

Development and Applicability of an Internet-Based Diet and Lifestyle Questionnaire for College Students in China

A Cross-Sectional Study

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Abstract: Diet contributes to the increasing incidence of chronic diseases. Thus, fast, accurate, and convenient dietary assessment tools are in demand. We designed an internet-based diet and lifestyle questionnaire for Chinese (IDQC). The objective of this study was to validate its applicability and assess the dietary habits of Chinese college students.

Six hundred forty-four college students from northern China were recruited and asked to complete the IDQC for the last 4 months (135 food items) and 3-day diet records (3DDRs). Food and nutrient intakes recorded in the IDQC were validated against those in the 3DDRs using the Wilcoxon matched-pairs *t* test, correlation analysis, and cross-classification. The Student *t* and χ^2 tests were used in the dietary assessment.

There were significantly positive correlations in the dietary intakes of 9 food groups and 23 nutrients between the IDQC and 3DDRs. All participants consumed low levels of fruits, vegetables, legumes, dairy, and certain micronutrients (ie, vitamin A, vitamin B₁, vitamin B₂, folic acid, vitamin C, calcium, selenium, and iodine), and high levels of iron and manganese. Male students consumed higher intakes of the food groups and nutrients than female students.

The IDQC represents an accurate and convenient dietary assessment tool that can be used in large populations. Inadequate and excessive nutrition co-existed in college students, and more fruits, vegetables, legumes, dairy, and various vitamins and minerals were needed in this population's daily diet. The IDQC is free of access at www.yyjy365.org/diet.

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Abbreviations: 3DDRs = 3-day diet records, AI = adequate intake, BMI = body mass index, Ca = calcium, Cu = copper, DRIs = Dietary Reference Intakes, EAR = estimated average requirement, Fe = iron, FFQ = food frequency questionnaire, I = iodine, IDQC = internet-based diet and lifestyle questionnaire for Chinese, K = potassium, Mg = magnesium, Mn = manganese, Na = sodium, P = phosphorus, RNI = recommended nutrient intake, Se = selenium, UL = tolerable upper intake level, VA = vitamin A, VB₁ = vitamin B₁, VB₂ = vitamin B₂, VC = vitamin C, VE = vitamin E, WC = waist circumference, Zn = zinc.

INTRODUCTION

Nutritional factors are strongly associated with the development, treatment, and prevention of chronic diseases such as hypertension, hyperlipidemia, diabetes mellitus, and cardiovascular diseases.¹⁻⁴ As the incidence of chronic diseases has increased dramatically worldwide,^{5,6} it is urgent to investigate nutrient and food intakes and evaluate dietary patterns, which is beneficial for improving etiologic research on diet.

To assess dietary habits accurately, many epidemiological studies had been conducted. The food frequency questionnaire (FFQ) is a simple, convenient, and economic dietary assessment tool for a large study population. It includes a series of questions on the frequency and amount of certain food items, and it provides a general understanding of the subjects' actual dietary food intakes.⁷ However, traditional, face-to-face, paper-based FFQs are expensive, time-consuming, and impossible to conduct in a short period,⁸ especially in China, which has a large population and vast territory. The internet is a fast, effective, widespread, and convenient tool used for daily communication, and various information and online courses can be found online. As people's health consciousness is growing, more individualized and professional evaluations of healthy diets are needed. Considering the aforementioned, we developed an internet-based diet and lifestyle questionnaire for Chinese (IDQC), which contains both a lifestyle survey and FFQ. Personal feedback on the subjects' long-term or current lifestyle and diet is provided when the survey is completed. The IDQC will be a valuable tool for assessing individual health, and it may serve as a diet survey for experts and facilitate health policy making by the government.

The present study was conducted to explore the applicability of the IDQC in real life. We recruited college students as volunteers for the following several reasons. (1) It was a convenience sample. (2) College students are a special population with different characters, such as a high education, open mind, and low-income sources. These factors all affect their daily food and nutrient selection,^{9,10} leading to unhealthy dietary patterns such as meal skipping, the consumption of unhealthy snacks, and participation in unhealthy weight-loss

diets, and so on.¹¹ (3) Diet assessment among college students is limited in China. Thus, we validated the utility of the IDQC in college students as a dietary survey and assessed their diet quality.

METHODS

Participants and the Study Design

Participants were randomly recruited by telephone or e-mail from 4 colleges in Harbin, China, from March 1 through April 29, 2014. Three hundred fifty male and 350 female students were enrolled. The students were not taking any medications, had no diseases or conditions that affected their dietary habits, and were not following any weight-loss diets or programs. The enrolled students were asked to complete the IDQC online, which recorded their demographic data (ie, age, sex, educational level, smoking status, alcohol use, height, weight, and waist circumference [WC]), health information (ie, physical activity, sleep duration, and diseases), FFQ for the last 4 months, and 3-day diet records (3DDR) within 1 week (2 workdays and 1 weekend). Physical activity included the frequency (times/wk), duration (h), and sport type in leisure time, and categorized into 3 groups: inactive, moderate, and vigorous, according to the guidelines in International Physical Activity Questionnaire.¹² Totally, 95.4% female and 93.7% male students completed the IDQC. After excluding participants who emptied ≥ 10 food items and had implausible high- or low-energy intakes (>4500 kcal/day and < 500 kcal/day, respectively), 315 male and 329 female students completed the IDQC and were included in our current analyses.

We obtained online informed consents from all students. The study followed the guidelines of the Declaration of Helsinki, and the survey protocol was approved by the Medical Ethics Committee of the Harbin Medical University (No. [2008]018).

IDQC Design

To design an accurate and suitable questionnaire, we developed the IDQC in 4 steps. First, experts in the fields of nutrition, epidemiology, and bio-statistics discussed the feasibility and implementation of the questionnaire. Considering the dietary habits in different regions of China, the food items were determined according to the diet patterns in northern, southern, eastern, western, and the middle regions of China. However, because of limited financial and manpower resources, we only selected individuals in Harbin, China. Second, 250 adult volunteers of both sexes who had not lived in Harbin for no more than 1 year were asked to complete a 24-h dietary record. Two hundred five participants completed the questionnaire. Third, all questionnaires were recorded in a spreadsheet along with the food item types ($n = 136$), frequencies, and amounts. The food items ($n = 135$) consumed by 2 or more participants were assigned to 1 of 16 food categories (ie, grains, potatoes, legumes, vegetables, fungus, fruits, seeds and nuts, livestock, poultry, dairy, eggs, fish, snacks, sugar, condiments, and beverages). Finally, we uploaded the questionnaire to a secure website (www.yyjy365.org/diet). Images of each food item's weight/volume were used as references to assist the participants in making accurate estimations.

The IDQC can be completed in 30 to 40 min. The frequency and amount of each food item must be selected before continuing with the next food item. For example, with

rice, the frequency (8 options: never [< 1 time/month], 1–3 times/month, 1 time/wk, 2–3 times/wk, 4–5 times/wk, 1 time/day, 2 times/day, or 3 times or more/day) and amount (6 levels: < 1 liang [1 liang = 1 Chinese serving = 50 g], 2–3 liang, 4–5 liang, 6–7 liang, 8–9 liang, or ≥ 10 liang) must be selected, and then the next food item can be chosen. The amount of each food item was listed according to its proportion consumed, for example, a small portion of food in one's daily diet, such as ginger, was counted as: < 10 g, 20 to 30 g, 40 to 50 g, 60 to 70 g, 80 to 90 g, or > 100 g. Beverages were recorded as the volume per bottle (550 mL/bottle). Personal food and nutrient intakes will be listed as soon as a volunteer completes the IDQC. Personal guidelines are provided simultaneously, according to the criteria of the Dietary Reference Intakes (DRIs).¹³

Food Group and Nutrient Intakes

The weight of food was calculated by multiplying the food consumption frequency by the amount. We added the food items to corresponding food categories and obtained the total intakes from each of the 16 food categories. The daily nutrient intakes were determined from the total nutrient content from the 135 food items according to the Food Nutrition Calculator (V1.60; Shixinghengxun, Beijing, China). Sixteen food categories and 23 nutrients were calculated, including the amounts of energy (kcal), protein (g), carbohydrates (g), fiber (g), cholesterol (g), vitamin A (VA, μgRE), vitamin B₁ (VB₁, mg), vitamin B₂ (VB₂, mg), folic acid (μg), niacin (mg), vitamin C (VC, mg), vitamin E (VE, mg), calcium (Ca, mg), phosphorus (P, mg), potassium (K, mg), sodium (Na, mg), magnesium (Mg, mg), iron (Fe, mg), zinc (Zn, mg), selenium (Se, μg), copper (Cu, mg), manganese (Mn, mg), and iodine (I, μg).

Dietary Assessment

Based on the Chinese Food Guide Pyramid, the 16 food categories were merged into 9 food categories:¹⁴ grains, fruits, vegetables, meat, eggs, legumes, dairy, oil, and salt. Food group intakes lower than the recommended level established by the Chinese Food Guide Pyramid were labeled as inadequate. In the case of oil and salt, excessive intake was defined as consumption levels higher than the maximum limit. Dietary reference intakes were used in the nutrient assessment. Nutrient intake levels lower than the recommended nutrient intakes (RNI), adequate intakes (AI), or estimated average requirement (EAR) were inadequate, whereas nutrient intake levels higher than the tolerable upper intake level were categorized as excessive.

Statistical Analysis

To validate the IDQC, the Wilcoxon matched-pairs *t* test, Pearson correlation, partial correlation (adjusted by the total energy), and cross-classification were used. Agreement between the 2 surveys was defined as having the same or adjacent quartiles, disagreement was defined as having a difference in one of the quartiles, and extreme disagreement was defined as having a difference in 2 or more of the quartiles. For the dietary assessment, the Student *t* and χ^2 tests were used for continuous and categorical variables. Prior to analysis, all data were log-transformed for skewed distribution and residual adjusted in general linear models by the total energy. SPSS software (version 18.0; Beijing Stats Data Mining Co., Ltd, Beijing, China) was used in all the statistical analyses. $P < 0.05$ was set as the threshold for significance.

TABLE 1. Demographic Characteristics of All College Students Recruited by Telephone or E-mails

	Male	Female	P
Participants (n/%)	315/48.9	329/51.1	
Age (years)	21.2 ± 2.0	21.1 ± 1.8	0.87
Height (cm)	174.4 ± 5.1	162.3 ± 4.3	<0.01
Weight (kg)	66.8 ± 11.0	54.9 ± 7.7	<0.01
BMI (kg/m ²)	22.0 ± 3.2	20.2 ± 2.1	<0.01
WC (cm)	78.3 ± 9.8	69.9 ± 6.7	<0.01
Alcohol user (n/%)	67/21.3	4/1.2	<0.01
Smoker (n/%)			
Never	290/92.1	326/99.1	<0.01
Current	22/7.0	3/0.9	
Ex-smoker	3/1.0	0/0	
Physical activities			
Duration (h/wk)	3.6 ± 3.6	2.5 ± 4.3	0.04
Intensity (n/%)			
Inactive	103/32.7	157/47.7	<0.01
Moderate	146/46.3	135/41.0	
Vigorous	66/21.0	37/11.2	

BMI = body mass index, WC = waist circumference.
Data signify mean ± standard deviation.

RESULTS

Demographic Characteristics

The demographic characteristics of all participants are summarized in Table 1. All male students (n = 315) were of a similar age as the female students (n = 329); however, male students had a higher body mass index (BMI), WC, alcohol consumption, and smoking rates. Among the men, 21.3% consumed alcohol, 7.0% were smokers, and 1.0% were ex-smokers. Male students spent (3.6 ± 3.6) h/wk in physical activities, longer than that of females (2.5 ± 4.3) h/wk. A total of 21.0% males took part in vigorous activities, higher than that in female students (11.2%). Around 47.7% girls were inactive.

Comparisons Between the IDQC and 3DDRs by the Food Groups and Nutrients

Intakes of the 9 food groups were calculated by the IDQC and 3DDRs. The correlations are presented in Table 2. The correlation coefficients of grain, meat, legumes, and dairy were all >0.4. The correlation coefficients of fruits, eggs, and salt were <0.4. Significant but lower correlations were obtained for vegetables and oil (0.28 and 0.27, respectively). After adjustments for energy were made, all the coefficients increased at an average of 0.40.

All macro- and micronutrient intakes are listed in Table 3. The correlation coefficients of total energy, protein, VE, P, Na, Zn, Se, and I were > 0.6. The correlation coefficients of carbohydrates, fiber, cholesterol, VA, VB₁, VB₂, niacin, Ca, K, Mg, and Fe were all <0.6, but >0.4. Others nutrients (folic acid, VC, and Cu) ranged between 0.28 and 0.36 (all <0.4). Almost all median nutrient intakes in the IDQC were higher than those in the 3DDRs.

Joint Classification of the Food Groups and Nutrients

The joint classifications of food groups and nutrients in the IDQC and 3DDRs are shown in Tables 4 and 5. Within the food groups, the agreement rates ranged from 68.9% for oil to 84.8% for dairy, whereas the disagreement rates ranged from 12.3% for legumes to 21.0% for vegetables. The rates of extreme disagreement for oil and salt were 11.5% and 11.9%, respectively, and < 8% for the rest of the food groups. Among the nutrients, 20 of 23 had high agreement rates (>70%). The agreement rates of VE, Na, and I were >90%, and that for energy was 81.39%. The agreement rates of VA, folic acid, and Se were 65.3%, 69.0%, and 69.0%, respectively (Table 5).

Dietary Assessment in College Students

Intakes of all the food groups are summarized in Table 6. Compared to female students, male students consumed more grains, meat, eggs, legumes, and oil, and fewer vegetables. A higher proportion of female students had inadequate intakes of grains and meat, whereas a higher proportion of male students had inadequate intakes of fruit and excessive intakes of oil.

TABLE 2. Comparisons Between the IDQC and 3DDRs by Food Groups

Food Groups (g)	IDQC		3DDRs		r	r [†]
	Median	Q1-Q3	Median	Q1-Q3		
Grains	354.7	181.5-485.3	312.7	169.3-450.3	0.47*	0.49*
Fruits	216.8	92.8-349.8	83.3 [#]	5.7-175.0	0.39*	0.39*
Vegetables	272.2	119.5-414.3	168.3	80.3-296.7	0.28*	0.33*
Meat	97.7	35.0-138.5	66.7 [#]	29.8-126.7	0.43*	0.49*
Eggs	16.5	9.0-25.0	12.5	6.5-25.0	0.36*	0.37*
Legumes	91.8	26.3-147.8	68.3 [#]	8.3-133.3	0.43*	0.47*
Dairy	52.5	20.1-183.0	32.5 [#]	3.0-118.8	0.46*	0.48*
Oil	18.3	10.3-35.0	16.3	7.3-30.3	0.27*	0.29*
Salt	5.0	3.3-10.3	4.5	3.3-9.5	0.30*	0.32*

3DDRs = 3-day diet records, IDQC = internet-based diet and lifestyle questionnaire for Chinese, Q1-Q3 = interquartile range.

r: Pearson correlation.

r[†]: energy-adjusted correlation.

* P < 0.05 in correlation analysis.

[#] P < 0.05 in median comparison.

TABLE 3. Comparisons Between the IDQC and 3DDRs by Nutrients

Nutrients	IDQC		3DDRs		r	r [†]
	Median	Q1-Q4	Median	Q1-Q4		
Energy (kcal)	2248.3	1737.8–2960.2	2041.2 [#]	1583.9–2727.8	0.69*	–
Protein (g)	78.2	59.9–102.4	69.2 [#]	52.5–94.0	0.66*	0.65*
Carbohydrate (g)	341.0	254.4–414.6	319.8 [#]	234.1–402.9	0.57*	0.57*
VA (μgRE)	756.5	429.0–1607.4	566.1 [#]	348.9–122.3	0.40*	0.45*
VB ₁ (mg)	1.2	0.8–1.6	1.1 [#]	0.7–1.4	0.55*	0.59*
VB ₂ (mg)	1.8	1.1–2.4	1.5 [#]	0.9–2.2	0.43*	0.41*
Folic acid (μg)	85.4	42.3–213.5	69.9 [#]	30.9–148.5	0.36*	0.39*
Niacin acid (mg)	22.3	16.2–33.0	18.8 [#]	14.2–27.5	0.54*	0.56*
VC (mg)	120.9	82.3–195.6	94.6 [#]	73.1–135.4	0.28*	0.33*
VE (mg)	44.3	34.5–57.3	33.1 [#]	23.1–45.9	0.85*	0.86*
Ca (mg)	481.7	328.2–785.0	357.2 [#]	217.8–535.7	0.46*	0.46*
P (mg)	1343.0	1028.8–1750.8	1138.8 [#]	878.0–1515.5	0.61*	0.59*
K (mg)	2423.6	1660.3–3317.0	2135.9 [#]	1585.8–2750.2	0.57*	0.58*
Na (mg)	2944.6	2245.5–4000.5	2451.8 [#]	1631.5–3583.6	0.94*	0.94*
Mg (mg)	464.3	368.0–629.4	389.4 [#]	305.3–493.3	0.53*	0.55*
Fe (mg)	26.2	20.2–33.9	23.0 [#]	17.7–29.0	0.57*	0.60*
Zn (mg)	15.4	11.8–19.2	13.0 [#]	10.1–16.3	0.66*	0.67*
Se (μg)	61.7	44.3–78.4	49.4 [#]	38.2–67.1	0.61*	0.63*
Cu (mg)	3.6	2.8–5.1	3.3 [#]	2.6–4.2	0.36*	0.40*
Mn (mg)	6.3	4.7–8.6	5.0 [#]	3.7–6.7	0.57*	0.56*
I (μg)	106.9	81.4–174.7	100.8 [#]	80.0–173.4	0.98*	0.98*

3DDRs = 3-day diet records, Ca = calcium, Cu = copper, Fe = iron, I = iodine, IDQC = internet-based diet and lifestyle questionnaire for Chinese, K = potassium, Mg = magnesium, Mn = manganese, Na = sodium, P = phosphorus, Q1-Q3 = interquartile range, Se = selenium, VA = vitamin A, VB₁ = vitamin B₁, VB₂ = vitamin B₂, VC = vitamin C, VE = vitamin E, Zn = zinc.

r: Pearson correlation.

r[†]: energy-adjusted correlation.

* P < 0.05 in correlation analysis.

P < 0.05 in median comparison.

Among 9 food groups, the inadequate intake proportion of the whole population for vegetables and eggs was >50% and that for dairy was >90%. With respect to nutrients, the proportions of excessive and inadequate intakes are summarized in Table 7. Male students consumed excessive levels of VA, niacin, Fe, and Mn. Female students had inadequate nutrient intakes of VA, VB₁, Ca, P, K, Na, Mg, Fe, Zn, Se, Mn, and I. Deficiencies in VA, VB₁, VB₂, folic acid, VC, Ca, Se, and I were quite

common; >40% of participants consumed less than the RNI, AI, or EAR. Excessive intakes of niacin, Fe, and Mn were observed in ~10% of the participants.

DISCUSSION

The present study validated the IDQC and provided a useful estimate of food and nutrient intakes among college students. The applicability of the IDQC was evaluated by comparing the results with those obtained from the 3DDRs. The food categories and nutrients in the IDQC were well correlated with those in the 3DDRs.

In a similar validation of the FFQ for national health and nutrition monitoring, the Spear rank correlations of food groups between the FFQ and 24-h dietary recalls ranged from 0.18 to 0.80 in a German Health Examination Survey for adults.⁸ The validation of certain food groups conducted by German EPIC showed a similar range: 0.14 to 0.90.¹⁵ The correlation coefficient of all nutrients ranged from 0.44 to 0.69¹⁶ in a DASH online FFQ and 0.26 to 0.76 in a Spanish dietary study.¹⁷ Other studies for certain nutrients have reported similar results. Validation of an FFQ for daily fat, fiber, alcohol, caffeine, and theobromine intakes among post-menopausal women had coefficients ranged from 0.47 for poly-unsaturated fatty acid to 0.94 for alcohol.¹⁸ The FFQ in Dutch cohorts of the European Prospective Investigation into Cancer and Nutrition was applied in assessment of glycemic index and glycemic load. The correlation coefficients was 0.63, when validated against with

TABLE 4. Agreements (%) Between Quartiles of the IDQC and 3DDRs in Food Groups

Food Groups	Same or Adjacent	Disagreement	Extreme Disagreement
Grains	74.5	18.2	7.3
Fruits	78.0	16.0	6.1
Vegetables	73.6	21.0	5.4
Meat	77.5	16.2	6.4
Eggs	73.6	18.5	7.9
Legumes	80.1	12.3	7.6
Dairy	84.8	15.4	3.0
Oil	68.9	19.6	11.5
Salt	70.9	17.2	11.9

3DDRs = 3-day diet records, IDQC = internet-based diet and lifestyle questionnaire for Chinese.

TABLE 5. Agreements (%) Between Quartiles of IDQC and 3DDRs in Nutrients

Nutrients	Same or Adjacent	Disagreement	Extreme Disagreement
Energy	81.4	16.6	2.0
Protein	74.2	18.6	7.2
Carbohydrate	71.7	22.1	6.2
Fiber	77.4	16.6	6.0
Cholesterol	72.7	18.1	9.2
VA	65.3	23.3	11.4
VB ₁	71.7	20.6	7.7
VB ₂	73.7	17.1	9.2
Folic acid	69.0	21.3	9.7
Niacin acid	72.0	16.9	11.2
VC	71.0	19.9	9.2
VE	90.6	7.4	2.0
Ca	78.2	17.1	4.7
P	73.7	18.9	7.4
K	75.9	18.1	6.0
Na	90.6	7.7	1.7
Mg	76.4	17.6	6.0
Fe	73.7	16.6	9.7
Zn	72.5	18.6	8.9
Se	69.0	23.8	7.2
Cu	75.9	16.9	7.2
Mn	71.7	22.1	6.2
I	96.3	2.0	1.7

3DDRs = 3-day diet records, Ca = calcium, Cu = copper, Fe = iron, I = iodine, IDQC = internet-based diet and lifestyle questionnaire for Chinese, K = potassium, Mg = magnesium, Mn = manganese, Na = sodium, P = phosphorus, Q1-Q3 = interquartile range, Se = selenium, VA = vitamin A, VB₁ = vitamin B₁, VB₂ = vitamin B₂, VC = vitamin C, VE = vitamin E, Zn = zinc.

12 24-h dietary recalls.¹⁹ In the present study, the coefficients and agreement rates for oil and salt between the IDQC and 3DDRs were low, and this may be partly explained by the fact that college students tend to do less housework and cooking, and have no experience using oil and salt.

Willett²⁰ reported that the correlation coefficients between the FFQ and dietary records were 0.6 to 0.7 for the food groups. A correlation coefficient of 0.40 has been proposed as the threshold for a strong correlation between the FFQ and diet records.²¹ However, it is not easy to reach this threshold value because of the limitations in the methodology and errors. For example, sample populations with a different age, sex, weight, job, educational level, race, and so on, generate different results. Furthermore, the coefficients can be affected by the study time, technique errors, and individuals' attitudes.²²⁻²⁶

In our present validation study, the correlation coefficients of all the food groups and nutrients correlated well between the IDQC and 3DDRs. The internet-based questionnaire, which has an acceptable accuracy, repeatability, and utility, represents a useful assessment tool of food and nutrient intakes. Following the validation of the IDQC, we assessed the diet quality of the college students.

College students in good health are a special subgroup of the whole population, they are young, and in a crucial period of lifestyle habit formation. But they tend to care less about food quality, follow unhealthy eating patterns (eg, a diet high in fat, sugar, and salt but low in fruits and vegetables).¹¹ In China, college students consume less vegetables, fruits, beans, fish, and dairy products than the recommended intakes in Chinese Food Guide Pyramid. Although they eat insufficient or/and excessive amount of grains or/and meat,²⁷ high energy, high lipid, and low micronutrients are common problems in Chinese college students' diet, and it has been reported that <10% students took adequate VA, VC, and Ca in daily diet.²⁸ Furthermore, female and male students have different dietary problems: females consume lower grains and meat, but higher vegetables and fruits than male students do; nutritional assessment in females tends to nutrient deficiency, whereas nutrient intakes in males are more likely to be excessive.^{27,28} In our present study, college students from northern China consume lower levels of fruits, vegetables, meat, eggs, legumes, and dairy, but higher levels of oil. Insufficient and excess nutrient intakes existed at the same time, and had gender differences: female students showed higher rates of inadequate nutrient intakes and males had higher rates of excessive nutrient intakes.

On the other hand, the mean time spent in physical activities was ~3 h/wk in the present study (male: 3.6 h/wk;

TABLE 6. Food Group Intakes in Male and Female College Students

Food Groups (g)	Male		Female			
	Mean ± SD	Excess (%)	Inadequate (%)	Mean ± SD	Excess (%)	Inadequate (%)
Grains	362.8 ± 192.6	–	21.9	306.2 ± 169.5*	–	35.3‡
Fruits	218.6 ± 183.5	–	57.1	308.7 ± 302.8*	–	38.6‡
Vegetables	346.3 ± 252.4	–	56.2	386.6 ± 366.6	–	51.7
Meat	155.0 ± 131.5	–	32.1	120.7 ± 114.5*	–	50.5‡
Eggs	28.4 ± 34.6	–	51.1	19.4 ± 17.6*	–	65.7
Legumes	155.4 ± 105.7	–	9.2	138.3 ± 105.4*	–	12.8
Dairy	133.5 ± 175.5	–	91.8	134.3 ± 180.7	–	91.8
Oil	26.3 ± 16.4	33.7	–	23.3 ± 15.7*	26.7†	–
Salt	6.0 ± 5.2	19.1	–	5.0 ± 5.1	19.8	–

SD = standard deviation.

* P < 0.05 in food group intakes comparison.

† P < 0.05 in excessive intake proportion.

‡ P < 0.05 in inadequate intake proportion.

TABLE 7. Nutrient Intakes and Evaluation in Male and Female College Students

Nutrients	Male			Female		
	Mean ± SD	>UL (%)	<RNI/AI/EAR (%)	Mean ± SD	>UL (%)	<RNI/AI/EAR (%)
Energy (kcal)	2350.5 ± 1972.3	–	32.3	2239.5 ± 872.9*	–	30.2
Protein (g)	87.4 ± 40.6	–	21.0	81.4 ± 37.9*	–	25.3‡
Carbohydrate (g)	356.6 ± 73.0	–	1.3	341.3 ± 69.8	–	1.2
VA (μgRE)	1281.5 ± 1307.7	13.7	41.3	1078.7 ± 929.0*	5.2†	54.9‡
VB ₁ (mg)	1.3 ± 0.6	–	55.6	1.2 ± 0.5*	–	65.7‡
VB ₂ (mg)	1.6 ± 1.0	–	47.9	1.5 ± 1.0*	–	51.8
Folic acid (μg)	92.3 ± 77.6	–	80.3	85.2 ± 71.9*	–	53.0
Niacin acid (mg)	23.8 ± 10.2	18.4	16.8	20.4 ± 9.9*	7.3†	21.9
VC (mg)	130.5 ± 151.3	1.6	47.0	154.0 ± 154.4*	0.0	43.8
VE (mg)	47.8 ± 38.4	–	7.0	42.0 ± 31.8*	–	9.2
Ca (mg)	539.9 ± 452.5	3.2	62.2	482.4 ± 412.7*	1.5	74.0‡
P (mg)	1478.3 ± 588.0	1.3	9.2	1348.4 ± 584.6*	0.9	15.2‡
K (mg)	2502.3 ± 1382.4	–	27.0	2479.1 ± 1371.5	–	39.7‡
Na (mg)	3027.5 ± 2105.7	–	12.1	2982.6 ± 2275.5	–	21.6‡
Mg (mg)	489.5 ± 203.7	–	23.2	413.8 ± 233.3*	–	35.9‡
Fe (mg)	29.1 ± 12.4	18.1	5.4	24.2 ± 12.0*	10.3†	39.4‡
Zn (mg)	16.72 ± 6.5	1.0	26.4	12.4 ± 5.9*	0.9	14.9‡
Se (μg)	68.0 ± 34.3	0.3	41.3	55.1 ± 35.3*	0.9	63.2‡
Cu (mg)	3.8 ± 2.3	6.4	0.3	3.2 ± 2.8*	4.9	1.6
Mn (mg)	6.6 ± 3.0	26.0	10.8	7.2 ± 3.5*	14.6†	22.5‡
I (μg)	113.1 ± 126.3	2.5	60.3	108.1 ± 135.4	2.1	69.8‡

3DDRs = 3-day diet records, AI = adequate intake, Ca = calcium, Cu = copper, EAR = estimated average requirement, Fe = iron, I = iodine, IDQC = internet-based diet and lifestyle questionnaire for Chinese, K = potassium, Mg = magnesium, Mn = manganese, Na = sodium, P = phosphorus, Q1–Q3 = interquartile range, RNI = recommended nutrient intake, Se = selenium, UL = tolerable upper intake level, VA = vitamin A, VB₁ = vitamin B₁, VB₂ = vitamin B₂, VC = vitamin C, VE = vitamin E, Zn = zinc.

* $P < 0.05$ in food group intake comparison.

† $P < 0.05$ in excessive intake proportion.

‡ $P < 0.05$ in inadequate intake proportion.

female: 2.5 h/wk), and female students have higher inactive proportion than males (47.7% and 32.7%). In a cross-sectional study among 23 countries in Central and Eastern Europe, the prevalence of inactivity in leisure time ranged from 23% to 44%, and it varied with cultural and economic factors.²⁹ Male students were more active than females in other study.³⁰ Physical activity and healthy diet are all closely associated with physical health. The 2 health behaviors are co-existed and inter-related in daily life. It has been proven that the interventions on the 2 behaviors conducted simultaneously were more likely to promote long-term beneficial behavior changes.³¹

Therefore, it is crucial to establish health programs for college schools to promote and popularize health education, provide professional nutritional guidelines, improve health, and lay the foundation for future comprehensive dietary survey. Compared with the general population, students in school, especially college, are highly educated and centralized. Thus, health education is more practical in this population. Many nutrition interventions have been conducted in schools, and they have all achieved good results and improved their diet quality.^{11,32–36}

Along with the progress in science and technology, health education can be conducted through not only traditional face-to-face lessons, but also internet. Face-book, Twitter, YouTube, and many other social media all created health communication platform.³⁷ It has been reported that over one-third US adults look for health advice online, and online health service will be a popular and important tool for both individual and public

health.³⁸ Researches on internet-based professional health assessment and management tool have been conducted all over the world, such as America, Europe, Australia, and so on.^{35,39,40} However, to date, there are no available tools in China. Thus, the IDQC was developed in accordance with dietary habits in China, and it will be an effective and promising electronic tool for long-term health management.

The IDQC was designed to be a comprehensive dietary assessment tool in China and covered a wide range of food items. However, we did not list fast-food as a separate food group. Fast-food is also an important part of Chinese daily diet. Western fast-food, such as hamburger, hot dog, potato chips, and so on, changed Chinese lifestyle a lot. Its convenience and taste make it spread worldwide quickly, especially among adolescents and young adults.⁴¹ But these foods are characterized by high fat, sugar, or sodium, which all contributed to obesity.⁴² Fast-food is also transforming and updating, and traditional Chinese food can also be included in fast-food, such as noodle, box lunch, set meal, and so on. Meanwhile, the combinations of western fast-food and local food materials often give some new nutritional characteristics to them. Accurate nutritional assessment could be developed based on food components. Considering all above, we did not list fast-food as a single group. They were separated, assigned, and analyzed into corresponding food groups.

Studies on vegetarians were limited in China. The proportion of vegetarians might be low in China, for example, 0.77% (0.45% were lactovegetarians and 0.12% were vegans) in

a representative sample of Shanghai.⁴³ Sources of energy and nutrients are grains, potatoes, legumes, vegetables, fungus, fruits, and seeds and nuts,⁴⁴ which all have been fully considered in our questionnaire. In the Internet-based food frequency questionnaire, we list 88 plant foods from these 7 food groups (total 135 food items in questionnaire) and give a wide range of intake frequency and amount. Participants can select nearly all food items according to their diet habits. Vegetarians is a population with specific diet characteristics, and the validation of this online questionnaire is necessary. Our present study was conducted among college students, and more validation studies will be conducted among various populations.

LIMITATIONS

There were some limitations in our study. First, it had geographical restrictions, as our study was conducted among college students from 4 colleges in Harbin, China; thus, it may lack generalizability to other areas in China. Second, regarding the dietary intake measurement, we obtained dietary records for 3 days, which may have contributed to lower dietary food and nutrient intakes in the 3DDRs, and low correlations between the IDQC and 3DDRs. Third, regarding the completion time, the study was conducted from March to April; thus, future studies should evaluate the consumption of seasonal foods to assess the applicability of the IDQC over 1 year. Finally, regarding the questionnaire's applicability in health education, the present study suggested that the IDQC was a useful tool in cross-sectional study. Its applicability in intervention or cohort studies needs evaluated in further dietary survey and evaluation.

In conclusion, the IDQC was developed as a comprehensive, time-saving, and convenient dietary assessment tool. In the validation among college students, the intakes of the food groups and nutrients in IDQC were well correlated with those in 3-day diet records. It is an accurate tool that could be used in health education and population survey among college students in northern China. College students have unbalanced dietary habits. Both under- and over-nutrition are serious. More fruits, vegetables, legumes, dairy, and various vitamins and minerals are needed in their daily diet.

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