Validation and reliability of a simplified food frequency questionnaire: A cross sectional study among physical health examination adults in southwest region of China

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Research

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Abstract

Background In China, many people are apt to participate in regular physical examination as a precaution. Some simplified food frequency questionnaire have been designed and used. However, the effectiveness of questionnaire is absent. This study was conducted to examine the reliability and validity of simplified food frequency questionnaire (SFFQ) used among physical examination adults in southwest region of China.

Methods This study was a cross sectional study among physical health examination adults in Southwest region of China. A total of 239 participants aged 20-65 were conducted during February to June in 2019. The performance of the SFFQ was evaluated by the mean of three-day 24-hour dietary recalls (3R24). The relative validity and agreement was assessed by the Pearson`s correlation and intra-class correlation coefficients(ICC) respectively.

Results The median energy-adjusted ICC of food groups between SFFQ2 and SFFQ1 was 0.59 (range: 0.49-0.73) and the ICC of nutrients was 0.47(range: 0.39-0.76). The Pearson correlation showed the validity between the SFFQ1 and 3R24, which ranged from -0.086 to 0.93 for food and and 0.21 to 0.71 for nutritions, respectively. Energy-adjustment slightly increased the correlation coefficients.

Conclusions The reliability and validity of the SFFQ was acceptable. It could be an appropriate dietary assessment tool for future epidemiological studies in physical health examination adults among Chinese in southwest China.

1. Introduction

The quantification and assessment of the diet are difficult tasks, although vital to the relationship between nutrients and non − transmissible chronic diseases (NTCDs) and in the monitoring of individual and populational dietetic behavior[1]. Those studies belong to the nutritional epidemiological area.

Several types of instruments are used to assess both the present and previous diet: the 24 hour diet record (R24), food − intake record (FR), and the food frequency questionnaire (FFQ). All of those instruments show either advantageous or limiting results. FFQ is a cost − effective method for dietary assessment in large population groups[2]. Presently, the FFQ has been widely used in epidemiological studies, intended to assess the relation between diet and disease for providing the information of the frequency and portion size of a defined food items list, with the merits of feasibility, low cost and low recall bias[3]. Especially when applying population survey or community trials, it had been recommended as one of the first − line methods in dietary measurements. For assessing the factors which have effects on incidence or prevalence of chronic disease, the diet pattern or various food intakes on the FFQ should be valid, which evaluate various kind of food intake and the dietary pattern to the occurrence of chronic diseases[4]. In recent years, there have been many reports of using FFQ to evaluate single nutrients[5]. Some scholars reported using food frequency questionnaires to assess disease risk[6].

But food intake largely varies depending on the ethnic, social, and cultural background of the study population. Validation study should be conducted in order to improve the FFQ application within a specific samples[7] and to improve accuracy and reduce bias levels related to disease occurrences[8].

In China, many people are apt to participate in regular physical examination as a precaution. It is important to analysis the relationship between die and their physical examination data, which has prominent characteristics: large and persistent. The data is the important source of forecasting disease risk factors. However, in China, the traditional food frequency questionnaires include more than one hundred kinds of food, which would take nearly 30 minutes to finish. It is generally assumed that questionnaire length has a significant effect on the survey response rate as respondents get tired, bored and/or distracted by external factors[5]. Some simplified food frequency questionnaire(SFFQ) has been designed and used in the special populations[9 – 10]. However, the effective of SFFQ for Chinese physical examination population is absent. It is unclear whether the SFFQ could evaluate intakes in the samples simlar to that of large – scale crowd survey.

In this study, based on the traditional FFQ questionnaire of China, combined the dietary habits of residents in southwest China, we designed to develop a new SFFQ, which assesses the dietary intake of a person in the preceding 3 months and assessed the reliability in two weeks and validity comparing with a 3 – day 24-hour dietary record (3R24) among physical examination adults in Southwest region of China, a method that has been found to be suitable for confirmation to esatablish validity.

2. Materials And Methods

2.1 Participants

This study was a cross sectional study among physical health examination adults in southwest region of China. Participants were from the physical examination population of the Medical Examination Center of Sichuan Provincial People`s Hospital, who were conducted inclusion during February to June in 2019. Subjects, aged 20 – 65, who could fill in the questionnaire independently and accepted a phone interview could be included. The dietary information was collected using SFFQ and 3 – day 24 – hour dietary recalls(3R24). All information was collected by 3 trained interviewers. Participants were rolled in this study for a period of 2 weeks(FIgure 1). The first SFFQ(SFFQ1) was collected at the medical examination site, and the second SFFQ(SFFQ2) was collected after 2 weeks by phone. The contents of SFFQ2 and SFFQ1 were the same, but the order of the questions was randomly generated by the computer. The 3R24s were designed on Saturday, Monday, and Tuesday, which covered two weekdays and one weekend day to account for intraindividual variation between day types. A sample of 239 completed 3R24s and SFFQ1 + 2. All participants were informed about the study and gave formal consents before being interviewed. The study was approved by the Ethics Committee at of Sichuan Provincial People's Hospital(Approval Number: 2017 – 153), China.

2.2. Dietary Assessment

2.2.1 Simplified Food Frequency Questionnaire (SFFQ)

Based on an FFQ used for Chinese,[10] combining the eating habits of southwest China, such as preserved meat, chilli and soy products intaking, a SFFQ was designed for the physical examination population. The SFFQ consisted of 50 items of food commonly consumed in the previous month, including the following three sections: the food list, the frequency response, and the average intake. The food items were divided into the following 14 categories: (1)cereal, (2)bread and noodle, (3)tubers, (4)red meat, (5)poultry, (6)haslet and processed meat products, (7)aquatic products, (8)soy products, (9)eggs, (10)dairy, (11)vegetables, (12)fruit, (13)phytocomycetes and (14)nuts. The food groups and their components are listed in Table 1. During completion of the SFFQ, participants were required to indicate how many times each food category was consumed per month/week/day in the past 3 months. Frequency of consumption was measured by selecting one of the following options: (1)never or less than once per month, (2)1 – 3 times per month, (3)1 – 3 times per week, (4)4 – 6 times per week, (5)how many times per day. And therefore, there was no unified portion size in China, food types and portion size of local food were surveyed in markets, and visual aids, which consisted of pictures of utensils and food portions, were used to assist with description of amounts consumed with the help of trained investigators. Food intake (g/day) was calculated by multiplying frequency of consumption by the portion size and obtained mean frequencies of consumption per day for each group.

Table 1
Food groups and their components in SFFQ

Food groups	Components
Cereal	Rice, millet, sorghnm
Bread and noodle	Bread, cake, noodle, flour, pizza
Tubers	Potato, cassava, yam
Red meat	Pork, beef, cow, goat, rabbit
Poultry	Chicken, duck, goose
Aquatic products	Fish, shrimp, aquid, crab
Haslet and processed meat products	Haslet, sausage, ham, preserved meat
Eggs	Boiled eggs, omelette
Dairy	Milk, yaourt, yoghourt, cheese
Vegetables	Leafy greens, chili, vegetables, green beans, vegetable juice
Phytocomycetes	Mushroom, kelp, sea beans
Soy products	Legumes, tofu, soy beans
Fruits	Berries, dried fruits, fruits, fruit juice
Nuts	Cashew nuts, walnuts, peanuts

2.2.2 3 – day 24 – hour Dietary Recalls (3R24s)

The study population completed 3R24s in one week, which including two working days and one rest day. The resulting dietary data included 4,024 “food mentions”, i.e., the entire amount of food items for all patients combined. These data were coded into 14 broad food groups and 12 types of nutrients as for the SFFQ according to Chinese Residents Dietary Guidelines’ selections. The mean weights were calculated respectively.

2.2.3 Assessment

The daily nutrient consumption of participants was calculated by matching the food code from the China food composition database. If one food was not listed in the database, food containing similar ingredients was used to be instead of calculating the nutritional values. For a food group, according to the similarity of ingredients, nutrient profile, and/or culinary usage among the food and the grouping scheme used in other studies, the SFFQ’s and the 3R24s’ food lists were reduced to 14 predefined food groups and 12 types of nutrients, respectively.

2.3 Statistical Analyses

All data were double – entered into Epidata. Pearson correlation coefficients were used to evaluate the validity of food frequency acquired by SFFQ1 with the average of 3R24s data (food weight). Adjusted correlation coefficients for total energy intake were calculated. The agreement between SFFQ1 and SFFQ2 was assessed by intra – cliass correlation coefficients(ICC) of energy – adjusted food and nutrients intakes. All analyses were performed using Statistical Package for the Social Science (SPSS) software, version 17.0 (IBM, Armonk, New York, NY, USA). A P value < 0.05 was considered statistically significant.

3. Results

3.1 Description of the study population

It took about 5 – 8 minutes averagely to complete one SFFQ under the help of investigators. Among the initial samples of 268 participants, 239(89.18%) of them had finished both 3R24 and SFFQ1/2, with the mean age of 44.29(9.12) years old. 51.88% participants had 3000 + RMB monthly income, however 37.24% of them refused to provide this informtion. The habit of having breakfast was good, accounting for 87% of all participants, which was beyond our expectation. But most of them ate outside frequently. The characteristics of study population are described in Table 2.

Table 2
Characteristics of the study subjects

Characteristic	Total(n = 239)	Male(n = 158)	Female(n = 81)
Age(n,%)	44.29 (9.12)	45.43(8.45)	42.02(8.23)
< 30	8(3.35)	4(2.53)	4(4.94)
30–40	69(28.87)	43(27.22)	26(32.10)
40–50	100(41.84)	67(42.41)	33(40.74)
50–60	44(18.41)	32(20.25)	12(14.81)
≥ 60	18(7.53)	12(7.59)	6(7.41)
Education(n,%)			
Missing	66(27.62)	44(27.85)	22(27.16)
High school	89(37.24)	62(39.24)	27(33.33)
College school	78(32.64)	48(30.38)	30(37.04)
Graduate school	6(2.51)	4(2.53)	2(2.47)
Monthly Income(RMB,n,%)			
Missing	89(37.24)	52(32.91)	37(45.68)
≤ 3000	26(10.88)	14(8.86)	12(14.81)
3000–6000	58(24.27)	39(24.68)	19(23.46)
6000–10000	34(14.23)	29(18.35)	5(6.17)
≥ 10000	32(13.39)	24(15.19)	8(9.88)
Family status(n,%)			
Single	40(16.84)	26(16.46)	14(17.28)
Co-habiting	199(83.26)	132(83.54)	67(82.72)
Employment status(n,%)			
Employed	182(76.15)	135(85.44)	47(58.02)
Not Employed	57(23.85)	23(14.56)	34(41.98)
Change in body weight in past 3 month(n,%)			
Change	69(28.87)	36(22.78)	33(40.74)
No change	170(71.13)	122(77.22)	48(59.26)

Characteristic	Total(n = 239)	Male(n = 158)	Female(n = 81)
Smoke(n,%)			
Yes	84(35.15)	76(48.10)	8(9.88)
No	155(64.85)	82(51.90)	73(90.12)
Dietary structure(n,%)			
Meat and vegetables mixed	192(80.33)	131(82.91)	61(75.31)
Meat based	26(10.88)	21(13.29)	5(25.93)
Vegetables based	21(8.79)	6(3.80)	15(18.52)
Breakfast frequency (per week, n,%)			
≥ 5 time	173(72.38)	127(80.38)	46(56.79)
3–4 time	35(14.64)	18(11.39)	17(20.99)
1–2 time	22(9.21)	8(5.06)	14(17.28)
None	9(3.77)	5(3.16)	4(4.94)
Dining out frequency (per week, n,%)			
≥ 5 time	38(15.90)	27(17.09)	11(13.58)
3–4 time	61(25.52)	51(32.28)	10(12.35)
1–2 time	128(53.56)	77(48.73)	51(62.96)
None	12(5.02)	3(1.90)	9(11.11)

3.2 Reliability of SFFQ1 vs. SFFQ2

Table 3 shows the descriptive statistics for the mean(standard deviation,SD) intake of 14 types of food groups and 12 types of nutrients between SFFQ1 and SFFQ2. The means total energy intake and food intake reported in SFFQ2 were higher than the means reported in SFFQ1,except the item of haslet and processed meat products. Compared with SFFQ2, the nutrient intake of vitamin B2 and calcium was slightly higher in SFFQ1. Intake of other nutrients such as carbohydrates, protein, fat, dietary fiber, vitamin C, and iron was not significantly different between SFFQ1 and SFFQ2. The median energy − adjusted ICC of food groups between SFFQ2 and SFFQ1 was 0.59 (range: 0.49 − 0.73). The energy − adjusted ICCs of nutrients 0.47(range: 0.39 − 0.76).

Table 3

Reliability of food groups and nutrients intakes between the SFFQ1 and SFFQ2(n = 239)

Food groups/Nutrients	SFFQ1	SFFQ2	ICC	
	Mean(SD)	Mean(SD)	Unadjusted	Energy-adjusted
Food groups(g/d)				
Cereal	210.7(96.6)	246.4(83.8)	0.63**	0.67**
Bread and noodle	63.2(45.8)	72.4(58.6)	0.46*	0.49*
Tubers	20.6(27.2)	25.4(18.9)	0.55*	0.58*
Read meat	86.9(60.1)	97.5(53.7)	0.53**	0.57**
Poultry	52.2(42.8)	64(38.9)	0.50*	0.56*
Aquatic products	59.1(76.7)	62(72.7)	0.62*	0.53*
Haslet and processed meat products	17.5(27.6)	14.3(29.4)	0.50*	0.57*
Eggs	31.4(28.9)	40.7(19.6)	0.58**	0.69**
Dairy	92.9(110.5)	101(114.7)	0.62**	0.65**
Vegetables	238.8(144.5)	247(152)	0.71**	0.73**
Phytocomycetes	16.5(21.0)	24.1(18.8)	0.49*	0.54*
Soy products	31.9(47.9)	34.1(39.6)	0.50*	0.54*
Fruits	112.3(116.9)	121.2(89.7)	0.63**	0.67**
Nuts	13.5(23.8)	20.7(18.9)	0.51*	0.53*
Nutrients				
Energy(Kcal/d)	1786.3(523.4)	1820.2(220.1)	0.72**	
Protein(g/d)	53.4(21.3)	60.3(10.8)	0.64*	0.68*
Carbohydrate(g/d)	207.2(38.4)	216.4(58.2)	0.62**	0.70**
Fat(g/d)	32.7(12.1)	35.6(9.2)	0.53*	0.69*
Dietary fiber(g/d)	49.5(54.4)	52.3(27.4)	0.34*	0.39*

Note: Standard deviation: SD, Intra-class correlation coefficient: ICC,

[a]: Sum of retinol, β-carotene, α-carotene, and cryptoxanthin. * $P < 0.05$. **$P < 0.01$.

Food groups/Nutrients	SFFQ1	SFFQ2	ICC	
	Mean(SD)	Mean(SD)	Unadjusted	Energy-adjusted
Vitamin A(ugRE/d) [a]	742.3(312.3)	772.7(603.4)	0.73*	0.76*
Vitamin B1(mg/d)	0.68(0.11)	0.74(0.31)	0.65*	0.70*
Vitamin B2(mg/d)	1.38(0.43)	1.2(0.2)	0.38*	0.40*
Vitamin C(mg/d)	115.2(41.3)	122.6(34.7)	0.67**	0.75**
Vitamin E(mg/d)	70.1(48.7)	73.4(54.7)	0.59**	0.62**
Calcium(mg/d)	567.2(162.4)	556.2(168.3)	0.52*	0.64*
Iron(mg/d)	7.1(2.2)	8.2(1.9)	0.64**	0.71**
Note: Standard deviation: SD, Intra-class correlation coefficient: ICC,				
[a]: Sum of retinol, β-carotene, α-carotene, and cryptoxanthin. * P < 0.05. **P < 0.01.				

3.3 Validation of the SFFQ1 vs. 3R24

Table 4 reports the descriptive statistics for the mean(standard deviation, SD) intake between SFFQ1 and 3R24. Overall, the crude Pearson coefficients between the SFFQ1 and 3R24 among different food groups and nutrients ranged from − 0.086 to 0.93 and 0.21 to 0.71, respectively. While the energy adjusted Pearson coefficients showed higher correlation than crude coefficients, which ranged from − 0.31 to 0.96 and 0.26 to 0.73 respectively. Compared with 3R24, the intake of tubers, poultry, aquatic products, eggs,dairy, phytocomycetes and soy products were slightly higher in SFFQ1. Results of the validity assessment of SFFQ1 vs. 3R24 are presented in Table 4. Phytocomycetes and aquatic products showed weak correlations with coefficients less than 0.4. Other four food groups(poultry, haslet and processed meat products, tubers, soy products and nuts) showed moderate correlations with coefficients ranged from 0.43 to 0.58. Strong correlations with coefficients higher than 0.6 were observed among the following eight food groups: cereal, bread and noodle, read meat, dairy, eggs, vegetables, and fruits. The Spearman`s correlation coefficients of nutrients between SFFQ1 and 3R24 ranged from 0.19 to 0.71. Adjusting for total energy intake incresed all correlation coefficients, ranging from 0.26 to 0.73. All correlationa were statiscally between the FFQ1 and 3R24 methods ($P \leq 0.05$).

Table 4
Validation of food groups and nutrients intakes between the SFFQ1 and 3R24 (n = 239)

Food groups/Nutrients	SFFQ1	3R24	Rs value	
	Mean(SD)	Mean(SD)	Unadjusted	Energy-adjusted
Food groups(g/d)				
Cereal	210.7(96.6)	230.2(72.0)	0.51**	0.76**
Bread and noodle	63.2(45.8)	56.4(72.7)	0.50**	0.86**
Tubers	20.6(27.2)	8.8(23.9)	0.19**	0.49**
Read meat	86.9(60.1)	110.5(57.3)	0.66**	0.72**
Poultry	52.2(42.8)	11.4(24.7)	0.16*	0.52*
Aquatic products	59.1(76.7)	12.1(28.8)	0.19*	0.32*
Haslet and processed meat products	17.5(27.6)	4.5(14.7)	0.36*	0.58*
Eggs	31.4(28.9)	13.3(23.6)	0.46**	0.78**
Dairy	92.9(110.5)	86.1(87.3)	0.57*	0.71*
Vegetables	233.9(144.5)	238.8(108.6)	0.93**	0.96**
Phytocomycetes	16.5(21.0)	2.7(13.1)	-0.086*	-0.31*
Soy products	31.9(47.9)	18.3(24.4)	0.52*	0.54*
Fruits	112.3(116.9)	156.4(130.4)	0.64**	0.65**
Nuts	13.5(23.8)	7.7(23.3)	0.32*	0.43*
Nutrients				
Energy(Kcal/d)	1786.3(523.4)	1923.2(356.3)	0.47*	
Protein(g/d)	53.4(21.3)	64.3(13.6)	0.29*	0.34*
Carbohydrate(g/d)	207.2(38.4)	264.6(47.2)	0.60**	0.63**
Fat(g/d)	32.7(12.1)	56.0(19.4)	0.19*	0.21*
Dietary fiber(g/d)	49.5(54.4)	52.6(43.2)	0.21*	0.26*

Note: Standard deviation: SD, Spearman correlation coeficient: Rs,

[a]: Sum of retinol, β-carotene, α-carotene, and cryptoxanthin. * P < 0.05. **P < 0.01.

Food groups/Nutrients	SFFQ1	3R24	Rs value	
	Mean(SD)	Mean(SD)	Unadjusted	Energy-adjusted
Vitamin A(ugRE/d)[a]	742.3(312.3)	811.8(372.3)	0.52*	0.55*
Vitamin B1(mg/d)	0.68(0.11)	0.91(0.12)	0.38*	0.41*
Vitamin B2(mg/d)	1.38(0.43)	1.48(0.25)	0.29*	0.31*
Vitamin C(mg/d)	115.2(41.3)	131.2(32.4)	0.54*	0.62*
Vitamin E(mg/d)	70.1(48.7)	83.4(53.3)	0.71**	0.73**
Calcium(mg/d)	567.2(162.4)	541.6(167.8)	0.47*	0.52*
Iron(mg/d)	7.1(2.2)	8.2(1.7)	0.65*	0.70*
Note: Standard deviation: SD, Spearman correlation coeficient: Rs,				
[a]: Sum of retinol, β-carotene, α-carotene, and cryptoxanthin. * P < 0.05. **P < 0.01.				

4. Discussion

This study examined the reliability and validity of a SFFQ to assess dietary intake among physical examination adults in southwest region of China. In this study,3 day diet record (3R24) were used as a reference method[11]. Results of usual food intake and correlation coefficients suggest that the SFFQ was reproducible and performed well compared with 3R24.

The validation of food assessment tools is essential to understand the relationships between the food and nutrition – related diseases. To assess validity, although always imperfect, 24h dietary recalls is used for comparison widely. In this study, we assessed the validity of a simplified FFQ (SFFQ) by comparing estimates of dietary intake from the 3 day dietary records (3R24) among adults who were taking physical examination in southwest of China. Overall, the SFFQ demonstrated good reproducibility for the estimation of intakes of food groups. The crude Pearson coefficients for the correlations between daily intakes of various food groups derived from two measures ranged from – 0.086 to 0.93 and the mean correlation is 0.44. After adjusted by total energy intake, the adjusted Pearson coefficients for the correlations improved, from 0.31 to 0.96, and mean correlation is 0.63. The correlation coefficients in our study and other studies were very similar for many food groups, which had reported correlations of 0.19 – 0.84[12–13].

A recent systematic review reported that the validity of FFQs should be re – evaluated because energy, carbohydrate, calcium, and vitamin C intakes were overestimated, especially in females[14]. Some scholars' research reported FFQs tended to have a larger measurement error for underestimating energy and

nutrient intake compared with the error associated with DR or 24 – hour dietary recalls, using biomarkers included doubly labeled water and urine collection as a reference[15]. And simplified dietary survey questionnaires tend to underestimate energy and nutrient intake compared with that of longer questionnaires and DR[16]. The SFFQ and the 3R24 recall questionnaire have some differences in their error sources. Two methods of investigation are sufficiently independent[17]. Both questionnaires are prone to memory bias (SFFQ vs. the 3R24) and have differences in the perception of portion sizes. The 3R24 method is based on open – ended questions; while the SFFQ is usually close – ended questions. In our study, the SFFQ considered 3R24 as reference that was underestimated energy and nutrient intake, consisted with previous research. The amount of nutritional intake can often be biased by individuals' inability to correctly estimate daily intake. Some individuals are unwilling to acknowledge the intake of foods that might be harmful to health, such as internal organs, fatty meat, processed meat products, etc.Therefore, this SFFQ do not provide accurate and precise estimates for some nutrients (i.e., vitamin B, dietary fiber, protein and fat). However, for foods with low frequency of usual intake, DR is likely to underestimate food intake. For example, in this study, tubers, poultry, aquatic products, phytocomycetes, etc.(in Table 4), the frequency intake of which was only 1 – 2 times a week or less than once a week, the results obtained by the 3R24 method were obviously less than those obtained by SFFQ. Although the correlation after adjusted by total energy intake was still higher than 0.3, it seemed more reliable to analyze and collect such data by SFFQ method. In this study, the amount of food, energy, and nutrients in the repetitive SFFQ2 were increased(Table 3), which might be related to the higher recall and higher attention of the subjects when the questionnaire was completed for the first time. Repeatedly completing SFFQ if possible might improve the authenticity of SFFQ. A more accurate estimate of these nutrients requires comparison of biomarkers as a reference for further study.

Fruit is the most frequently studied group in the literature and most FFQs. Concerning fruits, the correlations generally ranged between 0.5 and 0.7,[18–19] which was similar to those obtained in our study (fruits: r = 0.65). Vegetables, eggs,bread and noodle, dairy and read meat were observed stronger correlation (r = 0.96, 0.86, 0.78, 0.71,0.72), consistent with other studies reported [13, 20]. Moreover, the correlation and dietary intake of phytocomycetes, aquatic products, and nuts seemed lower than studies abroad. The intakes of cereal and soy product were lower than the average level reported in China. While the intakes of fruit, poultry and read meat were higher. Other foods were similar to those obtained in earlier studies in China health and nutrition survey (CHNS) [21]. It might be that the dietary and living habits of the population in southwest China caused a certain difference between the dietary outcome and the average situation of the national population, which was caused by the particularity of the samples. The low frequency of intake of certain foods in this area might affect the results. We analyzed collecting 3 days of dietary records were not enough to fully reflect the individual is the overall situation of food intake, being mentioned in the previous studies[9]. Of course, increasing the days of dietary record can effectively reduce the deviation.Some scholars had collected 7 days or more longer dietary records for research, [22] but this would undoubtedly increase the difficulty of the scale, which was not conducive to large – scale data collection and organization in the physical examination customers.

There are no “golden standard” dietary investigations in China. Several types of instruments are used to assess both the present and previous diet: the 24 hour dietary recall, food – intake record, and the food frequency questionnaire [19–22]. All of those instruments show either advantageous or limiting results. Which food intake methodology is used depends on the questions to be probed, the settings and participants, and the outcomes required. A best methods would be simple and quick, comprehensive and of high resolution, accurate and precise, and amenable to efficient and reliable data management. Moreover, the main objective of the current study was to develop an easy – to – use FFQ for future epidemiological studies in China. Earlier FFQs that have been used in Chinese epidemiological studies were included more than 160 food items, such as China Health and Nutrition Survey (CHNS) [21–22]. It would take about 30 minutes to finish one survey. However, A length questionnaire is less likely to be completed and returned[23]. The enduring participation rates of respondent effects the validation of the questionnaires[24]. Given that longer questionnaires may cause respondent fatigue and poorer quality of gathered information. Maybe it is not suitable for promotion in the physical examination adults. With reference to Chinese Residents Dietary Guidelines’ selections, we classified those food items into 14 food groups. We focused on nutrient – rich frequently consumed foods, shortened the time required to fill the questionnaire and decreased participants boredom and increased accuracy of dietary intake assessment. As a result, it would take 5 – 8 minutes to finish one survey. It had improved operability and practicability significantly.

As generally portion sizes are poorly estimated, the inclusion of portion sizes in FFQs is still controversial. For a country as complex as China in terms of food, it appears to be difficult to collect dietary information accurately using FFQ. It seems that the large percentage of between – persons variation could be explained by consumption frequency, rather than portion sizes. Estimating portion size of foods is difficult for most participants[25]. Some investigators have suggested to use the commonly consumed portion sizes for calculating nutrient intakes in case of missing portion sizes in a FFQ. This method has apparently resulted in reasonable estimates of nutrient intakes[26]. It is important for the validation to recognize the portion size of food intakes accurately. In this study, investigators assisted to fill in the questionnaire with the help of standard food map and hand measuring.In addition, based on the results, we could infer that foods with certain size or servings exhibited higher correlation. For example, dairy, fruits, vegetables, and eggs, always with a certain size, showed higher correlation(Table 4),which consisted with previous research results[27].

It was important to mention the higher number of male participants and the losses(Table 2). In this study, fewer men refused to fill in the questionnaire generally and most could stick to return questionnaires by telephone. However, women seemed difficult to complete all questionnaires. The reason for such losses, were the absence of 3R24, SFFQ incorrect record filling, and/or lacking of the Informed consent. It was possible that this percentage might have influenced the results concerning the viewing the final sample size.

The major strengths of this study include a high participation rate, streamlined questionnaire, data collection by trained interviewers, and using standard food map and hand measuring for estimating portion size and intake amount. An additional strenghth of this study is the normative design at the time of investigation of 3R24. The three consecutive days` 24h DRs were designed on Saturday, Monday, and Tuesday, which covered two weekdays and one weekend day to account for intraindividual variation between day types. Although diet records are recognized as the golden standard, errors in recording as well as changes in dietary habits as a result of keeping a record are inevitable, especialy in weekend and holiday. The 3R24 collection method used in this study can be more objectively collect dietary data of participants on work days and rest days, which could more comprehensive comparison with the data collected by SFFQ. The SFFQ in this study has good reliability and validity in the physical examination population in southwest China, and has a good application prospect in the future for analyzing the relationship between various physical examination indicators and dietary factors.Collect the health indicators and big data of the diet questionnaire through the physical examination link, conduct horizontal analysis and longitudinally monitor the health status of the population. This will provide evidence – based basis for adjusting the diet structure and promoting the health status of the population in the region.

The purpose of the present SFFQ is to evaluate dietary patterns, i.e., food groups and nutrients, among the physical health examination adults. There are, however, several limitations in the design of this SFFQ and the validity appraisal. Firstly, it is of short length and consists of 14 food groups rather than single food items or dishes. In addition, the reference period is only three months rather than the more usual one year which would be more representative of a person’s long – term dietary intake. There are seasonal variations in dietary and food intake, but these greatest seasonal variation occurs between summer and winter. Therefore, there may be a seasonal difference in the results of the SFFQ and the 3R24. Second, it is difficult to achieve an accurate estimatation of individual nutrients by an SFFQ as short or as of limited period of enquiry as that in physical health examination adults. In this study, SFFQ and 3R24 are both dependent on memory. The repeated 24 – hour recalls were collected within two weeks of SFFQ completion. Therefore, we cannot avoid the possibility that the validity may be higher than it should be. Along with all dietary assessment methods, some potential disadvantages could also be noted about this SFFQ including recall bias, overestimation of dietary intakes particularly for rarely – consumed and healthy – perceived foods (e.g., fruit and vegetables), and bias of current intake, misclassification and bias of pre – established food listing. Third, the sample size may not reflect the mean energy intake of the population in present study. Further study is needed for some nutrients(i.e., saturated and unsaturated fats, animal proteins and plant proteins, dietary fiber, vitamin B2 and vitamin B1). Finally, the problem of extrapolation within and between different food sub – groups in physical health examination adults is worth noting. There are regional disparity considerations in different Chinese area. One question is how universal these findings are among Chinese in southwest China, as in other area. One way to address this question would be to finish more evaluation studies to compare and validate Chinese food cultural instruments in other area.

5. Conclusions

The reliability and validity of the SFFQ questionnaire applied to the medical examination among Chinese in southwest China in this study is acceptable. It was easier to finish in less time consuming compared to the FFQ previously used for investigation. However, before its application in large epidemiological studies in other regions, the reliability and validation of this SFFQ should be be re-verified.

Abbreviations

SFFQ food frequency questionnaire; 3R24 three-day 24-hour dietary recalls; ICC intra-class correlation coefficients; NTCDs non-transmissible chronic diseases; R24 24 hour dietary record; SD standard deviation; CHNS China Health and Nutrition Survey

Declarations

Ethics approval and consent to participate: The study was approved by the Ethics Committee at of Sichuan Provincial People's Hospital(Approval Number: 2017-153), China. All participants were informed about the study and gave formal consents before being interviewed.

Consent for publication: The authors agree to publish in this journal.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare no conflicts of interest. This study is not related to any particular products of a company, and the results do not recommend any particular products.

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Figures

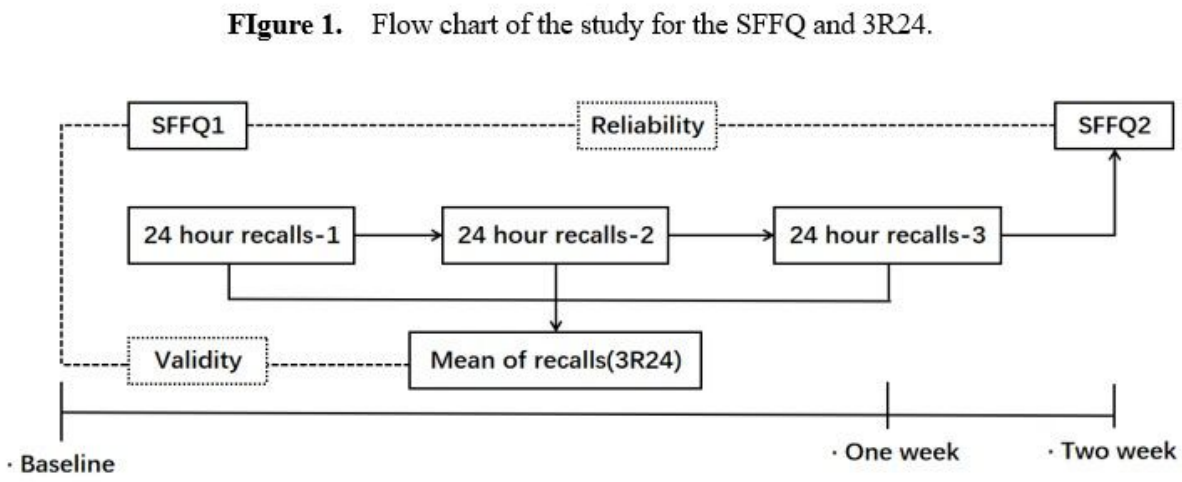

Figure 1

Flow chart of the study for the SFFQ and 3R24.