A China Healthy Diet Index-Based Evaluation of Dietary Quality among Pregnant Women in Shanghai across Trimesters and Residential Areas

Zhengyuan WANG¹, Jiaying SHEN¹, Yiwen WU¹, Xueying CUI¹, Qi SONG¹, Zehuan SHI¹, Changyi GUO², Jin SU¹ and Jiajie ZANG^{1,*}

¹ Division of Health Risk Factors Monitoring and Control, Shanghai Municipal Center for Disease Control and Prevention, Shanghai 200336, China

² General Office, Shanghai Municipal Center for Disease Control and Prevention, Shanghai 200336, China
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Summary Good dietary quality among pregnant women is critical for maternal and fetal health. The primary objective of our study was to analyze the dietary quality of pregnant woman and its influencing factors. Pregnant women were enrolled using a multistage, stratified, random-sampling method in Shanghai. We used a personal food frequency questionnaire and a household condiment weighing method for dietary assessments. Participants' scores on the China Healthy Diet Index (CHDI) were analyzed to evaluate diet quality. Significant differences in the median daily intake of almost all food types were found across all trimesters, and all food types were found across all residential areas (urban, suburban and rural). The median of total CHDI score was 71.6 in all subjects, 71.1 in early pregnancy, 71.5 in middle pregnancy and 72.3 in late pregnancy. The results of uni-variate analysis showed that significant differences in CHDI scores were found across trimesters and residential areas. Eighty one point six percent of participants scored below 80 points, indicating general or poor dietary quality. Logistic regression models showed that participants in early and middle pregnancy had lower scores than those in late pregnancy. Women in urban areas had higher scores than those in suburban and rural areas. Most of pregnant women living in Shanghai suffer from a general or poor dietary quality. Education on balance diet should be strengthened to guide pregnant women in making reasonable food choices and intake, especially those living in suburban and rural areas and those in their first and second trimesters.

Key Words pregnant women, China Healthy Diet Index, dietary quality, trimester, residential area

Nutrition during pregnancy is a key determinant of pregnancy success and maternal and fetal health (1, 2). Nutritional requirements vary in different stages of pregnancy. Increased caloric and macro-nutrient intake in the 2nd and 3rd trimesters and micro-nutrients (e.g., iron and folate) throughout the gestational period are necessary for a healthy pregnancy. There are mounting evidences show that a deficient or excessive dietary intake of one or more macro- and micro-nutrients is common among pregnant populations (3, 4); under- and over-nutrition are proven to be involved in diseases, such as obesity, gestational diabetes mellitus, cardiovascular mortality and infant abortion. Thus, it is essential to monitor the dietary intake of pregnant populations to determine the degree to which they meet nutritional requirements in order to update public health messages and tailor recommendations.

Contrary to popular single-food and -nutrient studies, the Diet Quality Index has been used since 1999 (5), and has received increased attention as a tool for evalu-

ating overall diet quality and for categorizing individuals based on their eating behavior, as dietary components are not consumed in isolation, but interact with one another (6). The Healthy Eating Index (HEI), Diet Quality Index (DQI), Healthy Diet Indicator (HDI) and Mediterranean Diet Score (MDS) are four original diet-quality scales that based on dietary recommendations and been validated internationally. However, these index may not applicable to China because of its distinct dietary habits. The previous Chinese Diet Balance Index (DBI) and the revised instrument (DBI_16) were developed successively in China. The 2017 Chinese Healthy Diet Index (CHDI) is the latest comprehensive evaluation approach (7). It is based on the 2016 Chinese Dietary Guidelines which captures variations in the components of dietary patterns, sensitively reflects under- and over-nutrition, and has proved useful in surveilling national nutrition transitions and epidemiological trends (7, 8).

Many studies have examined the importance of dietary quality and their long-term effects on health among various populations. A study found that higher scores for “vegetables-fruits” and “snacks-drinks-milk

*To whom correspondence should be addressed.
E-mail: 464315924@qq.com

products" patterns are associated with a reduced risk of cognitive impairment in older Chinese women (9). Children who were breastfed are more likely to have healthier dietary patterns and those who ate more fruits and vegetables in late infancy are more likely to continue their eating habits at age 6 (10).

However, few investigations have focused on maternal dietary intake, and there is a lack of well-designed, population-representative studies. Furthermore, as an international coastal metropolis, Shanghai has its own regional and dietary characteristics. The people have undergone noticeable changes in their diet and eating behavior in the past decades, which reflect in their nutritional and health status. Our previous study on the dietary scores of Shanghai residents showed that there were differences in dietary scores among residents in different regions, strengthen the accessibility and the supply of food across regions should be considered (11). Yet, with the rapid development of economy and food processing industry, diet quality among pregnant women in China has not been adequately assessed, and the associations of trimester, residential areas and dietary quality need to be further investigated.

Pregnant women living in Shanghai were selected as the study's target population to address this gap in the literature and propose up-to-date suggestions. The primary objective of our study was to examine the dietary quality of pregnant woman across trimesters and residential areas using the CHDI.

MATERIALS AND METHODS

Subjects and study design. We collected data from participants in the Iodine Status in Pregnancy and Offspring Health Cohort (ISPOHC) study, which was conducted in April–October 2017. A multistage, stratified random sampling method was used to obtain a representative sample. The formula for calculating stratified random sampling sample size which is $n = z^2 * S^2 * deff / d^2$ was used to calculate the sample size required for analysis. We defined the two-sided significance level $\alpha = 0.05$, $1 - \beta = 0.8$, $z_{\alpha/2} = 1.96$. According to the results of high school students CHDI survey in 2015 in Shanghai, $S = 20$, $d = 20 * 0.03 = 0.6$. The *deff* value of stratified random sampling was 1. At least 4,269 pregnant women without illnesses that could interfere with the research process were needed for the survey. The metropolis consist of urban, suburban and rural areas and they were categorized based on the ratio of the non-agricultural registered population in the sub-districts to those in town. The sample size in each administrative district was evenly determined in accordance with the sample size and the number of pregnant women in each administrative district in 2016. Each district was divided into five sections, a street was randomly selected from each section as well as 40–70 pregnant women. Participants from different stages of pregnancy were evenly distributed within each section selected street's participant selection. The Shanghai Municipal Center for Disease Control and Prevention (CDC) Ethics Committee approved the survey (No. 2017-15). All of the surveys

were conducted after written consent from the respondents was obtained.

Data collection. Participants were interviewed face-to-face by train qualified investigators to collect data on their demographics, pregnancy history, dietary habits, physical activity and related information. Dietary assessments were conducted using a personal food-frequency questionnaire (FFQ) to measure food consumption habits and a household condiment weighing method to measure amount of cooking oil, salt and sugar.

A validated and reliable FFQ (12) was consisted of 68 items including average daily food variety and used to assess the frequency and amount of foods consumed including dietary supplements over the past 3 mo. Food and nutrient intake was estimated using food composition tables published for use in China (13). Participants weighed changes in the cooking oil, salt and soy sauce over a continuous period of 1 wk at home. At the same time, the number of people who consumed the household condiments at each meal and whether the participants ate flavorings at each meal were recorded.

All data were reviewed by the local district Centers for Disease Control and Prevention (CDC) project team, and at least 5% of the data was reviewed by the Shanghai CDC project team.

Assessment of diet quality. The CHDI was used to evaluate overall patterns of dietary intake of the Chinese population, and it corresponds to the Chinese Dietary Guidelines and the Chinese Food Pagoda. The data from FFQ and the household condiment weighing could be used to obtain all information needed to calculate CHDI. The grains, dry beans and tubers were calculated by dry weight. The vegetables, fruit, meat, eggs, fish, shellfish and mollusks were calculated by wet weight. Considering standardized food protein content, soy products were uniformly referenced with soybeans and dairy products were referenced with fresh milk. The CHDI consists of 13 indexes, including (1) food variety (0–10 points); (2) refined grains (0–5 points); (3) whole grains, dry beans and tubers (0–5 points); (4) total vegetables (0–5 points); (5) dark green and orange vegetables (0–5 points); (6) fruit (0–10 points); (7) dairy (0–10 points); (8) soybeans (0–10 points); (9) meat and eggs (0–5 points); (10) fish, shellfish and mollusks (0–5 points); (11) calories from saturated fatty acids (SEA) (0–10 points); (12) sodium (0–10 points); and (13) calories from empty calories (0–10 points).

The food types reflects the degree of food diversity, and nine food intake indicators are used to evaluate food intake. The calories from SEA reflect the proper selection of high quality protein-source food, empty calories is an indicator for less oil, sugar control and limited alcohol. Scores on each component are summarized and the total score ranges from 0 to 100 (0 being the lowest and 100 being the highest possible score). A higher score reflects a better quality of dietary intake. According to the CHDI instructions, a total score of below 60 indicates a "poor" quality of dietary intake; a score between 60 and 80 indicates a "general" quality

Table 1. Characteristics of the study participants stratified by stage of pregnancy.

	Early pregnancy	Middle pregnancy	Late pregnancy	Pooled	χ^2	<i>p</i>
<i>N</i>	1,661	1,549	1,364	4,574	/	/
Maternal age (y) at delivery (<i>n</i> , %)						
<35	1,410 (84.9)	1,337 (91.6)	1,174 (85.9)	3,921 (85.7)	2.36	0.308
≥35	251 (15.1)	207 (13.4)	184 (13.5)	642 (14.04)		
Having physical activity habit (<i>n</i> , %)	1,437 (8.6)	168 (10.8)	110 (8.1)	421 (9.2)	2.65	0.277
Parity (<i>n</i> , %)						
0	1,044 (37.5)	920 (33.1)	819 (29.4)	2,783 (60.8)	50.60	<0.001
≥1	617 (34.5)	629 (35.1)	545 (30.4)	1,791 (39.2)		
Educational status (<i>n</i> , %)						
≤9 y	204 (12.3)	277 (17.9)	222 (16.3)	703 (15.4)	36.53	<0.001
Senior high school and college	647 (39.0)	661 (42.7)	554 (40.6)	1,862 (40.7)		
Bachelor's degree and above	809 (48.7)	609 (39.3)	587 (43.0)	2,005 (43.8)		
Occupational status (<i>n</i> , %)						
Mental	955 (57.5)	863 (55.7)	751 (55.1)	2,569 (56.2)	2.04	0.361
Physical	699 (42.1)	679 (43.8)	608 (44.6)	1,986 (43.4)		
Family income for the past year Yuan (<i>n</i> , %)						
<100,000	237 (14.3)	287 (18.5)	256 (18.8)	780 (17.1)	17.95	0.001
100,000–200,000	679 (40.9)	644 (41.6)	554 (40.6)	1,877 (41.0)		
≥200,000	743 (44.7)	613 (39.6)	551 (40.4)	1,907 (41.7)		
Former smoker (<i>n</i> , %)	47 (2.8)	41 (2.7)	29 (2.2)	117 (2.6)	1.59	0.452
Former drinker (<i>n</i> , %)	162 (9.8)	177 (11.4)	134 (9.8)	473 (10.3)	2.91	0.234
Residential area (<i>n</i> , %)						
Urban	762 (45.9)	637 (41.1)	593 (43.5)	1,992 (43.6)	22.65	<0.001
Suburban	459 (27.6)	414 (26.7)	320 (23.5)	1,193 (26.1)		
Rural	440 (26.5)	498 (32.1)	451 (33.1)	1,389 (30.4)		

of dietary intake; and a score greater than or equal to 80 indicates “good” quality of dietary intake (7).

Definitions of related indicators. Calories from SFA was defined as the ratio of energy from SFA: total energy. Empty calories were defined as alcohol, sugar and cooking oil. Sodium intake included the total intake from food, cooking salt and other condiments. Former smokers were defined as participants who smoked cigarettes in the past, excluding those who took a few tentative puffs. Former drinkers were defined as participants who drank alcoholic beverages during non-gestational periods in the past, excluding those who sipped some wine. The pregnant women were divided into old gravida (greater than or equal to 35 y) and non-old gravida (under 35 y). The pregnant women who have 120 min and longer time in moderate-intensity physical activity per week were regarded as having physical activity habit, those who don't were defined as having no exercise habits. According to the characteristic citizen education background in China, the educational status were divided into compulsory education (≤9 y), general education (Senior high school and college) and advanced education (Bachelor's degree and above). The occupational status were divided into mental labor position and physical labor position by the time that cost mentally and physically in the job. Based on average annual salary of employees in Shanghai in 2017, and assume that all pregnant families are couples living alone, family income for the past year was divided into

<100,000 Yuan group, 100,000–200,000 group and ≥200,000 group.

Statistical analysis. All statistical analyses were conducted using EXCEL (2010 Edition, Microsoft, China) software and IBM SPSS Statistics version 21.0 (IBM Corp., Armonk, NY, USA). A *p*-value <0.05 was considered to be statistically significant. Regression coefficients and the 95% confidence intervals were calculated.

The data on the variables were not normally distributed, and were therefore, summarized as median (interquartile range) and percentage. The Kruskal–Wallis one-way ANOVA (K samples) test was used with the multiple independent samples. All pairwise methods were implemented as pairwise comparisons. Comparisons of proportions were evaluated using the Chi-square test. CHDI scores were categorized as <60 (poor scores) and ≥60 (qualified scores) for the analyses, scores <60 points were set as “0” and scores ≥60 as “1.” Univariate and multivariate logistic regression were used in the analyses. The criterion for inclusion in the regression model was *p*<0.05, and the criterion for exclusion was *p*>0.1. Statistical significance was set at *p*<0.05.

RESULTS

Characteristics of the study participants stratified by stage of pregnancy

A total of 4,900 pregnant women were surveyed.

Table 3. Distribution of the China Healthy Diet Index (CHDI) scores by residential area and pregnancy stage (M, P25, P75).

CHDI components	Score range	Pooled	Pregnancy stage			Residential area			
			Early	Middle	Late	Urban	Suburban	Rural	F
Food variety	0-10	10.0 (7.9, 10.0)	10.0 (7.5, 10.0)	10.0 (8.2, 10.0)	10.0 (8.3, 10.0)	10.0 (7.8, 10.0)	10.0 (7.3, 10.0)	10.0 (8.9, 10.0)	60.7
Refined grains	0-5	5.0 (4.8, 5.0)	5.0 (4.8, 5.0)	5.0 (4.7, 5.0)	5.0 (4.8, 5.0)	5.0 (4.5, 5.0)	5.0 (5.0, 5.0)	5.0 (4.8, 5.0)	21.8
Whole grains, dry beans and tubers	0-5	1.0 (0.4, 1.8)	1.0 (0.4, 1.8)	1.0 (0.5, 1.8)	0.9 (0.4, 1.8)	1.0 (0.5, 1.8)	1.0 (0.5, 1.8)	0.9 (0.4, 1.8)	4.1
Total vegetables	0-5	2.4 (1.6, 3.8)	2.4 (1.6, 3.8)	2.3 (1.5, 3.6)	2.5 (1.7, 4.0)	2.6 (1.7, 4.1)	2.4 (1.5, 3.6)	2.3 (1.5, 3.6)	36.2
Dark green and orange vegetables	0-5	2.0 (1.3, 3.3)	2.1 (1.3, 3.3)	1.9 (1.2, 3.1)	2.1 (1.3, 3.5)	2.2 (1.4, 3.6)	1.9 (1.2, 3.2)	1.8 (1.2, 3.1)	34.3
Fruits	0-10	10.0 (6.1, 10.0)	10.0 (6.3, 10.0)	10.0 (6.1, 10.0)	9.5 (5.9, 10.0)	9.7 (6.1, 10.0)	10.0 (6.7, 10.0)	9.7 (5.9, 10.0)	21.0
Diary	0-10	8.2 (4.0, 10.0)	8.0 (3.8, 10.0)	8.0 (3.6, 10.0)	8.7 (4.5, 10.0)	8.6 (4.0, 10.0)	8.2 (4.3, 10.0)	7.8 (3.6, 10.0)	6.8
Soybeans	0-10	10.0 (6.1, 10.0)	10.0 (5.7, 10.0)	10.0 (6.4, 10.0)	10.0 (6.6, 10.0)	10.0 (6.8, 10.0)	10.0 (5.7, 10.0)	10.0 (5.6, 10.0)	17.2
Meat and eggs	0-5	5.0 (5.0, 5.0)	5.0 (4.8, 5.0)	5.0 (4.9, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (4.7, 5.0)	5.0 (4.5, 5.0)	77.6
Fish, shellfish and mollusks	0-5	4.7 (2.5, 5.0)	4.7 (2.4, 5.0)	4.5 (2.4, 5.0)	4.9 (2.6, 5.0)	5.0 (3.0, 5.0)	4.0 (2.1, 5.0)	4.7 (2.2, 5.0)	67.2
Calories from SFA	0-10	2.2 (0.0, 6.9)	2.7 (0.0, 7.3)	1.8 (0.0, 6.9)	2.0 (0.0, 6.5)	2.2 (0.0, 6.7)	1.6 (0.0, 6.5)	2.7 (0.0, 7.7)	9.7
Sodium	0-10	7.2 (4.8, 8.9)	7.1 (4.7, 8.8)	7.1 (4.7, 9.0)	7.3 (5.1, 9.0)	7.1 (4.8, 8.8)	6.8 (4.3, 8.7)	7.5 (5.3, 9.3)	45.8
Empty calories	0-10	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	32.6
Total score	100	71.6 (63.9, 77.9)	71.1 (63.7, 77.5)	71.5 (63.3, 77.5)	72.3 (65.1, 78.7)	72.4 (64.6, 78.6)	70.4 (63.3, 76.3)	71.2 (63.4, 78.2)	30.1

Fig. 1. The China Healthy Diet Index (CHDI) composition ratios for the different residential areas and pregnancy stages.

The analysis of the composition ratio of CHDI showed that 13.7% of participants had scores below 60 points. Significant differences in the CHDI score compositions of the participants in the different trimesters and residential areas were found ($\chi^2=14.95, 33.75; p=0.005, <0.001$). The proportion of scores below 60 among women in the late stage of pregnancy was lower than that of the women in the early and middle stages. The proportion of participants with a score below 60 was higher among those in suburban and rural areas compared to those in urban areas (Fig. 1).

Logistic analysis of the factors that contribute to qualified CHDI scores

General characteristics, pregnancy stage and residential area were treated as independent variables and CHDI score groups as the dependent variable.

The uni-variate logistic regression showed that residential area, pregnancy stage, educational background and family income in the past were significantly correlated with CHDI score groups ($p<0.05$). The multi-variate logistic regression showed a significant difference in qualified CHDI scores among participants in the different trimesters. Participants in early and middle pregnancy had lower scores, compared to those in late pregnancy ($p<0.05$). Participants living in urban areas tended to have more qualified CHDI scores, compared to those in suburban and rural areas. Women with less than 9 y of formal education had less qualified scores compared to those with more education (i.e., senior high school and college) and above, and a family income less than 100,000 Yuan during the past year was associated with less qualified scores compared to the two higher levels of family income (Table 4).

DISCUSSION

Nutrition is a predictor of pregnancy success and dietary patterns can affect pregnant women for the rest of their lives. The overall diet quality of pregnant women in Shanghai was found in this study to be average, and unbalanced, which is similar to the previous findings of Shanghai residents (11). The median CHDI score was 71.6 and merely 18.4% scored ≥ 80 points, which is higher than that of Chinese adult (7) and Shanghai senior high school students (14). Pregnancy

stages and residential areas were associated with CHDI scores, as were socioeconomic factors (educational level and family income). The dietary scores of urban residents were higher than those of suburban and rural residents, and being in the later stages of pregnancy served as a protective factor for good dietary intake.

Though pregnant women in Shanghai ate a wide variety of foods, the dietary was not reasonable with an over-intake of meat and under-intake of whole grains, dairy products and vegetables. The under-consumption of whole grains, dry beans and tubers may be related to the diet habits of Shanghai residents, which is difficult to change in a short time. Whole grains and its constituents have antioxidants and anti-inflammatory properties, which promote fertility (15); a fertility clinic study showed that a higher intake of whole grains was associated with better birth outcomes (16). Although the promotion of whole grain consumption has been on-going since the establishment of the Chinese Dietary Guidelines in 2016 (17), people in the southern region of China are accustomed to living on rice on a long-term basis, which leads to the insufficient consumption of whole grains, such as corn, millet, buckwheat and miscellaneous beans. In this study, only 11.4% of pregnant women consumed more than the reference intakes of milk. Milk products are excellent sources of calcium and protein for maternal and fetal health rather than other foods, and a chronic calcium deficiency may cause increased bone loss during pregnancy (18, 19).

Another diet problem lies in the severely inadequate consumption of total vegetables, dark green and orange vegetables and over-consumption of meat, which was also reported in a previous national survey in 2010–2012 (20). Only 8.9% of pregnant women ate more than the reference intakes of vegetables, while more than half of pregnant women consumed more than the reference intakes of meat. Pregnant women were advised to have 300–450 g/d of total vegetables and 40–75 g/d of livestock and poultry meat, dark green and orange vegetables would account for over 66.7% of all the vegetables consumed (17). Several studies have proposed that a healthy diet comprised of sufficient vegetables is associated with a reduction in the risk of gestational diabetes mellitus during pregnancy while a

Table 4. Logistic regression models for the qualified CHDI scores.

Item	CHDI score Median	Univariate model				Multivariate model			
		β	Coeff.	95% CI	p	β	Coeff.	95% CI	p
Maternal age at delivery ≥ 35 y									
No	71.5 (64.0, 78.0)		Reference				Reference		
Yes	71.0 (63.6, 77.4)	0.001	/	/	0.980	0.011	/	/	0.916
Having physical activity habit (n , %)									
No	70.9 (63.4, 77.2)		Reference				Reference		
Yes	71.8 (64.2, 78.2)	2.124	/	/	0.195	1.197	/	/	0.274
Parity									
0	71.6 (64.0, 78.0)		Reference				Reference		
≥ 1	71.3 (63.7, 77.7)	3.720	/	/	0.054	0.920	/	/	0.337
Educational status									
≤ 9 y	69.5 (62.2, 76.7)		Reference				Reference		
Senior high school and college	71.1 (63.7, 77.4)	0.399	1.490	1.182–1.880	0.001	0.333	1.396	1.096–1.778	0.007
Bachelor's degree and above	72.3 (64.8, 79.0)	0.498	1.645	1.304–2.075	<0.001	0.397	1.487	1.145–1.931	0.003
Occupational status									
Mental	72.0 (64.4, 78.3)		Reference				Reference		
Physical	71.0 (63.5, 77.3)	0.500	/	/	0.479	0.002	/	/	0.969
Family income in the past year, Yuan									
$<100,000$	69.4 (61.7, 75.6)		Reference				Reference		
100,000–200,000	71.4 (64.1, 77.8)	0.416	1.515	1.209–1.898	<0.001	0.340	1.404	1.109–1.779	0.005
$\geq 200,000$	72.3 (64.5, 78.9)	0.467	1.595	1.272–2.001	<0.001	0.322	1.380	1.069–1.782	0.013
Former smoker									
No	71.6 (63.9, 78.0)		Reference				Reference		
Yes	69.6 (63.4, 74.8)	0.076	/	/	0.782	0.005	/	/	0.946
Former drinker									
No	71.6 (63.9, 78.0)		Reference				Reference		
Yes	70.7 (64.3, 76.5)	1.179	/	/	0.278	1.373	/	/	0.241
Pregnancy stage									
Early	71.1 (63.7, 77.5)	−0.313	0.732	0.588–0.910	0.005	−0.322	0.724	0.581–0.903	0.004
Middle	71.2 (63.3, 77.5)	−0.375	0.687	0.552–0.856	0.001	−0.344	0.709	0.568–0.884	0.002
Late	72.3 (65.1, 78.7)		Reference				Reference		
Residential area									
Urban	72.4 (64.6, 78.6)		Reference				Reference		
Suburban	70.4 (63.3, 76.3)	−0.375	0.688	0.558–0.847	<0.001	−0.311	0.739	0.601–0.931	0.005
Rural	71.2 (63.4, 78.2)	−0.331	0.718	0.587–0.878	0.001	−0.275	0.764	0.621–0.955	0.011

higher consumption of total meat, especially red and processed meat, could increase the hazard (21, 22).

We found that participants in later pregnancy had a relatively higher overall diet quality compared to those in early pregnancy. It may be related to that in early pregnancy many women have morning sickness, which could potentially adversely affect nutrient intake. On the other hand, it also may be related to the stress of pregnancy. A cohort study from the Fudan School of Public Health which included 2,634 participants found that increased pregnancy-specific stress in the middle and third trimesters may motivate pregnant women to follow a healthy balanced diet, and thus, equip them with more nutritional knowledge compared to novices in their first trimester, which was thought as the weak association with poor birth outcomes in previous studies (23). Compared to the chronic stress experienced during early pregnancy, the stress in the later trimesters is acute stress, characterized by increased blood sugar and poor appetite, which lure pregnant women to choose food that stimulates their appetite to meet their nutritional needs prior to labor (24, 25). Hence, it is important to strengthen diet-related health education for pregnant women during all trimesters, especially the first one.

Residential area was found to be another determining factor of dietary quality. The dietary scores of the urban residents were higher than those of the suburban and rural residents. People dwelling in the countryside tend to consume more refined grain and less vegetables and meat, which is consistent with the finding in China and UK (26, 27) and associated with the local food environment and food availability. Full-service supermarkets and grocery stores in downtown are more densely distributed than those in the remote areas are. Another explanation may be related to differences in socioeconomic status among the urban, suburban and rural areas. A large amount of epidemiologic data has revealed an association of diet quality with the socioeconomic status (28, 29). Educational and family income levels were also found to be protective factors in our study, the distribution of which differed between the residential areas. Pregnant women with high educational levels have more opportunities to earn more money and settle downtown rather than in rural areas. They are likely to have higher rates of literacy and healthier dietary habits (30). Their work experience might empower them to make better decisions about their dietary healthcare during pregnancy (31), and thus, have a higher diet quality. Pregnant women with lower incomes tend to consume fewer fruits and vegetables and more sugar-sweetened beverages (32), as the cost of food is an insurmountable gap for them, making it a challenge to access nutrient-dense diets (28).

To the best of our knowledge, this is the first study to apply CHDI indicators to assess diet quality among pregnant woman. This investigation was a systematic sampling survey covering all districts of Shanghai using a large representative sample and reasonable survey methods, which reflects the dietary intake of the popu-

lation and should lead to generalizable conclusions. However, our study has limitations. The CHDI has some drawbacks. Each CHDI score has only a single threshold and it cannot explain the balance of the overall dietary pattern of a target population. And the health outcomes were not assessed in this study, and thus, the relationship between the CHDI and health outcomes should be evaluated in the future.

CONCLUSION

Most of pregnant women living in Shanghai suffer from a general or poor dietary quality, with 13.7% of participants in this study scoring below 60 points, indicating “poor” diet quality. Pregnancy stage, residential area, educational status and family income level were associated with diet quality. Relevant health education and health promotion strategy should be strengthened to guide pregnant women in making reasonable food choices, especially those living in suburban and rural areas and those in their first and second trimesters. And also more researches are required to understand the motivators and barriers to women achieving dietary guidelines.

Authorship

Z.W., J.Z., C.G. and J.S. designed research; Z.W. and J.S. analyzed data; Z.W., J.S. and Y.W. wrote the paper; X.C., Q.S. and Z.S. conducted research; All authors have read and approved the final manuscript.

J.S. and J.Z. contributed equally to this work.

Disclosure of state of COI

The authors have no conflicts of interest relevant to this study.

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