Original Article

Promoting and Updating Food Frequency Questionnaire Tool to Measure Food Consumption and Nutrient Intake Analysis

Zahra Madani, Maryam Sadat Moussavi Javardi, Majid Karandish[1], Ariyo Movahedi[2]

Department of Nutrition, Master of Science in Public Health Nutrition, Science and Research Branch, Islamic Azad University, Tehran, Iran, [1]Department of Nutrition, Paramedical School, Jundishapour Medical University, Ahvaz, Iran, [2]Department of Nutrition, Science and Research Branch, Islamic Azad University, Tehran, Iran

Abstract

Background: One of the problems that nutritionists have always faced in research projects is the analysis of food intake of the subjects. Various approaches have been proposed in which the use of food frequency is one of the most used in this field. Many tools have been proposed in this area that aim of present research is to update and optimize one of the most common forms mentioned above. **Method:** In this study, we attempted to update and optimize the 147-item common food frequency questionnaire using USDA database. Moreover, the values of dietary antioxidant profiles, lipid ratios, dietary fat quality, atherogenic and thrombogenic indices, amino acids, flavonoids, and other requirements are included in the above tool to meet nutrition research needs. **Results:** The re-analysis of the obtained data with USDA Bank showed no difference due to the similarity of the source of information and the accuracy of the above instrument was confirmed. **Conclusion:** Due to the applicability of this tool, it can be recommended to researchers to use the above tool. We hope to see the Iranian database in the coming years to optimize the above tools based on the Iranian bank.

Keywords: *Diet, micronutrient, nutrition values, ORAC, software tool*

Introduction

Nutritional information of micronutrient/macronutrient intake is one of the most important and fundamental needs of researchers in understanding the relationship between food intake and various diseases, especially chronic diseases such as cardiovascular disease, diabetes, cancer, and so on.[1] On the other hand, this information can lead to proper food and nutrition policy in preventing or monitoring these diseases. Diseases that many of these studies suggest can be prevented by correcting eating habits.[2] Measuring nutrient intake is one of the most challenging because it requires skilled people, accurate labs, and a great deal of cost and budget.[3] Improved methods in this area are necessary to provide accurate estimates of dietary intake for both epidemiological studies and clinical trials.[4] Therefore, simple and inexpensive methods that can partially alleviate this problem are of great importance. Therefore, using the Food Frequency Questionnaire is one of the best options in epidemiological studies and even small cross-sectional studies.[5] On the other hand, the food frequency questionnaire can reveal the long-term impact of food consumption on various diseases, whereas in the 24-hour food recall or food registration questionnaires virtually this cannot be achieved.[6,7] By using food frequency questionnaires, it is possible to identify the causal relationships between food consumption and the risk of various diseases in the long-term and shows the importance of this method.[8]

What is challenging in the second step after completing the Feed Frequency Questionnaire is the analysis of micronutrient/macronutrient (s) information consumption using validated databases. Unfortunately, the software available in the market is highly reputable, but the cost of the software has actually made it out of reach for most researchers, especially in Iran. To address this problem, some researchers have made some of the cheapest using MS-Office features such as MS-EXCEL-based FFQ tools used by many studies in Iran since the past decade.[9–11] Despite the feasibility and low cost of the tool that has made it one of the most important FFQ data analyzers,

Address for correspondence:
Dr. Ariyo Movahedi, PhD., Assistant Professor in Clinical Nutrition, Department of Nutrition, Science and Research Branch, Islamic Azad University, Tehran, Iran.
E-mail: amm35@mail.aub.edu

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it unfortunately lacks information such as amino acid levels, thrombogenic and atherogenic indices,[12–14] lipid quality, flavonoids, and some other important components. In the above tool, the need to revise and optimize the tool doubled.

When considering the role of dietary fat in cardiovascular disease, the risk varies between saturated and unsaturated fatty acids. Two major risk factors for cardiovascular disease are high cholesterol saturated fatty acids SFA and thrombogenic SFA. The five protective unsaturated fatty acids include n-6 (linoleic), n-3 (linolenic), fatty acids PUFA series, MUFA unsaturated fatty acids, dietary fiber and antioxidants. In addition, in all epidemiological data, energy consumption as a confounding variable is difficult to separate from fat consumption. Two indicators of dietary fat quality, the Atherogenesis Index (AI) and the Thrombogenicity Index (TI), allow the comparison of different foods and diets that were not available in the previous instrument.[14] Both indices take into account the ratio of SFA saturated fatty acid and MUFA and PUFA unsaturated fatty acids.[15] Hypercholesterolemia (hH) and Pn-3/Pn-6 ratios and polyunsaturated/unsaturated fatty acids (P: S) are often used as indicators for dietary fat quality and atherogenicity.[16] Previous studies have shown that diets with C18: 0 (stearic acid) do not raise serum cholesterol and act as an oleic acid in lowering LDL.[17,18] Short-chain saturated fatty acids also do not raise blood cholesterol, so atherogenic (SFA) probably causes C12: 0 (Lauric), C14: 0 (Myristic) and C16: 0 (Palmitic), formerly known by Keys in 1965. Increases in cholesterol, which myristic has the greatest effect on cholesterol.[19] Many studies have shown that long-chain (SFA) (ie, C14: 0, C16: 0, and C18: 0) are thrombogenic; they accelerate thrombosis and act against fatty acids (PUFA) and (MUFA).[20–22] The ratio of cholesterol to total saturated fat (CSI) is another index used in many studies,[23–25] which was also considered in the present study in instrumentation.

The above indices are of great important in the studies. For example, index of nutritional quality (INQ), thrombogenic and atherogenic foods are associated with many diseases, especially cardiovascular disease.[26] In most cases, cardiovascular disease is due to coronary artery obstruction caused by atherosclerosis or thrombosis. It has been hypothesized that the main cause of vascular injury is cholesterol in LDL circulating lipoproteins due to free radicals. Studies show that some are atherogenic fatty acids and some are anti-atherogenic.[14] Therefore, knowing the amount and type of dietary fatty acids intake has great prominence in food frequency questionnaires. On the other hand, the ORAC index is one of the other requirements in today's studies. There are various assays for measuring antioxidant activity, antioxidant compounds, of which the above index is.[27–29] Studies have shown that a high antioxidant dietary intake can improve health, especially by reduction of free radicals in the body.[30,31] The calculation of total dietary antioxidant capacity (DTAC) has been used frequently in recent years, and its role demonstrated in many studies.[30]

The absence of the above important details, along with the lack of amino acids in the previous tool, has made the need to have the right tool a basic necessity. Therefore, the purpose of this study was to optimize and construct a suitable tool for analyzing the 147-item Feed Frequency Questionnaire.

Methods

Totally, 147 food frequency questionnaire which has been previously used in numerous articles as one of the primary food frequency questionnaire in Iranian studies.[9–11] In the present study, by using the latest version of USDA food data bank, extra nutrients including all amino acids, fatty acids, phytochemicals and flavonoids were added to the previous tool.[32] The values of fat quality indices were calculated based on the Ulbricht and Southgate equations[14] and placed in separate columns in the new FFQ tool.

$$AI = \frac{[(\mathrm{C12:0} + 4 \times \mathrm{C14:0} + \mathrm{C16:0})]}{(\sum \mathrm{MUFA\ n\text{-}9} + \sum \mathrm{n\text{-}6} + \sum \mathrm{n\text{-}3})}$$

$$TI = \frac{(\mathrm{C14:0} + \mathrm{C16:0} + \mathrm{C18:0})}{[(0.5 \times \sum \mathrm{MUFA}) + (0.5 \times \sum \mathrm{n\text{-}6}) + (3 \times \sum \mathrm{n\text{-}3}) + \frac{(\sum \mathrm{n\text{-}3})}{(\sum \mathrm{n\text{-}6})}]}$$

$$hH = \frac{(\mathrm{C18:1n\text{-}9} + \mathrm{C18:2n\text{-}6} + \mathrm{C20:4n\text{-}6} + \mathrm{C18:3n\text{-}3} + \mathrm{C20:5n\text{-}3} + \mathrm{C22:5n\text{-}3} + \mathrm{C22:6n\text{-}3})}{(\mathrm{C14:0} + \mathrm{C16:0})}$$

$$CSI = \frac{Total\ Cholesterol}{\sum SFA}$$

The ORAC value which was calculated for 326 different nutrients expressed as micromolecules equivalent to trollex per 100 g (mmolTE/100 g) of food is stated in the USDA database and used to evaluate dietary oxygen radicals uptake capacity.[33] For the spices in the food frequency form, the mean of the three main spices, including turmeric, pepper and cinnamon, were used as food index spices in most Iranian foods.[34]

In order to see the differences between new and old tools, paired sample t test was used and P value less than 0.05 was considered as significant.

Results

As Table 1 shows, since Iranian food composition table was used and modified by USDA data bank, in some of macro/micronutrients no significant differences were found. Furthermore, 86 nutrients were newly added to the new tool that did not exist previously. As all information of the new tool was extracted from the USDA database, obviously no

Table 1: Comparison of Old and New Tool of FFQ-147

Macro/Micronutrients	*P*	Macro/Micronutrients	*P*	Macro/Micronutrients	*P*
Weight (gr)	NS	Vitamin A, IU	*NN*	18:3i	*NN*
Water	NS	Lycopene	NS	18:4	*NN*
Energy Kcal	NS	Lutein + zeaxanthin	NS	20:2 n-6 c, c	*NN*
Protein	NS	Vitamin E (alpha-tocopherol)	NS	20:3 undifferentiated	*NN*
Total lipid (fat)	NS	Vitamin D (D2+D3)	*NN*	20:3 n-6	*NN*
Ash	*NN*	Vitamin D3 (cholecalciferol)	*NN*	20:4 undifferentiated	*NN*
Carbohydrate, by difference	NS	Vitamin D	NS	20:4 n-6	*NN*
Fiber, total dietary	NS	Vitamin K (Phylloquinone)	NS	20:5 n-3 (EPA)	NS
Sugars, total	NS	Fatty acids, total saturated	NS	22:4	*NN*
Sucrose	NS	4:0	*NN*	22:5 n-3 (DPA)	*NN*
Glucose (dextrose)	NS	6:0	*NN*	22:6 n-3 (DHA)	NS
Fructose	NS	8:0	*NN*	Fatty acids, total trans	NS
Lactose	NS	10:0	*NN*	Fatty acids, total trans-monoenoic	*NN*
Maltose	NS	12:0	*NN*	Cholesterol	NS
Galactose	NS	13:0	*NN*	Phytosterols	*NN*
Starch	*NN*	14:0	*NN*	Stigmasterol	*NN*
Calcium, Ca	NS	15:0	*NN*	Campesterol	*NN*
Iron, Fe	NS	16:0	*NN*	Beta-sitosterol	*NN*
Magnesium, Mg	NS	17:0	*NN*	Tryptophan	*NN*
Phosphorus, P	NS	18:0	*NN*	Threonine	*NN*
Potassium, K	NS	20:0	*NN*	Isoleucine	*NN*
Sodium, Na	NS	22:0	*NN*	Leucine	*NN*
Zinc, Zn	NS	24:0	*NN*	Lysine	*NN*
Copper, Cu	NS	Fatty acids, total monounsaturated	NS	Methionine	*NN*
Manganese, Mn	NS	14:1	*NN*	Cystine	*NN*
Selenium, Se	NS	15:1	*NN*	Phenylalanine	*NN*
Fluoride, F	NS	16:1 undifferentiated	*NN*	Tyrosine	*NN*
Vitamin C, total ascorbic acid	NS	16:1 c	*NN*	Valine	*NN*
Thiamin	NS	16:1 t	*NN*	Arginine	*NN*
Riboflavin	NS	17:1	*NN*	Histidine	*NN*
Niacin	NS	18:1 undifferentiated	*NN*	Alanine	*NN*
Pantothenic acid	NS	18:1 c	NS	Aspartic acid	*NN*
Vitamin B-6	NS	18:1 t	*NN*	Glutamic acid	*NN*
Folate, total	NS	20:1	*NN*	Glycine	*NN*
Folic acid	*NN*	22:1 undifferentiated	*NN*	Proline	*NN*
Folate, food	*NN*	22:1 c	*NN*	Serine	*NN*
Folate, DFE	NS	22:1 t	*NN*	Hydroxyproline	*NN*
Choline, total	*NN*	24:1 c	*NN*	Alcohol, ethyl	*NN*
Betaine	*NN*	Fatty acids, total polyunsaturated	NS	Caffeine	NS
Vitamin B-12	NS	18:2 undifferentiated	*NN*	ORAC	*NN*
Vitamin B-12, added	*NN*	18:2 CLAs	*NN*	CSI	*NN*
Biotin	NS	18:2 n-6 c, c	NS	SFA%	*NN*
Vitamin A, RAE	*NN*	18:2 i	*NN*	USFA%	*NN*
Retinol	NS	18:2 t not further defined	*NN*	AI	*NN*
Carotene, beta	NS	18:3 undifferentiated	*NN*	TI	*NN*
Carotene, alpha	NS	18:3 n-3 c, c, c (ALA)	NS	hH	*NN*
Cryptoxanthin, beta	NS	18:3 n-6 c, c, c	*NN*	n3:n6	*NN*

NS: Non Significant difference; NN: New Nutrient; Data was analyzed using paired sample t test

difference between the tool outputs and USDA data bank was found. The tool has been studied in more than 7 research theses and the accuracy of the new tool has been confirmed by a total of about 1000 food frequency questionnaires.[35–41]

Discussion

Given the importance of food frequency on the one hand and optimization of existing tools on the other hand, it seems that using the new tool will do an important part of the calculations and outputs required by the researchers. Both the precision of the new freeware tool, and its compatibility with previous collected data of the studies, not only could be part of the ongoing research but also could extract new findings from older studies, which has been done based on the 147 food frequency questionnaire, and provide valuable information to researchers for new findings. Although the new tool was designed based on food frequency, since most common edible foods are more or less similar to 24 recalls or food records, the present tool can assist these studies as well. Obviously, the above tool should be updated and optimized time to time using USDA data Bank.

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Conflicts of interest

There are no conflicts of interest.

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