

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

## 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.<sup>[1]</sup> 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.<sup>[2]</sup> Measuring nutrient intake is one of the most challenging because it requires skilled people, accurate labs, and a great deal of cost and budget.<sup>[3]</sup> Improved methods in this area are necessary to provide accurate estimates of dietary intake for both epidemiological studies and clinical trials.<sup>[4]</sup> 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.<sup>[5]</sup> 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.<sup>[6,7]</sup> 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.<sup>[8]</sup>

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.<sup>[9-11]</sup> Despite the feasibility and low cost of the tool that has made it one of the most important FFQ data analyzers,

**Zahra Madani,  
Maryam Sadat  
Moussavi Javardi,  
Majid Karandish<sup>1</sup>,  
Ariyo Movahedi<sup>2</sup>**

*Department of Nutrition, Master of Science in Public Health Nutrition, Science and Research Branch, Islamic Azad University, Tehran, Iran, <sup>1</sup>Department of Nutrition, Paramedical School, Jundishapour Medical University, Ahvaz, Iran, <sup>2</sup>Department of Nutrition, Science and Research Branch, Islamic Azad University, Tehran, Iran*

**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: ammi35@mail.aub.edu

### Access this article online

**Website:**  
[www.ijpvmjournal.net/www.ijpvm.ir](http://www.ijpvmjournal.net/www.ijpvm.ir)

**DOI:**  
10.4103/ijpvm.IJPVM\_511\_20

### Quick Response Code:



**How to cite this article:** Madani Z, Sadat M, Javardi M, Karandish M, Movahedi A. Promoting and updating food frequency questionnaire tool to measure food consumption and nutrient intake analysis. *Int J Prev Med* 2021;12:165.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow\_reprints@wolterskluwer.com

it unfortunately lacks information such as amino acid levels, thrombogenic and atherogenic indices,<sup>[12-14]</sup> 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.<sup>[14]</sup> Both indices take into account the ratio of SFA saturated fatty acid and MUFA and PUFA unsaturated fatty acids.<sup>[15]</sup> 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.<sup>[16]</sup> 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.<sup>[17,18]</sup> 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.<sup>[19]</sup> 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).<sup>[20-22]</sup> The ratio of cholesterol to total saturated fat (CSI) is another index used in many studies,<sup>[23-25]</sup> 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.<sup>[26]</sup> 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.<sup>[14]</sup> 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.<sup>[27-29]</sup> Studies have shown that a high antioxidant dietary intake can improve health, especially by

reduction of free radicals in the body.<sup>[30,31]</sup> The calculation of total dietary antioxidant capacity (DTAC) has been used frequently in recent years, and its role demonstrated in many studies.<sup>[30]</sup>

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.<sup>[9-11]</sup> 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.<sup>[32]</sup> The values of fat quality indices were calculated based on the Ulbricht and Southgate equations<sup>[14]</sup> and placed in separate columns in the new FFQ tool.

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

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

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

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

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.<sup>[33]</sup> 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.<sup>[34]</sup>

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.<sup>[35-41]</sup>

## 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.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

**Received:** 04 Sep 20 **Accepted:** 22 Jan 21

**Published:** 14 Dec 21

### References

1. Abreo A, Gebretsadik T, Stone CA, Hartert TV. The impact of modifiable risk factor reduction on childhood asthma development. *Clin Transl Med* 2018;7:15.
2. Bennett BJ, Hall KD, Hu FB, McCartney AL, Roberto C. Nutrition and the science of disease prevention: A systems approach to support metabolic health. *Ann N Y Acad Sci* 2015;1352:1–12.
3. Jackson MD, Motswagole BS, Kwape LD, Kobue-Lekalake RI, Rakgantswana TB, Mongwaketse T, *et al.* Validation and reproducibility of an FFQ for use among adults in Botswana. *Public Health Nutr* 2013;16:1995–2004.
4. Shim JS, Oh K, Kim HC. Dietary assessment methods in epidemiologic studies. *Epidemiol Health* 2014;36:e2014009.
5. Subar AF. Developing dietary assessment tools. *J Am Diet Assoc* 2004;104:769–70.
6. Mertens E, Kuijsten A, Geleijnse JM, Boshuizen HC, Feskens EJM, Van't Veer P. FFQ versus repeated 24-h recalls for estimating diet-related environmental impact. *Nutr J* 2019;18:2.
7. Sasanfar B, Toorang F, Djazayeri A, Nahvijou A, Movahedi A, Asghari SS, *et al.* Effect of nutrition intervention on indices of growth in day care centers of the city of Birjand, Iran. *J Nutr Sci Diet* 2019;5. Available from: <http://jnsd.tums.ac.ir/index.php/jnsd/article/view/247>.
8. Willett W. *Nutritional Epidemiology*. Vol 40. Oxford University Press; 2012.
9. Hosseini Esfahani F, Asghari G, Mirmiran P, Azizi F, Esfahani FH, Asghari G, *et al.* Reproducibility and relative validity of food group intake in a food frequency questionnaire developed for the Tehran lipid and glucose study. *J Epidemiol* 2010;20:150–8.
10. Mirmiran P, Hosseini Esfahani F, Mehrabi Y, Hedayati M, Azizi F, Esfahani FH, *et al.* Reliability and relative validity of an FFQ for nutrients in the Tehran lipid and glucose study. *Public Health Nutr* 2010;13:654.
11. Asghari G, Rezaeideh A, Hosseini-Esfahani F, Mehrabi Y, Mirmiran P, Azizi F. Reliability, comparative validity and stability of dietary patterns derived from an FFQ in the Tehran Lipid and Glucose Study. *Br J Nutr* 2012;108:1109–17.
12. Fehily AM, Pickering JE, Yarnell JWG, Elwood PC. Dietary indices of atherogenicity and thrombogenicity and ischaemic heart disease risk: The caerphilly prospective study. *Br J Nutr* 1994;71:249–57.
13. Attia YA, Al-Harathi MA, Korish MA, Shiboob MM. Fatty acid and cholesterol profiles, hypocholesterolemic, atherogenic, and thrombogenic indices of broiler meat in the retail market. *Lipids Health Dis* 2017;16:1–11.
14. Ulbricht TLV, Southgate DAT. Coronary heart disease: Seven dietary factors. *Lancet* 1991;338:985–92.
15. Santos-Silva J, Bessa RJB, Santos-Silva F. Effect of genotype, feeding system and slaughter weight on the quality of light lambs. II. Fatty acid composition of meat. *Livest Prod Sci* 2002;77:187–94.
16. Barbiciri P, Nunes JC, Torres AG, Nishimura RY, Zuccolotto DCC, Crivellenti LC, *et al.* Indices of dietary fat quality during midpregnancy is associated with gestational diabetes. *Nutrition* 2016;32:656–61.
17. Keys A, Anderson JT, Grande F. Serum cholesterol response to changes in the diet: IV. Particular saturated fatty acids in the diet. *Metabolism* 1965;14:776–87.
18. Bonanome A, Grundy SM. Effect of dietary stearic acid on plasma cholesterol and lipoprotein levels. *N Engl J Med* 1988;318:1244–8.
19. Hegsted DM, McGandy RB, Myers ML, Stare FJ. Quantitative effects of dietary fat on serum cholesterol in man. *Am J Clin Nutr* 1965;17:281–95.
20. Hornstra G, Lussenburg RN. Relationship between the type of dietary fatty acid and arterial thrombosis tendency in rats. *Atherosclerosis* 1975;22:499–516.
21. McEwen B. The influence of diet and nutrients on platelet function. *Semin Thromb Hemost* 2014;40:214–26.
22. Galli C. *Dietary ω3 and ω6 Fatty Acids: Biological Effects and Nutritional Essentiality* [Internet]. Springer US; 2013. (NATO ASI series: Life sciences). Available from: <https://books.google.com/books?id=vcbSBwAAQBAJ>.
23. Aparecida Ferraz da Silva Torres E, Rodrigues Sampaio G, Moreira Nery Castellucci C, Simioni de Abreu E, Augusto Cardoso M. Low levels of cholesterol/saturated fat index (CSI) in a Japanese–Brazilian diet. *Blades M, editor. Nutr Food Sci* 2005;35:324–9.
24. Rudling M, Laskar A, Straniero S. Gallbladder bile supersaturated with cholesterol in gallstone patients preferentially develops from shortage of bile acids. *J Lipid Res* 2019;60:498–505.
25. Connor SL, Gustafson JR, Artaud-Wild SM, Flavell DP, Classick-Kohn CJ, Hatcher LF, *et al.* The cholesterol/saturated-fat index: An indication of the hypercholesterolaemic and atherogenic potential of food. *Lancet (London, England)* 1986;1:1229–32.
26. Lopes LD, Böger BR, Cavalli KF, Silveira-Júnior JF do S, Osório DV, De Oliveira DF, *et al.* Perfil de los ácidos grasos, índices de calidad de los lípidos y compuestos bioactivos de las harinas de residuos de la uva. *Cienc. Inv. Agr* 2014;41:225–34.
27. Waisundara V, Hoon LY. A comparative study on the antioxidant activity of commonly used South Asian herbs. *J Tradit Complement Med* 2013;3:263–7.
28. Sueishi Y, Ishikawa M, Yoshioka D, Endoh N, Oowada S, Shimmei M, *et al.* Oxygen radical absorbance capacity (ORAC) of cyclodextrin-solubilized flavonoids, resveratrol and astaxanthin as measured with the ORAC-EPR method. *J Clin Biochem Nutr* 2012;50:127–32.
29. Nishimura K, Osawa T, Watanabe K. Evaluation of oxygen

- radical absorbance capacity in kampo medicine. *Evid Based Complement Alternat Med* 2011;2011:812163. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/19126557>.
30. Parohan M, Anjom-Shoae J, Nasiri M, Khodadost M, Khatibi SR, Sadeghi O. Dietary total antioxidant capacity and mortality from all causes, cardiovascular disease and cancer: A systematic review and dose–response meta-analysis of prospective cohort studies. *Eur J Nutr* 2019;58:2175–89.
  31. Abshirini M, Siassi F, Koohdani F, Qorbani M, Mozaffari H, Aslani Z, *et al.* Dietary total antioxidant capacity is inversely associated with depression, anxiety and some oxidative stress biomarkers in postmenopausal women: A cross-sectional study. *Ann Gen Psychiatry* 2019;18:3.
  32. USDA. USDA Food Composition Databases [Internet]. U.S. Department of Agriculture. 2019 [cited 2019 Nov 11]. Available from: <https://fdc.nal.usda.gov>.
  33. Haytowitz D, Bhagwat S. USDA Database for the Oxygen Radical Absorbance Capacity (ORAC) of Selected Foods, Release 2. *US Dep Agric* 2010;10–48. Available from: <https://naldc.nal.usda.gov/download/43336/PDF>.
  34. ITC. Spices in Iranian Cuisine [Internet]. Iran Traveling Center. 2015. Available from: <https://www.irantravelingcenter.com/spices-in-iranian-cuisine/>.
  35. Moussavi Javardi MA. Assessment of the Relationship Between the Dietary Atherogenesis and Thrombogenesis Indices with Changes in Serum Levels of Liver Enzymes, Fasting Blood Sugar and Lipid Profiles in Overweight and Obese Individuals as Compared to Normals. [Tehran, Iran]: Science and Research Branch Islamic Azad University; 2019.
  36. Ghalandari A. Study Of The Relationship Between Oxygen Radical Absorbance Capacity (ORAC) And Liver Enzymes, Fasting Blood Glucose And Lipid Profile In People With Type 1 Diabetes Among 2–to 18-year-olds. [Tehran, Iran]: Science and Research Branch Islamic Azad University; 2020.
  37. Shabestan Shahjooei H. Comparison of Serum Vitamin D, Dietary Groups, Amino Acid Profile and Fatty Acid Intake, Anthropometric Parameter, and Mental Status in Patients with Psoriasis and Healthy Individuals\_2. [Tehran, Iran]: Science and Research Branch, Islamic Azad University; 2020.
  38. Alinezhad M. Relationship between Anthropometric Indices, (ORAC) Oxygen Radical Absorption Capacity and Healthy Eating Index (HEI) with Acne in Adolescents. [Tehran, Iran]: Science and Research Branch, Islamic Azad University; 2020.
  39. Beitollahi M. The relationship between branch-chained and aromatic amino acids, dietary inflammatory indexes, and anthropometric indexes and female adolescent mental health living in east of Tehran. [Tehran, Iran]: Science and Research Branch, Islamic Azad University; 2019.
  40. Moussavi N. Comparison of Food Groups Consumption, Diet Protein Quality, DTAC, ORAC, Anthropometric Indices and Psychological Health Status in Vitiligo Patients and Healthy Persons. [Tehran, Iran]: Science and Research Branch, Islamic AZAd University; 2020.
  41. Madani Z. Assessment of the Relationship Between the Dietary Oxygen Radical Absorbance Capacity Index (ORAC) with Level of the Liver Enzymes, Fasting Blood Sugar and Lipid Profiles in Overweight and Obese as Compared to Normal Weight. [Tehran, Iran]: Science and Research Branch, Islamic Azad University; 2019.