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Effects of dietary structure on the incidence of gestational diabetes mellitus and macrosomia

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ABSTRACT

Objectives: To explore the relationship between dietary structure and the incidence of gestational diabetes mellitus and macrosomia.

Material and methods: In this retrospective study, the diet records of pregnant women admitted to the Shanghai Jiao Tong University Affiliated Sixth People's Hospital between August 2017 and August 2018 were collected with the approval of the local ethics committee. Corresponding medical and clinical information of pregnant women were obtained from the medical system. The relationship between diet structure and the incidence of gestational diabetes and macrosomia was analyzed.

Results: A total of 93 pregnant women with elevated blood sugar (including new gestational diabetes mellitus and diabetes mellitus with pregnancy) were enrolled. There were 21 newborns with macrosomia. The consumption of tofu was negatively correlated with the occurrence of macrophages. The consumption of pork eaten was negatively correlated with blood sugar levels two hours after eating. The consumption of vegetables was positively correlated with the blood glucose level one hour after eating. Eggs may increase triglycerides and blood sugar, which is an important inducer of pregnancy complicated with diabetes and macrosomia.

Conclusions: The diet structure of pregnant women is correlated with the occurrence of diabetes mellitus and macrosomia in pregnancy. It is recommended to eat more potatoes and not fried noodles with edible oil and to eat more high-quality protein, such as vegetable protein and lean pork.

Key words: dietary structure

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INTRODUCTION

Gestational diabetes is a common complication during pregnancy, including pregestational diabetes mellitus (PGDM) and gestational diabetes mellitus (GDM), with an incidence of 6–9% [1]. The glucose metabolism of most patients returns to normal after delivery, but the risk for developing type 2 diabetes in the future increases [1]. Gestational diabetes is harmful to both mothers and children and one of the most important complications is macrosomia [2]. During pregnancy, due to estrogen, progesterone, and placental lactogen, B cell proliferation increases, hypertrophy and hypersecretion of islets occurs, insulin secretion increases, leading to slightly increased levels of blood sugar in pregnant woman than the non-pregnant woman [2]. The increase of insulin content in blood was higher in pregnant women compared with non-pregnant women after intravenous glucose injection, and the decrease in blood glucose levels after insulin injection was not as effective as that in non-pregnant women, indicating that the islet B cells are active and secreted [3]. There are many hypotheses for the pathogenesis of gestational diabetes mellitus, including genetic factors, insulin resistance, abnormal fat factors and inflammatory factors [3]. It is well known that improper eating habits may lead to obesity, which is a high-risk factor for diabetes [4]. Diet control has become an effective control method for pregnancy complicated with diabetes [4]. Therefore, we suspected that dietary structure may also affect the incidence of gestational diabetes mellitus. Previous literature suggested that red meat, eggs, and sea fish are the main sources of methylamine in the diet [5]. Methylamine produces trimethylamine oxide, while circulating trimethylamine oxide increases the risks of type 2 diabetes

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and cardiovascular disease [5]. In addition, some studies have shown that diet can affect the occurrence of diabetes by changing intestinal flora. Ferrocino et al. [6] analyzed the dietary structure and intestinal flora of 41 GDM pregnant women who were under the guidance of dietitians and found that patients following dietary recommendations showed better metabolic and nutritional structure, and decreased the number of bacteria associated with high-fat diet [7]. In this retrospective study, we collected the diet records of pregnant women who were admitted to the Shanghai Jiao Tong University Affiliated Sixth People's Hospital between August 2017 and August 2018 and aimed to explore the relationship between diet structure and the incidence of pregnancy with diabetes.

MATERIAL AND METHODS

With the approval of the Ethics Committee of the Shanghai Jiao Tong University Affiliated Sixth People's Hospital, the diet records of pregnant women who were admitted to the Shanghai Jiao Tong University Affiliated Sixth People's Hospital between August 2017 and August 2018 were retrospectively reviewed. All pregnant women who were admitted between this period and diagnosed with gestational diabetes were enrolled, except for those with other severe acute or chronic diseases. Corresponding medical and clinical information of pregnant women were obtained from the medical system. The relationship between diet structure and the incidence of pregnancy with diabetes and macrosomia was explored using statistical analysis.

The SPSS software (version 22.0) was used for data analysis. The t-test was used to analyze the difference between two groups, while rank test was performed to analyze the difference among multiple groups. Chi-square test was used to analyze the correlation between two factors.

RESULTS

A total of 93 pregnant women diagnosed with gestational diabetes (including GDM and PGDM) were enrolled. There were 21 newborns diagnosed as macrosomia (9 cases with diabetes-related macrosomia and 12 cases with macrosomia unrelated to diabetes). As shown in Table 1, there was no significant difference in delivery, neonatal score, and postpartum hemorrhage in these women. Obesity is a high-risk factor for pregnancy with diabetes and macrosomia. Low family income is also a high-risk factor for fetal macrosomia.

The relationship between diet and gestational diabetes mellitus and macrosomia, as well as the levels of blood glucose during pregnancy was analyzed (Tab. 2 and 3).

Staple food: potato food reduced blood sugar for two hours. Fried pasta significantly increased the levels of low--density lipoprotein and cholesterol. When the intake of edible oil fried noodles more than 42 per week, low density lipoprotein level increased 0.12 mmol/L and cholesterol increased 0.12 mmol/L. Proteins: Fatty fish raised blood sugar in pregnant women. Tofu reduced the levels of triglycerides and was negatively correlated with the occurrence of macrosomia. The consumption of pork was negatively correlated with the levels of blood sugar two hours after meal. Vegetables: the amount of vegetables consumed was positively correlated with the levels of blood sugar one hour after meal, indicating that vegetables should be eaten properly. Drinks: Juice, yogurt lowered blood sugar. Other drinks raised the levels of LDL and cholesterol, Average absolute value of LDL increased by 0.21 mmol/L in pregnant women who drank other beverages. Oil: soybean oil and animal oil are better choices. Soy oil reduced the incidence of pregnancy and diabetes. Animal oil reduced the incidence of macrosomia. Eggs raised triglyceride and blood sugar levels. When the consumption of eggs was more than 30 per month (1 per day), an increase of 0.33 mmol/L in absolute value of triglyceride, an increase of 0.13 mmol/L in fasting blood glucose, and an increase of 0.38 mmol/L in Blood glucose one hour after meal were observed. Excessive consumption of eggs is the cause of pregnancy with diabetes and macrosomia diet. Social factors: obesity and old age were important risk factors for pregnancy with diabetes. Low-income and low education level were risk factors for giant children.

DISCUSSION

Obesity and old age are high risk factors for pregnancy with diabetes, both PGDM and GDM [7]. In this study, we also found that obesity and old age are important risk factors for pregnancy with diabetes and macrosomia. Pregnant women with diabetes have an increased risk for later hypertension in addition to the risk of macrosomia [8]. Pregnancy with diabetes may also be accompanied by fetal malformation, hyperbilirubinemia, hypocalcemia and neonatal respiratory distress, and may cause amniotic fluid excess and premature delivery [8].

According to the results of this study, pregnant women who ate much staple food should add coarse grain reasonably. Although potato food is a main source of starch, it contains more cellulose and can increase satiety [9]. Fried pasta can increase blood lipid levels; therefore, should be avoided during pregnancy [9]. The fat content in the fat fish is relatively high, which can raise the blood sugar levels, increase the risk of diabetes [10]. Thus, fat fish is not a high-quality protein choice for pregnant women. Lean red meat and bean products can reduce blood sugar and blood lipids; therefore, they are a high-quality protein source during pregnancy. Juice and yogurt can reduce blood sugar levels, but other drinks (such as cola) can increase blood lipid levels [10].

Our data showed that soybean oil and animal oil were better choices for pregnant women. Soybean oil can reduce

Table 1. Baseline information of pregnant women

	Gestational diabetes mellitus		p value	Fetal macrosomia		p value
	Yes	No		Yes	No	
Age			0.000			0.653
≥ 35 years old	16	12		2	26	
< 35 years old	77	291		19	349	
BMI	27.70	26.49	0.002	28.22	26.69	0.041
Educational level			0.234			0.315
Primary school and below	1	0		0	1	
Junior high school	4	30		2	32	
Senior high school, technical secondary school	14	48		7	55	
Junior college	19	67		4	82	
undergraduate	44	122		7	159	
Master and above	11	36		1	46	
Per capita household income			0.365			0.000
1K below	0	2		1	1	
1K–3K	1	3		0	4	
3K–5K	6	41		3	44	
5K–8K	21	72		6	87	
8K–10K	28	69		6	91	
More than 10K	35	99		5	129	
Delivery mode			0.481			0.144
Eutocia	45	172		8	209	
Forceps Delivery	3	10		1	12	
Elective cesarean section	22	64		4	82	
Emergency cesarean section	21	47		8	60	
Neonatal weight	3257	3178	0.283	4126	3142	0.000
Neonatal score			0.311			1.000
10 points	88	272		20	340	
< 10 points	3	19		1	21	
Postpartum blood loss	352	358	0.781	387	352	0.353

the incidence of pregnancy with diabetes, while animal oil can reduce the incidence of macrosomia. We also found that consumption of vegetables was positively correlated with the levels of blood sugar at one hour after meal, indicating that too much consumption of vegetables may increase. Excessive consumption of eggs (more than 1 per day) significantly increased blood lipid levels, and hyperlipidemia caused a series of complications, such as acute fatty liver and coagulation disorders [11].

Intestinal microecology, which can be affected by many factors (e.g., age, heredity, dietary structure, and body mass index) play a key role in diabetes during pregnancy [12]. Pedersen et al. have shown that the intestinal flora of pregnant women with gestational diabetes mellitus is abnormal at many levels, including phylum and genus, compared with pregnant women with normal blood sugar [12]. Zheng et al. [13] evaluated the dynamic changes of intestinal microbiota in 141 pregnant women from the first three months to the middle three months, and they found significant differences in intestinal microecology of pregnant women with diabetes and normal control pregnant women as gestational weeks progressed, as evidenced by a continuous downward trend fecal coccus and streptococcus in pregnant women.

The potential mechanisms by which intestinal microecology affects metabolism are as follows: (1) changes in intestinal flora lead to changes in the levels of hormones, such as insulin, gastric inhibitory peptides and adipokines, results in metabolic disorders [14]; (2) disruption of homeostasis between intestinal microbes and the immune system leads to intestinal bacterial endotoxin entering the systemic circulation, causing "metabolic endotoxemia", systemic inflammatory response, and insulin resistance [14]; (3) changes

Table 2. Pregnancy diet for pregnant women with diabetes mellitus and fetal macrosomia

	Gestational diabetes mellitus		p value	Fetal macrosomia		p value
	Yes	No		Yes	No	
Rice (twice/week)	13.33 ± 7.75	13.18 ± 9.52	0.894	9.60 ± 6.19	13.42 ± 9.34	0.068
Flour (twice/week)	5.96 ± 5.64	6.06 ± 5.64	0.880	6.62 ± 5.42	6.00 ± 5.65	0.626
Crops (twice/week)	2.49 ± 3.26	3.19 ± 4.28	0.149	4.04 ± 4.81	2.84 ± 3.59	0.141
Potato (twice/week)	2.62 ± 2.89	3.24 ± 3.94	0.163	2.07 ± 1.82	3.15 ± 3.80	0.199
Fried dough foods (twice/week)	3.06 ± 6.47	2.84 ± 8.45	0.814	1.86 ± 2.39	2.95 ± 8.23	0.544
Pork (twice/week)	5.19 ± 4.82	6.15 ± 4.95	0.099	3.43 ± 3.21	6.07 ± 4.98	0.017
Beef and mutton (twice/week)	8.21±13.355	6.29±9.70	0.13	6.62 ± 6.09	6.75 ± 10.89	0.957
Poultry (twice/week)	7.97 ± 9.57	8.75 ± 11.0	0.543	7.76 ± 5.00	8.61 ± 10.91	0.724
Viscera (twice/week)	1.17 ± 1.75	1.70 ± 4.67	0.278	1.71 ± 2.26	1.57 ± 4.26	0.878
Fatty fish(twice/week)	6.38 ± 10.58	4.10 ± 7.93	0.026	3.14 ± 3.95	4.72 ± 8.85	0.418
Other fish (twice/week)	6.87 ± 17.61	4.11 ± 7.93	0.034	2.90 ± 4.55	4.86 ± 11.28	0.430
Alga (twice/week)	2.17 ± 2.95	2.41 ± 3.86	0.575	1.40 ± 1.54	2.41 ± 3.74	0.222
Other aquatic product (twice/week)	8.22 ± 16.60	7.42 ± 13.68	0.639	6.09 ± 6.68	7.69 ± 14.72	0.622
Milk (twice/week)	84.98 ± 65.10	72.51 ± 73.02	0.141	92.76 ± 68.04	74.47 ± 71.50	0.254
Milk powder (twice/week)	9.68 ± 25.16	15.86 ± 33.24	0.099	20.38 ± 45.41	14.07 ± 30.70	0.374
yogurt (twice/week)	23.20 ± 26.30	28.27 ± 31.39	0.159	16.76 ± 20.59	27.66 ± 30.69	0.109
Egg (twice/week)	26.11 ± 18.04	22.08 ± 15.83	0.039	31.71 ± 29.98	22.54 ± 15.26	0.013
Tofu (twice/week)	14.25 ± 14.35	13.30 ± 12.86	0.547	7.43 ± 5.66	13.86 ± 13.43	0.030
Soybean milk (twice/week)	28.27 ± 36.16	31.57 ± 40.76	0.484	28.81 ± 34.62	30.91 ± 40.01	0.814
Dried bean (twice/week)	2.68 ± 7.20	3.06 ± 7.75	0.679	2.00 ± 4.97	3.02 ± 7.74	0.550
Vegetables (twice/week)	125.8 ± 75.68	115.7 ± 88.31	0.377	98.86 ± 104.1	118.9 ± 84.39	0.295
Pickles (twice/week)	4.37 ± 14.08	3.57 ± 9.94	0.537	3.00 ± 6.75	3.89 ± 11.23	0.747
Cake (twice/week)	6.54 ± 9.58	8.92 ± 17.44	0.208	3.76 ± 4.96	8.62 ± 16.33	0.175
Fruit (twice/week)	161.0 ± 113.4	162.9 ± 124.6	0.899	136.2 ± 107.5	163.9 ± 122.7	0.312
Nut (twice/week)	7.58 ± 16.07	5.71 ± 10.04	0.179	7.56 ± 14.78	6.07 ± 11.57	0.672
Fruit juice (twice/week)	2.09 ± 3.90	3.42 ± 7.45	0.100	2.43±6.64	3.14 ± 6.82	0.639
Other drinks (twice/week)	1.09 ± 2.39	2.24 ± 12.52	0.377	0.62 ± 2.62	2.04 ± 11.31	0.565
Peanut oil	55/93	163/302	0.406	8/21	210/374	0.119
Soya-bean oil	37/93	164/302	0.018	11/21	190/374	1.000
Colza oil	50/93	187/302	0.183	13/21	224/374	1.000
Salad oil	26/93	101/302	0.375	5/21	122/374	0.479
Sesame oil	49/93	184/302	0.185	12/21	221/374	1.000
Animal oil	18/93	62/301	0.883	1/21	79/373	0.050
Quantity of oil						
1-more	7/87	17/259	0.336	0	24	0.650
2-middle	57/87	180/259		14	223	
3-less	22/87	62/259		4	80	
Quantity of salt						
1-more	2/90	15/284	0.203	1	16	0.934
2-middle	52/90	159/284		10	201	
3-less	35/90	110/284		9	136	
Quantity of sugar						
1-more	8/89	17/287	0.725	2	23	0.775
2-middle	31/89	110/287		6	135	
3-less	45/89	141/287		10	176	

Table 3. The effect of some foods on blood lipid and glucose levels.

	Low density lipoprotein	Cholesterol	Triglyceride	Blood glucose (0 min)	Blood glucose (postprandial 1 h)	Blood glucose (postprandial 2 h)
Potato	/	/	/	/	/	–
Fried dough foods	+	+	/	/	/	/
Cake	/	/	/	–	/	/
Fatty fish	+	/	/	/	/	/
Pork	/	/	/	/	/	–
Tofu	/	/	–	/	/	/
Eggs	/	/	+	/	+	/
Vegetables	/	/	/	/	+	/
Milk	/	/	/	/	+	/
Soybean milk	/	+	/	/	/	/
Yogurt	/	/	/	–	/	/
Fruit juice	/	/	/	–	/	–
Other drinks	+	+	/	/	/	/

This table is measured by chi-square test, "+" represents a positive correlation and a statistically significant difference; "–" represents negative correlation and statistically significant difference; "/" means no statistical difference

in short-chain fatty acids caused by intestinal dysbacteriosis, followed by a series of signal transduction pathways, lead to low-grade intestinal inflammatory response, dyskinesia, and increased intestinal mucosal permeability, which ultimately affect maternal and fetal energy metabolism [15].

Some social factors also affect the occurrence of pregnancy with diabetes and macrosomia. Low income and low education level are risk factors for macrosomia. It has been long believed that nutrition should be strengthened during pregnancy, which reduces the intrauterine growth restriction caused by malnutrition [15]. However, many pregnant women overeat during pregnancy and gain significant weight, resulting in obesity and diabetes [15]. The risk of macrosomia also increases. The results of our study showed that pregnant women with higher education level and better medical compliance had the concept of weight control. The weight increased reasonably during pregnancy, and the size of fetus was controlled within a reasonable range. In the low-educated and low-income population, due to the neglect of pregnancy care and conservative concept, a considerable proportion of pregnant women still do not pay attention to the control of calorie intake during pregnancy, resulting in obesity, diabetes, macrosomia and other complications. Diabetes is no longer a "rich disease". It is pay attention to pregnant women with low income and low education level.

CONCLUSIONS

The occurrence of gestational diabetes mellitus and macrosomia was related to the diet structure of pregnant women. It is recommended to eat more potato and high-quality proteins, such as vegetable protein and lean red meat. Polyfat fish are rich in protein and easy to digest but have a high fat content and a small amount of consumption. vegetables should be consumed moderately, and excessive consumption may increase blood sugar levels. Juice and yogurt, but not other beverages, are recommended. Soybean oil and animal oil are better choices. The intake of eggs cannot be more than one per day. There are also important social factors in the occurrence of gestational diabetes mellitus and macrosomia. Obesity, old age, low income, and low education level are risk factors.

Ethics approval and consent to participate

The ethic approval was obtained from the Ethic Committee of Shanghai Jiao Tong University Affiliated Sixth People's Hospital.

Consent to publish

All the authors have Consented to publish this research.

Availability of data and materials

The data are free access to available upon request.

Authors' contributions

Each author has made an important scientific contribution to the study and has assisted with the drafting or revising of the manuscript.

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Conflict of interests

All authors declare no conflict of interest.

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