intake of macro- and micro-nutrients, the intake of specific food items such as milk, probiotics foods, vegetables, meat/fish, fruits, juice per day, and if the women had started any specific food during their pregnancy or not. The total amount of nutrient taken by each woman was calculated using the FoodCalc assessment tool [5]. The provided questionnaire was studied by the specialist investigators of the First Affiliated Hospital of

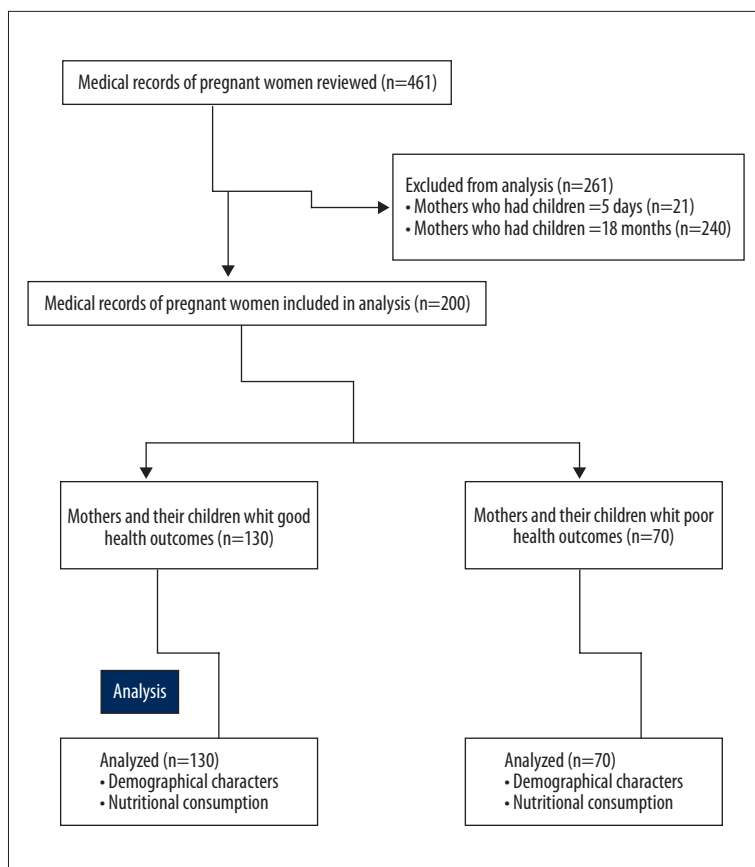


Figure 1. Flow diagram of the study.

Sun Yat-sen University, Guangzhou, China. The questionnaires, which were provided to each enrolled patient, were validated by the First Affiliated Hospital of Sun Yat-sen University, Guangzhou, China. The mothers and their children with good health outcomes were defined as live birth of a singleton neonate born at term of 37 weeks or more, completed gestation weeks infant weight of 2.5 kg or more, without any birth defects, and with minimal post-pregnancy complications [6] and the mothers and their children with poor health outcomes were defined as miscarriages and post pregnancy complications, or premature birth with birth weight less than 2.5 kg [7].

Statistical analysis

Correlations of health outcomes with maternal nutrition were done using Pearson's correlation/regression models respect to Z-scores [5]. The Mann-Whitney U test was used for continuous variables and the Fisher's exact test [8] was performed for constant variables. All the tests were 2-sided. Data were examined using GraphPad Prism version 8.0.2 (263), GraphPad Software, San Diego CA, USA. The results were considered significant at 95% confidence level.

Results

Maternal social, demographic, economic, and household characteristics

In this study, pregnancy records of a total of 461 women admitted to the First Affiliated Hospital of Sun Yat-sen University, China and the referring hospitals of Guangzhou region of China from January 1, 2014 to November 13, 2018 were reviewed. Among these, 21 mothers had children younger than 5 days old and 240 women had children older than 18-months of age. Therefore, data of these women were excluded from the study. In the study, medical records of 200 women regarding demographical characters and nutritional consumptions were analyzed (Figure 1). Based on the health outcomes of mothers and their children, the study divided the 200 women into 2 groups. The first group was mothers and their children with good health outcomes (the GHO group, n=130; 65%) and the second group was mothers and their children with poor health outcomes (the PHO group, n=70; 35%; Figure 2).

In the PHO group, maternal age was higher ($P<0.0001$), maternal body mass index (BMI) before pregnancy was lower as compared to the GHO group ($P=0.012$). Moreover, the level of education (in years) was fewer in the PHO group when compared

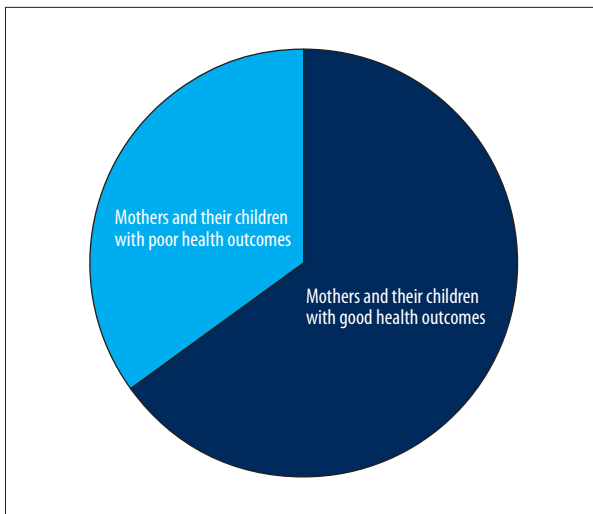


Figure 2. The health outcomes of mothers and their children in enrolled women.

to the GHO group ($P<0.0001$). In the GHO group, a smaller number of women had a history of nausea and vomiting than those in the PHO group. Furthermore, the economic status of women in the GHO group was found to be better as compared to women in the PHO group ($P=0.015$). Also, the number of women who were active smokers was lower in the GHO group compared to the PHO group (15% versus 21%). In the GHO group, most of the women were living with their husbands ($P=0.038$) and more women had a male baby ($P=0.033$). The other maternal social, demographic, and household characteristics of both groups are reported in Table 1.

Comparison of maternal nutrition

In the GHO group, the calorie intake was greater compared to the PHO group (79% versus 33%, $P<0.0001$). A similar trend was observed when comparing the levels of macro- and micro-nutrient intake in the GHO group. Also, the study found that the levels of vitamin intake was greater in women in the GHO group compared to women in the PHO group. A similar trend was noted for other nutritional factors including a fiber-rich diet ($P<0.0001$). The intake of fat was found to be higher in women in the GHO group as compared to women in the PHO group (88% versus 11%, $P<0.0001$). In our study, good health outcomes were noted in women who consumed protein rich diets such as those diets that included milk, non-vegetable protein, eggs, fish, and meat as compared to mothers who consumed less protein in their diet (65% versus 23%, $P<0.0001$, Table 2). Also, good health outcomes were noted in women who consumed milk products (78% versus 13%, $P<0.0001$), probiotic-rich diets and non-vegetarian foods (90% versus 19%, $P<0.0001$), vegetables rich diets with macro- and micro-nutrient and fresh fruits (68% versus 27%, $P<0.0001$), and juice

(79% versus 13%, $P<0.0001$) daily as compared to mothers who consumed these foods less often (Table 3).

Factors predicting the health outcomes for mothers and their children

This study also assessed the factors predicting health outcomes for mothers and their children using correlation coefficients. Results showed a positive correlation between the financial status of the mother (salaried, $P<0.001$), maternal BMI ($P=0.001$), maternal nutrition ($P<0.001$), maternal education (in years, $P<0.001$), maternal age ($P=0.004$) with health outcomes of mothers and their children (Table 4).

Discussion

In this study, the importance of maternal nutrition was the focus, and we found that maternal nutrition played an important role in improving the health of mothers and their children and also offered healthy growth of newborn infants. There is an urgent need to treat severe acute malnutrition because several deaths have been associated with it in PR China [9,10]. In consideration of the results of this study, maternal nutrient plays an important role in the development of the child and should not be neglected in the Guangzhou region of PR China.

This study suggested that the financial status of the mother (salaried) and the educational status (in years) were key determinants of predicting health outcomes for mothers and their children. The results of this study were in line with another available study [3]. Employed, educated, and salaried mothers have an important role to play in the healthy development of children in China [11]. The results of our study suggested that women who are educated and employed can contribute to improved development and growth of newborn infants.

This study found that older mothers had good health outcomes for their children ($P=0.004$). These results were not in line with the hypothesis that advanced maternal age of Chinese women could be a risk factor for poor health outcomes for their children that was part of an earlier study (from June 2015 to June 2017) in the Liaocheng region of the PR China [12] and another study in the Kunming Shi region of PR China that suggested that advance aged women had poorer perinatal outcomes [13], but our findings were in line with the hypothesis that maternal age is an independent factor for adverse perinatal outcomes stated in a study performed in the Changsha region of PR China [8]. Studies have suggested that maternal and children's health outcomes could be good if Chinese parents waited to have a child for a few years [14] and if a child is born to the age group of 20- to 30-year-old Chinese women [15]. The results of our study were in line with an available study by Yang et al. [9]. With respect to

Table 1. Social, demographic, economic, and household parameters of enrolled women.

Variables	Group		Comparison between groups	
	GHO	PHO		
Type of health outcomes	Mothers and their children with good health outcomes	Mothers and their children Poor health outcomes		
Numbers of women enrolled (sample size; n)	130	70	<i>p</i> -Value	
Age (year)	≤18	13 (10)	<0.0001***	
	19–34	77 (59)		
	≥35	40 (31)		
	Mean ±SD	31.21±1.21	28.01±4.31	
Weight (kg)	Before pregnancy	64.01±2.11	51.02±1.61	<0.0001***
	After pregnancy	62.02±1.31	50.01±1.71	<0.0001***
Body mass index before pregnancy	*Overweight	40 (31)	35 (50)	0.012***
	Non-overweigh	90 (70)	35 (50)	
Smoking	Cigarette smoker	25 (19)	15 (21)	0.853
	Not smoking at all	105 (81)	55 (79)	
Education (years)	>8	40 (31)	27 (39)	<0.0001***
	9–15	25 (19)	35 (50)	
	≥16	65 (50)	8 (11)	
Former pregnancy (if any)	Yes	74 (57)	35 (50)	0.43
	No	56 (43)	35 (50)	
Former miscarriages	Yes	24 (18)	17 (24)	0.429
	No	106 (82)	53 (76)	
Occupation	Regular wage earner	5 (4)	1 (1)	0.015***
	Casual wage earner	12 (9)	2 (3)	
	Business or trade owner	7 (5)	1 (1)	
	Domestic worker	23 (18)	5 (8)	
	Unemployed	83 (64)	61 (87)	
Monthly income (≤8,000**)	23 (18)	2 (3)	0.007***	
Marital status	Married	117 (90)	61 (87)	0.038***
	Divorced	13 (10)	9 (13)	
Ethnicity	Han Chinese	115	61	0.994
	Tibetan	2	1	
	Mongolian	11	5	
	Chinese American	2	1	
Geographical areas	Urban	110 (85)	51 (73)	0.061
	Rural	20 (15)	19 (27)	
Children’s gender	Male	89 (68)	37 (53)	0.033***
	Female	41 (32)	33 (47)	
Nature of delivery	Caesarian	11 (8)	11 (16)	0.155
	Normal delivery	119 (92)	59 (84)	

Continuous variables are represented as mean ±SD and constant data are represented as number (percentage). The Fisher’s exact test is performed for constant data and the Mean-Whitney U test is performed for continuous variables as statistical analysis. A *p*<0.05 is considered as significant. * 25–29 kg/m²; ** Average monthly income of Chinese citizen in Guangzhou region of PR China; *** Significant different factor.

Table 2. Comparison of maternal nutrition between groups.

Variables	Group		Comparison between groups
	GHO	PHO	
Type of health outcomes	Mothers and their children with good health outcomes	Mothers and their children with poor health outcomes	
Numbers of women enrolled (sample size; n)	130	70	<i>p</i> -Value
High calorie diet source	103 (79)	23 (33)	<0.0001
Carbohydrates rich diet	90 (69)	15 (21)	<0.0001
Protein rich diet	85 (65)	16 (23)	<0.0001
Fibers rich diet	103 (79)	22 (31)	<0.0001
Fat rich diet	115 (88)	8 (11)	<0.0001
Vitamins and micronutrients diet source			
Retinol rich diet source	99 (76)	18 (26)	<0.0001
Carotene rich diet source	101 (78)	19 (27)	<0.0001
Folic acid rich diet source	70 (54)	13 (19)	<0.0001
Vit. B1 rich diet source	116 (89)	10 (14)	<0.0001
Vit. B2 rich diet source	85 (65)	16 (23)	<0.0001
Vit. B3 rich diet source	109 (84)	15 (21)	<0.0001
Vit. B4 rich diet source	96 (74)	12 (17)	<0.0001
Vit. B6 rich diet source	99 (76)	16 (23)	<0.0001
Vit. A rich diet source	103 (79)	14 (20)	<0.0001
Vit. D rich diet source	75 (58)	9 (13)	<0.0001
Iron rich diet source	116 (89)	16 (23)	<0.0001
Vit. E rich diet source	95 (73)	21 (30)	<0.0001
Vit. B12 rich diet source	46 (35)	8 (11)	0.0005
Folic acid rich diet source	70 (54)	17 (24)	0.0001
Calcium rich diet source	74 (57)	20 (29)	0.0002
Magnesium rich diet source	116 (89)	22 (31)	<0.0001

Data are represented as number (percentage). Fisher's exact test was performed for statistical analysis. A $p < 0.05$ is considered as significant. Vit. – vitamin.

the results of our study, somewhat mature (age in the mid to late 20s) Chinese women can provide better health outcomes for themselves with their children than younger Chinese women.

This study reported that maternal BMI had an adverse effects on maternal health outcomes and their children ($P=0.001$). In another study, greater maternal BMI and waist circumference were associated with a higher risk of adverse pregnancy outcomes in Chinese women [16]. The results of our study were in line with the available study by Dong and Yin [3]. In addition,

Tang et al. found that gestational weight gain had an effect on the outcomes of pregnancies and infants in PR China [2]. That study recommended a balanced diet to Chinese women for their better health outcomes with their children.

There were several limitations to our study, for example, the study was designed as a pilot study with a small sample size and was conducted in a single Guangzhou region in China. Therefore, the present findings cannot be generalized to the overall Chinese population. The maternal height [5], paternal

Table 3. Comparison of maternal daily consumptions of fresh fruits and juice between groups.

Variables	Group		Comparison between groups
	GHO	PHO	
Type of health outcomes	Women and their children with good health outcomes	Women and their children with poor health outcomes	
Numbers of women enrolled (sample size; n)	130	70	<i>p</i> -Value
Calcium and protein rich source (milk products*)	101 (78)	13 (19)	<0.0001
Probiotic rich diet	94 (72)	10 (14)	<0.0001
Sodium rich diet	108 (83)	12 (17)	<0.0001
Non-veg (fat and protein rich diet)	117 (90)	13 (19)	<0.0001
Vegetables rich with macro and micronutrient	59 (45)	8 (11)	<0.0001
Fruits (seasonal)	88 (68)	19 (27)	<0.0001
Fresh Juice (seasonal)	103 (79)	9 (13)	<0.0001
*Cold drinks	99 (76)	48 (69)	0.322

Data are represented as number (percentage). Fisher’s exact test was performed for statistical analysis. A *p*<0.05 is considered as significant. * Available in PR China only.

Table 4. Maternal factors predicting the health outcomes for mothers and their children.

Maternal factor	Coefficient value (beta, Z score)	<i>p</i> -Value	95% CI
BMI (kg/m ²)	0.72	0.001*	0.42–0.93
Financial status (salaried)	1.09	<0.001*	1.02–1.23
Nutrition (kcal)	1.13	<0.001*	1.23–1.81
Education (in years)	1.23	<0.001*	1.11–1.62
Age (in years)	0.62	0.004*	0.32–0.83
Smoking	0.12	0.08	0.55–0.65
Former pregnancy	0.13	0.09	0.54–0.64
Former miscarriages	0.14	0.092	0.53–0.63
Marital status	0.15	0.093	0.54–0.65
Ethnicity	0.16	0.1	0.57–0.68
Geographical areas	0.02	0.95	0.58–0.6
Children’s gender	0.03	0.99	0.57–0.61
Nature of delivery	0.05	0.99	0.57–0.62

A *p*<0.05 is considered as significant. BMI – body mass index. Pearson’s correlation/regression models. * Significant factor for health outcomes for mothers and their children.

guardianship, and parental reporting of illness also has an effect on the health outcomes on mothers and their children. However, this study did not evaluate these factors. A small number of women were enrolled in this study. Maternal death or child death were not discussed.

Conclusions

The results of this retrospective study showed that the financial status of the mother, maternal age, maternal nutrition, and maternal education were key determinants of predicting health outcomes of mothers and their children in the Guangzhou region of PR China. The study authors thus advise Chinese parents to

wait to have a child for a few years for better health outcomes for the mother and child. This study might serve as a basis for conducting large multi-center and multi-country clinical studies to assess the association between maternal nutrition with health outcomes for mothers and their children.

References:

1. Li Y, Zhang Y, Fang S et al: Analysis of inequality in maternal and child health outcomes and mortality from 2000 to 2013 in China. *Int J Equity Health*, 2017; 16: 66
2. Tang L, Pan XF, Lee AH et al: Maternal lifestyle and nutritional status in relation to pregnancy and infant health outcomes in Western China: Protocol for a prospective cohort study. *BMJ Open*, 2017; 7: e014874
3. Dong CX, Yin SA: [The nutrition status of lactating women in China.] *Chinese J Prev Med*, 2016; 50: 1108–13 [in Chinese]
4. Zhu Z, Cheng Y, Zeng L et al: Association of antenatal micronutrient supplementation with adolescent intellectual development in rural western China: 14-year follow-up from a randomized clinical trial. *JAMA Pediatr*, 2018; 172: 832–41
5. Zhang J, Kang H, Wang LF et al: Relations between children and maternal nutrition in Qinghai and Gansu, North Western rural China. *Biomedica*, 2017; 33: 84–88
6. Zhu L, Zhang Y, Liu Y et al: Maternal and live-birth outcomes of pregnancies following assisted reproductive technology: A retrospective cohort study. *Sci Rep*, 2016; 6: 35141
7. Zhu LQ, Chen H, Chen LB et al: Effects of emergency cervical cerclage on pregnancy outcome: A retrospective study of 158 cases. *Med Sci Monit*, 2015; 21: 1395–401
8. Qin C, Mi C, Xia A et al: A first look at the effects of long inter-pregnancy interval and advanced maternal age on perinatal outcomes: A retrospective cohort study. *Birth*, 2017; 4: 230–37
9. Zhang J, Kang H, Wang LF et al: A prevalence analysis to assess the relationship between maternal and children's nutritional status in North-Western rural China. *Clinics Mother Child Health*, 2016; 13: 2
10. Lu MS, He JR, Chen Q et al, Born in Guangzhou Cohort Study Group: Maternal dietary patterns during pregnancy and preterm delivery: A large prospective cohort study in China. *Nutr J*, 2018; 17: 71
11. Zhou H, Lv B, Guo X et al: The relation between maternal work hours and primary school students' affect in China: The role of the frequency of mother-child communication (FMCC) and maternal education. *Front Psychol*, 2017; 8: 1777
12. Xu J, Wang J, Xuan S et al: The effects of childbirth age on maternal and infant outcomes in pregnant women. *Iran J Public Health*, 2018; 47: 788–93
13. Qu ZQ, Yang MH, Du MY et al: [Outcome of vaginal birth after cesarean section in women with advanced maternal age.] *Chinese J Obstet Gynecol*, 2017; 52: 521–25 [in Chinese]
14. Wang C, Wang XY, Yang HX: [Effect of maternal age on pregnancy outcomes in Beijing.] *Chinese J Obstet Gynecol*, 2017; 52: 514–20 [in Chinese]
15. Liu X, Zou L, Chen Y et al: [Effects of maternal age on pregnancy: A retrospective cohort study.] *Chinese J Med*, 2014; 94: 1984–88 [in Chinese]
16. Gao X, Yan Y, Xiang S et al: The mutual effect of pre-pregnancy body mass index, waist circumference and gestational weight gain on obesity-related adverse pregnancy outcomes: A birth cohort study. *PLoS One*, 2017; 12: e0177418

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Conflict of interest

None.