Original Article

Calibration of a food frequency questionnaire in Koreans

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The current trend of changes in nutrient intakes may have some relationship with the increase in the occurrence of degenerative diseases in the Korean population. To date, a calibrated food frequency questionnaire (FFQ) has not been developed that can be further used for large-scale epidemiological research in Koreans aged 40 and older. This study was undertaken to develop and calibrate an FFQ in Koreans. A total of 144 Koreans aged 40 years and above participated in the first phase, which was conducted using the three-day dietary record method. One hundred and thirty-eight of those who completed the first phase were then interviewed to test FFQ against dietary records as a reference. The mean absolute nutrient intakes estimated by the dietary records were statistically compared with those estimated by the FFQ using paired *t*-tests. The mean values from the FFQ differed at most by 14% from those of the dietary records for all nutrients with the exception of vitamin A. Spearman rank-order correlation coefficients and cross-classification were also calculated. The energy-adjusted and corrected correlations for attenuation varied from 0.36 to 0.82. The degree of good agreement by cross-classification between the dietary records and the FFQ ranged from 67% to 90%. The newly developed FFQ can be used as a dietary assessment tool to measure usual nutritional status of Koreans aged 40 years and older. Furthermore, this study demonstrates that the FFQ also provides a more labour-efficient tool that is easier to use than any of the commonly used methods for large-scale epidemiological studies of the relationships between nutrition and diseases in Koreans.

Key Words: food frequency questionnaire, FFQ, calibration, dietary intake methodology, dietary assessment, dietary records, Koreans

Introduction

Of the commonly accepted tools for assessing dietary intake in epidemiological studies, the one that is most often used in population surveys is a food frequency questionnaire (FFQ).[1-3] The data from an FFQ are often used to rank subjects into broad categories of low, medium, and high intakes of certain foods, based on tertiles, for example. Such rankings are often compared with prevalence and/or mortality statistics for a specific disease within the population studied.[4] FFQs to be used in epidemiological studies should first be assessed for their applicability to the population under study. In general, to test an instrument, one must have a standard against which the instrument can be measured. However, in dietary assessment, such a standard is not always available. Ideally, biochemical markers could be used as a standard, but unfortunately, biomarkers do not exist for many of the common dietary components studied [5,6]

Alternatively, one could conduct non-intrusive long-term observations (over a period of months or years) to determine individual diets, but this is difficult and impractical. Therefore, self-reported food records or food recalls of multiple days are often used as standards when comparing methods of dietary assessment.[7]

Calibration refers to the process of assessing the ability of an FFQ to estimate the dietary intake during an appropriate period, with appropriate accuracy.[8] The usual procedure is to test the FFQ against another method, which is assumed more accurate than other methods among a representative sample of the study population.[7] In the process of calibrating dietary assessment methods, the reference measurement should be as accurate and as precise

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as possible, and any errors associated with the two methods should be independent.[9] Dietary records were chosen as the reference method for comparison purposes in the present study, because they have a high applicability in terms of measuring the actual food consumption of an individual. It is also important that the time period covered by the dietary assessment is long enough to give an accurate assessment of usual intake if the data are to be used for the study of diet-disease relationship.[10]

Therefore, when calibrating an FFQ for use in studies of nutrient intake, the investigator should pay careful attention to both the quality and the quantity of the dietary records used for comparison purposes, so that the best possible measurement of the efficacy of an FFQ is ensured.[3] In the present study, an FFQ was developed for application to chronic diseases, e.g., colorectal cancers. The FFQ was then tested in terms of nutrient intakes by comparing its results with three-day dietary records as a reference method.

There is a growing interest among Koreans in health problems associated with changes in food consumption patterns. Korean vital statistics data show that diseases of the circulatory system and cancer have become the major causes of death, and death from infectious diseases has declined sharply since 1980.[11] The current trend of increased fat intake may have some relationship with the increase in the occurrence of degenerative diseases in the Korean population.[12] There have been some reports of an FFQ used in epidemiological studies for Koreans, such as for middle-aged men,[13] women,[14] or the elderly;[15] however, no FFQ that will be further used for large-scale epidemiological research in Koreans aged 40 and older has been tested for calibration, e.g., by taking measurement-error correction into consideration.

Using the FFQ approach, the intakes of foods on the questionnaire can be specified in order to make the instrument sensitive to the dietary habits of the study populations. Such tailoring of the nutrient intakes obtained from the foods in the FFQ for the specified population should enhance the relevance of the dietary intake estimates of the FFQ in epidemiological studies.

Methods

Development and calibration of the FFQ

This study was reviewed and approved by the Human Subjects Committee of Seoul National University Hospital. The FFQ was developed based both on contribution analysis and on multiple regression analysis in the first phase of the study during September – October 2000, using the three-day dietary record method (p 249). National statistics have shown that those aged 40 years and older are likely to have a higher prevalence of colorectal cancers.[16] After about six months, during March – April, 2001, the developed FFQ was tested for calibration using face-to-face interview by graduate students majoring in nutrition and dietetics. Finally, 138 of 144 who completed the first phase of the study at 40 years of ages and above, participated in the second phase of the study. The results obtained were then compared against the three-day dietary records. The FFQ was administered to each participant to identify both usual consumption frequencies and the average portion size for food items using food models with standard measures. The participants were asked how often and how much of each food item was eaten on the average over the previous year.

Data Analysis

Descriptive statistics, such as means, standard deviations, and testing for normality, were calculated on all relevant data using the SPSS-10.0 software package.[17] Nutrient compositions of dishes and foods were obtained from food composition table revised by National Rural Living Science Institute.[18] The nutrient intakes from the three-day records were calculated using DS24,[19] a computer software program. By inputting all the information on portion sizes and nutrients from the three-day dietary records, the average nutrient composition of dishes was standardized. A new computerized software program with the same nutrient composition database as DS24,[19] FAST (FFQ Analysis Software Tool) was developed by the authors to analyze the individual nutrient intakes from the FFQ. The information on frequencies and consumed portion sizes of each specific food item were transformed into daily nutrient consumption. Data editing procedures (such as provisions for missing data) were performed using FAST.

The nutrient intakes (energy, protein, fat, carbohydrate, Ca, P, Fe, K, vitamin A (RE), Na, vitamin B_1, vitamin B_2, niacin, vitamin C, Zn, vitamin B_6, folate, retinol, carotene, crude fibre, vitamin E, and cholesterol) were compared. These were calculated by DS24 for the three-day dietary records and by FAST for the FFQ. The equivalence of the mean nutrient intake by the two methods was evaluated using paired *t*-tests for each nutrient. Ranking similarity of nutrient intakes obtained by the two methods were assessed by calculating the Spearman rank-order correlation coefficients. Calorie-adjusted nutrient intakes were used in the analysis to compensate for the effect of energy intake errors and also to help reduce between-person variations due to general over- or under-reporting.[8] This approach is useful to remove extraneous variations due to body size, physical activity, and metabolic efficiency. Calorie adjustment was done by computing residuals from regression models, with nutrient intake as the dependent variable and total energy intake as the independent variable. The residuals so obtained were added to obtain the expected caloric intake of an individual.[20] An attenuation correction of the correlations was used to correct for the day-to-day variations of subjects in the three-day dietary records.[21] To de-attenuate correlations between the dietary records and the FFQ, the observed correlations were multiplied by the factor $(1 + S^2_W/S^2_B)^{1/2}$, where S^2_W is the intra-individual variance and S^2_B the interindividual variance.

To measure the degree of agreement, respondents were categorized by nutrient values into quartiles based on the two dietary assessment methods. This comparison examined the percentage with good agreement (either the same quartile ranking or a disparity of one quartile between the two methods; e.g., the first quartile on both the FFQ and the three-day dietary record or the first quartile on the FFQ and the second quartile on the three-

day dietary records), and the percentage showing a poor agreement (disparities of two or three quartiles; e.g., the first quartile on the dietary record but the third or fourth quartile on the FFQ).

Result

Table 1 describes the age and gender profile of the participants who completed both the first and second phase of the study. One hundred and thirty-eight of the original group of 144 responded to the study surveys (96% completion rate). The mean ages of those that completed the surveys were 56.5 years for men and 63.3 years for women.

Table 2 compares the daily nutrient intakes obtained for the two dietary assessment methods. The mean absolute nutrient intakes estimated by the three-day dietary records were statistically equivalent to those calculated from the FFQ in terms of energy, protein, calcium, phosphorus, potassium, sodium, vitamins B1, B_2, niacin, Zn, vitamin B_6, and vitamin E. However, the FFQ tended to over-estimate fat, carbohydrate, iron, vitamins A (RE), C, folate, retinol, carotene, fibre, and cholesterol compared to the three-day dietary records. The mean values from the FFQ differed at most by 14% from those of the dietary records for all nutrients with the exception of vitamin A.

Unadjusted observed Spearman rank-order correlation coefficients between the nutrient intakes based on the three-day dietary records and those based on the FFQ varied from 0.34 for vitamin B_6 to 0.66 for fat and vitamin E (Table 3). The energy-adjusted correlations ranged from 0.36 for vitamin B_6 to 0.68 for fat and vitamin A (RE). Adjustment for total energy intake improved the correlations slightly for most nutrients but not for carbohydrate, vitamins B_1, B_2, C, retinol, and cholesterol. The correlations varied from 0.36 (carbohydrate) to 0.82 (fat) after correcting for attenuation.

Another way of examining the agreement between the dietary records and the FFQ involves cross-classifying the respondents' distribution. Respondents were divided into quartiles by nutrient intakes as measured by the two methods (Table 4). Cross-classification into the same quartiles ranged from 24% for vitamin C to 51% for cholesterol. One quartile differences were greatest for calcium (62%) and least for niacin (29%). Using the good agreement criteria, zinc was the nutrient with the least agreement (67%), classified into the same quartile, and vitamin E (90%) showed greatest agreement. With the exception of carbohydrate and vitamin B_2 for which 5% or respondents differed by three quartiles, three quartile differences occurred in 2% or less of the respondents.

Table 1. The distribution of respondents by age and gender

	First Phase (N = 144)		Second Phase (N = 138)	
Age/Gender	Male (N= 67)	Female (N = 77)	Male (N = 63)	Female (N = 75)
40 – 49	27 (18.8)*	26 (18.1)	25 (18.1)	26 (18.8)
50 – 59	20 (13.9)	21 (14.6)	19 (13.8)	20 (14.5)
60 – 69	12 (8.3)	18 (12.5)	12 (8.7)	17 (12.3)
70+	8 (5.6)	12 (8.3)	7 (5.1)	12 (8.7)

*N (% of the respondents participated in each phase of the study)

Table 2. Mean daily nutrient intakes (± standard deviation) estimated by three-day dietary records (DR) and a food frequency questionnaire (FFQ) (N = 138)

Nutrients	DR	FFQ
Energy (kcal)	1609.4 ± 491.9	1652.9 ± 499.9
Protein (g)	62.7 ± 27.2 (15.6 ± 3.9[a])	63.8 ± 25.5 (15.4 ± 4.2)
Total fat (g)	32.7 ± 19.3 (18.3 ± 5.5)	33.9 ± 15.0 (18.5 ± 3.9)
Carbohydrate (g)	262.1 ± 68.7 (65.2 ± 9.1)	271.9 ± 75.2 (65.8 ± 8.3)
Calcium (mg)	420.1 ± 182.1	425.9 ± 236.3
Phosphorus (mg)	847.6 ± 344.9	852.2 ± 367.3
Iron (mg)	11.0 ± 4.1	11.9 ± 4.8
Potassium (mg)	2222.9 ± 882.4	2275.4 ± 1002.5
Vitamin A (RE)	462.1 ± 302.1	617.6 ± 331.3 [b]*
Sodium (mg)	3672.1 ± 1636.4	3697.3 ± 1467.0
Vitamin B_1 (mg)	0.99 ± 0.50	1.02 ± 0.39
Vitamin B_2 (mg)	0.88 ± 0.38	0.87 ± 0.41
Niacin (mg)	14.9 ± 7.1	14.7 ± 5.9
Vitamin C (mg)	76.3 ± 52.0	83.9 ± 47.7*
Zinc (μg)	8.29 ± 3.23	8.43 ± 2.69
Vitamin B_6 (mg)	23.0 ± 7.7	23.8 ± 7.2
Folate (μg)	188.6 ± 84.3	205.1 ± 90.1*
Retinol (μg)	74.0 ± 65.0	81.3 ± 43.2*
Carotene(μg)	2125.2 ± 1455.3	2426.5 ± 1371.5**
Fibre (g)	5.24 ± 2.14	5.63 ± 2.22
Vitamin E (mg)	9.40 ± 5.03	9.33 ± 5.34
Cholesterol (mg)	239.8 ± 145.2	273.1 ± 130.8**

[a] % of calories; [b]*P < .01, **P < .001 from paired t-tests

Discussion

The nutrient intakes analyzed by the FFQ tend to be higher than those obtained from the three-day dietary records in this study, which is consistent with the results of several other studies.[10,14] However, there are also other reports that show just the opposite: the FFQs in these studies produced a nutrient intake estimate that was about 20% lower than the dietary records.[4,22,23] These studies also overestimated vitamin A intake, as was observed in the present study. Willett pointed out that vitamin A discrepancy is due in part to modifications to the USDA nutrient database, which has been changed drastically with respect to the vitamin A values of several vegetables and fruits.[8]

In this study, paired t-tests revealed significant differences between the two dietary assessment methods for fat, carbohydrate, iron, vitamins A (RE), C, folate, retinol, carotene, fibre, and cholesterol. Another study also found statistically significant differences for total calories, total fat, saturated fat, cholesterol, vitamin A, and β-carotene.[24] In addition to errors in recall and data processing, another cause for the differences may be limitations of the nutrient database. In addition, there is a possibility of errors caused by insufficient information in the three-day dietary records. Participants were instructed to report all the foods and beverages consumed, in as much detail as possible, by specifying brand names and cooking methods in the three-day dietary records. It should also be noted that many variations in nutrient values are caused by other factors, especially factors such as food ingredients or preparation/ cooking methods. Nutrient intakes vary according to when or how the food was produced, whether it was cooked or raw or broiled or stir-fried, and what was added to food (e.g., jam or butter on toast). Therefore, the two dietary assessment methods, both the three-day dietary records and the FFQ used in this study, could not agree completely enough when assessing nutrient intakes. A more likely basis for differences between the FFQ and three-day dietary record data is that three days of recorded intakes may not have represented usual intake for most individuals and that the FFQ categories are not able to capture all the detail available from the three-day records.

In this study, correlation coefficients ranged from 0.34 (vitamin B_6) to 0.66 (fat and vitamin E) for crude correlation, from 0.36 (vitamin B_6) to 0.68 (fat and vitamin A) after energy adjustment, and from 0.36 (carbohydrate) to 0.82 (fat) after correcting for within-person variations. A study conducted to calibrate an FFQ in Koreans showed that the correlation coefficients varied from 0.26 to 0.59, which is similar to the results of the present study, though slightly lower.[14] In the study by Lee[24], the correlation coefficient was lowest for total fat and highest for calcium, ranging from 0.21 to 0.66. Neither of these studies used measurement error correction, such as energy-adjustment or deattenuation methods. High values were reported by Balough *et al.*,[25] ; i.e. the correlation coefficient for fat was 0.94 and for energy, 0.74. Low values were reported by Stuff *et al.*,[26]: 0.04 for fat and 0.09 for energy, with the highest correlation for calcium, 0.24.

Table 3. Spearman rank-order correlation coefficients comparing nutrient intakes from three-day dietary records and a food frequency questionnaire (N = 138)

Nutrients	Observed correlation	Energy-adjusted[a]	Energy-adjusted and corrected for attenuation[b]
Energy (kcal)	.54	-	-
Protein (g)	.44	.45	.68
Total fat (g)	.66	.68	.82
Carbohydrate (g)	.37	.37	.36
Calcium (mg)	.59	.66	.72
Phosphorus (mg)	.49	.57	.80
Iron (mg)	.57	.67	.69
Potassium (mg)	.56	.58	.72
Vitamin A (RE)	.64	.68	.77
Sodium (mg)	.56	.59	.66
Vitamin B_1 (mg)	.55	.54	.60
Vitamin B_2 (mg)	.62	.60	.61
Niacin (mg)	.47	.48	.63
Vitamin C (mg)	.39	.37	.54
Zinc (μg)	.38	.44	.53
Vitamin B_6 (mg)	.34	.36	.63
Folate (μg)	.54	.56	.61
Retinol (μg)	.56	.56	.69
Carotene(μg)	.57	.60	.68
Fibre (g)	.52	.54	.67
Vitamin E (mg)	.66	.67	.72
Cholesterol (mg)	.56	.56	.59

[a]The energy-adjusted correlation used the residuals from regressing each nutrient on the total calories.
[b]Corrected for the ratio of the within-person to the between-person variance components by observed correlation

Two statistical techniques that can be used to adjust energy intake consist of dividing the nutrient intakes by calories (nutrient densities) or adjusting nutrients based on energy intakes using regression analysis. According to Rimm,[27] energy adjustment by regression analysis is a better technique than adjustments involving nutrient density, because the latter procedure does not fully control for confounding by total energy intake in the epidemiological analysis.

Energy adjustment by regression analysis did not improve the crude correlation coefficients in the present study. The effect of adjustment by total caloric intake was minimal, as has been found by other studies.[10,22] Lee[24] pointed out that the reason for little or no improvement after energy adjustment was that the body weights of individuals had been quite stable during the study period (none had shown substantial weight loss or gain). Therefore, their total energy and macronutrient intakes and the relationships between energy and other nutrients may have been stable even after energy adjustment.

Correction for attenuation in our study improved the crude correlation slightly more than energy adjustment, as has been shown in some other studies,[22,23,28] although not as much as in other cases.[9,29] The reason for the improvement is probably due to large within-person day-to-day variability in nutrient intake.[30,31] In addition, three days are not sufficient to correctly classify the average intake for many nutrients.

In the study by Willett *et al.*,[9] about 50% of the respondents fell into the same lowest or highest quintile using both methods. In the present study, overall, there was a range of 67% to 90% of good agreement between respondents in terms of the same quartiles and the first quartile differences by FFQ and dietary records, which is similar to that obtained by Bonifacj *et al,*.[30] and Pietinen *et al.*[10]

In conclusion, the mean values from the FFQ differed by no more than 14% from those of the dietary records for all nutrients with the exception of vitamin A. The energy-adjusted and corrected correlations for attenuation varied from 0.36 to 0.82. The degree of good agreement by cross-classification between the dietary records and the FFQ ranged from 67% to 90%. This study was undertaken to develop an FFQ that approaches the accuracy of dietary records, so that it could be used in epidemiological studies. By implementing both the three-day dietary records and the FFQ, standardized lists of average portion sizes and ingredients for the usual dishes and foods consumed by Koreans aged 40 and older were developed. The study results enabled us to develop a dietary assessment software program that can analyze the nutrient intakes of individuals and groups.

However, there is a limitation in this study: it considered only people residing in Seoul and its vicinity. In order to obtain results that are more generally representative of Koreans, other Korean population subgroups that differ in terms of age and gender profiles may be required. It is suggested that other subgroups residing in different regions, with different food availabilities and different eating habits be included in additional research studies.

Table 4. Cross-classification of nutrient distribution quartiles from three-day dietary records and a food frequency questionnaire (N = 138)

Nutrients quartile	Concordant classification	One quartile differences (%)[a]	Two quartile differences	Three differences
Energy (kcal)	48	33	19	0
Protein (g)	36	45	19	0
Total fat (g)	48	38	14	0
Carbohydrate (g)	43	38	14	5
Calcium (mg)	26	62	12	0
Phosphorus (mg)	33	43	24	0
Iron (mg)	38	50	12	0
Potassium (mg)	31	52	17	0
Vitamin A (RE)	38	43	19	0
Sodium (mg)	36	50	14	0
Vitamin B_1 (mg)	33	52	14	0
Vitamin B_2 (mg)	38	45	14	2
Niacin (mg)	45	29	26	0
Vitamin C (mg)	24	60	14	2
Zinc (μg)	36	31	33	0
Vitamin B_6 (mg)	31	43	21	5
Folate (μg)	36	52	12	0
Retinol (μg)	40	45	12	2
Carotene(μg)	45	38	17	0
Fibre (g)	46	38	14	2
Vitamin E (mg)	50	40	7	2
Cholesterol (mg)	51	32	17	0

[a]Percentages may not add up to 100 due to rounding to the nearest whole number.

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References

1. Gibson RS. Principles of nutritional assessment. New York: Oxford University Press, 1990.
2. Zulkifli SN, Yu SM. The food frequency method for dietary assessment. J Am Diet Assoc 1992; 92: 681-685.
3. Briefel RR, Flegal KM, Winn DM, Loria CM, Johnson CL, Sempos C. Assessing the nation's diet: limitations of the food frequency questionnaire. J Am Diet Assoc 1992; 92: 959-962.
4. Block G, Thompson FE, Hartman AM, Larkin FA, Guire KE. Comparison of two dietary questionnaires validated against multiple dietary records collected during a 1-year period. J Am Diet Assoc 1992; 92: 686-693.
5. Block G, Coyle LM, Hartman AM, Scoppa SM. Revision of dietary analysis software for the Health Habits and History Questionnaire. Am J Epidemiol 1994; 139: 1190-1196.
6. Sinha R, Patterson BH, Mangels AR, Rosner B, Bain C, Witschi J, Hennekens CH, Speizer FE. Determinants of plasma vitamin E in healthy males. Cancer Epidemiol Biomarkers 1993; 2: 473-479.
7. Thompson FE, Byers T. Dietary assessment resource manual. Nutr 1994; 24: 2245S-2317S.
8. Willett WC. Nutritional epidemiology, 2nd edn. New York: Oxford University Press, 1998.
9. Willett WC, Sampson L, Stampfer MJ, Levander OA, Gibson T, Taylor PR, Block G. Reproducibility and validity of a semiquantitiative food frequency questionnaire. Am J Epidemiol 1985; 122: 51-65.
10. Pietinen P, Hartman AM, Haapa E, Rasaner L, Haapakoski J, Palmgren J, Albanes D, Virtamo J, Huttunen JK. Reproducibility and validity of dietary assessment instruments. I. self-administered food use questionnaire with a portion size picture booklet. Am J Epidemiol 1988; 128: 655-666.
11. Kim JP, Park IS, Ahn YO, Shin MH, Ahn DH. 1991 cancer incidence in Seoul, Korea: results of the implementation study of the Seoul cancer registry. J Korean Med Sci 1995; 10: 74-84.
12. Kim S, Moon S, Popkin BM. The nutrition transition in South Korea. Am J Clin Nutr 2000; 71: 44-53.
13. Kim MK, Lee SS, Ahn YO. Reproducibility and validity of a self-administered semi-quantitative food frequency questionnaire among middle-aged men in Seoul. Korean J Commun Nutr 1996; 1: 376-394.
14. Kim WY, Yang EJ. A study on development and validation of food frequency questionnaire for Koreans. Korean J Nutr 1998; 31:220-230.
15. Oh SY, Hong MH. Development of a simple food frequency questionnaire using the contribution of specific foods to absolute intake and between-person variation of nutrient consumption for the Korean elderly. Korean J Nutr 2000; 33: 429-437.
16. Korean Ministry of Health & Welfare. Year report of death rates. Seoul: Korean Ministry of Health & Welfare, 2000.
17. SPSS Inc. SPSS professional statistics 10.0. Chicago: SPSS Inc., 2000.
18. National Rural Living Science Institute. Food composition table, 6th edn. Suwon: Rural Development Administration, 2001.
19. Human Nutrition Lab. Department of Food and Nutrition, Seoul National University and AI/DB Lab., Sookmyung Women's University. DS 24. Seoul: Seoul National University Press, 1996.
20. Tabachnick BG, Fidell LS. Using multivariate statistics, 4th edn. Boston: Allyn & Bacon, 2000.
21. Rosner B, Willett WC. Internal estimates for correlations coefficients corrected for within-person variation: implications for study design and hypothesis testing. Am J Epidemiol 1988; 127: 377-386.
22. Kim J, Chan MM, Shore RE. Development and validation of a food frequency questionnaire for Korean Americans. Int J Food Sci Nutr 2002; 53: 129-142
23. Martin-Moreno JM, Boyle P, Gorgojo L, *et al*. Development and validation of a food frequency questionnaire in Spain. Int J Epidemiol 1993; 22: 512-519.
24. Lee MM, Lee F, Ladenla SW, Miike R. A semiquantitative dietary history questionnaire for Chinese Americans. Ann Epidemiol 1994; 4: 188-197.
25. Balough M, Medalie JH, Smith H, Groen JJ. The development of a dietary questionnaire for an ischemic heart disease survey. Isr J Med Sci 1968; 4: 195-203.
26. Stuff JE, Garza C, Smith EO, Nichols BL, Montandon CM. comparison of dietary methods in nutritional studies. Am J Clin Nutr 1983; 37: 300-306.
27. Rimm EB, Giovannucci EL, Stampfer MJ, Colditz GA, Litin, LB, Willett WC. Authors' response to "Invited commentary: some limitations of semiquantiative food frequency questionnaires." Am J Epidemiol 1992; 135: 1133-1136.
28. Hernandez-Avila M, Romieu I, Parra S, Hernandez-Avila J, Madrigal H, Willett WC. Validity and reproducibility of a food frequency questionnaire to assess dietary intake of women living in Mexico City. Salud Publica Mex 1998; 40: 133-140.
29. Mannisto S, Virtanen M, Mikkonen T, Pietinen P. reproducibility and validity of a food frequency questionnaire in a case-control study on breast cancer. J Clin Epidemiol 1996; 49: 401-409.
30. Bonifacj C, Gerber M, Scali J, Daures JP. Comparison of dietary assessment methods in a Southern French population: use of weighed records, estimated-diet records and a food frequency questionnaire. Eur J Clin Nutr 1997; 51: 217-231.
31. Yaroch AL, Resnicow K, Davis M, Davis A, Smith M, Khan LK. Development of a modified picture-sort food frequency questionnaire administered to a low-income, overweight, African-American adolescent girls. J Am Diet Assoc 2000; 10: 1050-1060.