Nutrition and Food Sciences Research Vol 2, No 1, Jan-Mar 2015, pages: 11-18

Original Article

Food Security Is Associated with Dietary Diversity: Tehran Lipid and Glucose Study

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Received: November 2014 **Accepted:** January 2015

ABSTRACT

Background and Objectives: This study was undertaken to determine the relationship between food security and individual dietary diversity score (IDDS).

Materials and Methods: This population-based cross-sectional study was conducted on 200 non-diabetic individuals aged ≥40 years, selected randomly from the Tehran Lipid and Glucose Study. Household food security was measured using a validated United States Department of Agriculture (USDA) 18-item questionnaire and IDDS using a valid and reliable 147-item food frequency questionnaire based on five food groups of the Food Guide Pyramid.

Results: Overall, 48.5% of the study subjects had high, 36.0% had borderline, and 15.5% had low food security. Significant inverse correlations were observed between the scores for food security, diversity of fruits and vegetables, and total IDDS. Food secure group had significantly higher total IDDS (4.74 ± 1.40 vs. 5.15 ± 1.28, *P* = 0.033) and score for diversity of fruits (1.48 ± 1.40 vs. 1.68 ± 1.28, *P* = 0.030) as compared to the food insecure group. After adjusting for covariates, higher food security score was associated with lower total IDDS (regression coefficient for a 1-unit difference in diversity score = -0.130, *P* = 0.040), and score for diversity of fruits (regression coefficient for a 1-unit difference in diversity score = -0.182, *P* = 0.010).

Conclusions: The results showed an inverse relationship between food security score and dietary diversity score. Intake of different fruits is associated with higher food security.

Keywords: Dietary diversity; Food security; Food insecurity

Introduction

Based on the internationally agreed definition, food security is described as "*Everyone's access to enough food for an active and healthy life in all the times, which is required for a population to be healthy and well-nourished*" (1, 2). Studies in Iran show that 20% of households have been considered food insecure.

It has further been reported that food insecurity is associated with dietary behaviors, including specific food choices and preparation methods such as methods lead to increase or decrease of high calorie and high fat diets (3-6). Since food insecurity leads people to consume low healthy diets (7), inexpensive foods with high energy density and low micronutrients content (4-6), low intake of fruits, vegetables (5, 6, 8-10), and dairy products (8), the association of food insecurity and non-communicable diseases can be explained partly by the impact of food insecurity on dietary pattern. Individuals affected by food insecurity are exposed to higher risks of obesity

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and overweight (11, 12), high blood pressure (13), and smoking (14).

Recently, investigators focus on the overall diet quality to overcome the interaction between foods and nutrients. Individual dietary diversity score (IDDS), an indicator of overall diet, is associated with some nutrient adequacy ratios, higher intakes of fruits and vegetables (15-17). There is an inverse association between IDDS and some risk factors for non-communicable diseases (18, 19).

Two recent studies in Iran have assessed the validity of food insecurity measures (5, 20). The measurement of food security as a rising global concern can help focus the attention of national and local policymakers to improved health policies. Dietary diversity and food expenditures are used by researchers for measuring the different aspect of food security (21, 22), because a more diversified diet is associated with a number of improved outcomes such as decrement of mortality, and is correlated with caloric and nutrient adequacy (23-27).

Since little is known about the association of food insecurity and IDDS as an overall diet quality index in Iran, this study was designed to determine the relationship between food security and IDDS in a population of the Tehran Lipid and Glucose Study (TLGS).

Materials and Methods

Subjects: This cross-sectional study was conducted within the framework of the TLGS, a prospective study aimed at identifying the risk factors for non-communicable diseases among a representative urban population of Tehran. The first phase of the TLGS began in March 1999, and data collection is ongoing at three-year intervals (28, 29).

For the current study, the subjects aged 40+ years were selected randomly from the fourth phase of the TLGS (2009–2012). Demographic information including age, sex, occupation, marital status, anthropometric measures, and food intake of each individual were obtained. The subjects were excluded if they had diagnosis of chronic diseases such as cardiovascular or kidney diseases, diabetes and malignancy, if they were on weight-reducing diets during the last 12 months, or if they had under- or over-reported dietary intakes (< 800 kcal/d or > 4200 kcal/d, respectively). Finally, 200 non-diabetic persons (including 86 males and 114 females) remained for statistical analysis.

The Ethics Committee of the Research Institute for Endocrine Sciences (Tehran, Iran) approved this study. Informed written consent was obtained from all subjects.

Dietary assessment: The usual dietary intake was assessed using a valid and reliable 147-item semi-quantitative food frequency questionnaire (FFQ) (30-32). Trained dietitians, with at least 5 years of experience in the TLGS survey, asked the participants to report their intake frequency for each food item consumed during the past year in terms of day, week, month and year. The reported frequency according to the desired serving size of each food item or household measure was converted into grams per day (33). Because the only available Iranian food composition table (FCT) (34) analyzes a very limited number of raw food items and nutrients, we used the USDA FCT as the main FCT; the Iranian FCT was used as an alternative for traditional Iranian food items like Kashk, which are not included in the USDA FCT .

Dietary diversity score of each individual was calculated based on five main groups of the Food Guide Pyramid (FGP): bread/grains, vegetables, fruits, meats and meat substitutes, and dairy (35). These main groups were divided into 23 subgroups according to Haines *et al*. (35). The 'bread/grains' group was categorized into seven subgroups (refined bread, biscuits, macaroni, whole bread, cornflakes, rice, refined meal), 'fruits' into two subgroups (fruits and fruit juices, berries and citrus), 'vegetables' into seven subgroups (vegetables, potatoes, tomatoes, starchy vegetables, legumes, yellow vegetables, and green vegetables), 'meats and meat substitutes' into four subgroups (red meat, poultry, fish, and egg), and 'dairy' into three subgroups (milk, yogurt, and cheese). To be counted as a 'consumer' for any of the food group categories, a respondent had to consume at least one-half serving, as defined by the FGP quantity criteria, during one day. To calculate the score of each food group, we divided the number of subgroups consumed by the total number of subgroups in each main group, and then multiplied this by 2. Individual dietary diversity score represents the mean scores of the five groups. Each of the five broad food categories receive a maximum diversity score of 2 out of the 10 possible score points. The maximum and minimum scores of diversity were between 0 and 10, respectively. Within each food group, the score reflects the percentage of the possible maximum score. Total score was the sum of the scores of the five main groups.

To assess the household food security status in the last 12 months, we used the questionnaire with 18 questions proposed by the USDA (2). The validity and reliability of this questionnaire were previously reported in a study of urban households in Isfahan (36). Trained dietary interviewers administered the household food security questionnaire during the face-to-face interviews with the participants. Food security score of each person was calculated according to the standard method, based on the number of positive responses on the questionnaire (1). Accordingly, the subjects were divided into four groups based on scores of the questionnaire: high food security (≤2.32), marginal food security (2.33-4.55), low food security (4.56-6.52), and very low food security (>6.52). Higher scores indicate lower food security status. To have enough sample size in each group, the subjects were divided into two groups: Food insecure group (marginal, low, and very low food security) and Food secure group (high food security).

Other measurements: Anthropometric measurements were done according to the study protocol; weight was measured with minimal clothing and without shoes using a digital scale (model 707, range 0.1-150 kg, Seca, Hamburg, Germany) in the range 100 g. Height was measured using tape (208 Portable Body Meter Measuring Device; Seca, Hamburg, Germany) standing against the side wall with no shoes while scapula are in normal circumstance to the nearest 1 cm. BMI was calculated by dividing weight (kg) to height squared (m^2).

Fasting blood samples, for the measurement of glucose, were drawn after the subjects had fasted overnight. The analysis of samples was performed using Selectra 2 auto-analyzer (Vital Scientific, Spankeren, Netherlands). Fasting plasma glucose (FPG) was measured on the day of blood collection by the enzymatic colorimetric method using glucose oxidase. Inter- and intra-assay CVs were both 2.2% for FPG. Diabetes was defined according to the criteria of the American Diabetes Association (ADA) as FPG ≥126 mg/dl or 2-h post 75 gram glucose load ≥200 mg/dl or current therapy for a definite diagnosis of diabetes (37).

Statistical analysis: The Kolmogorov–Smirnov test and histograms were used to test the normality of dietary intakes and diversity scores. Significant differences in sex, age groups, obesity, education, marriage, occupation, and smoking status between the food secure and insecure groups were observed using the Chi-square test. Independent student t test was used to compare the dietary intakes including energy, protein, fat, carbohydrate, saturated fatty acid (SFA), monounsaturated fatty acid (MUFA), polyunsaturated fatty acid (PUFA), fiber, whole grains, fruits, dark vegetables, low fat dairy, simple sugar and diversity scores between the food secure and insecure groups.

Linear regression was used to determine the relation between food security score and dietary diversity. In multivariable adjusted models, the data were controlled for the following factors: age (continuous), sex (men, women), BMI (continuous), energy intake (continuous), occupation (employed, homemakers, retired), marital status (single, married, divorced), education (≤ 11th grade, high school graduate, academic graduate), and smoking status (smokers, non-smokers). For data analysis, the SPSS software (version 16.0; SPSS Inc., Chicago, IL, USA) was used, and P values <0.05 were considered statistically significant.

Results

The mean age of the participants was 51.4 ± 8.2 years. Overall, 48.5% of study subjects had high, 35.5% had marginal, 15.5% had low, and 0.05% had very low food security. Characteristics of the study participants are displayed in Table 1. Subjects in the food insecure group were more women, obese, and housewives, and had lower education status in comparison to those in the food secure group. Intakes of energy, protein, carbohydrate, fat, SFA, MUFA, PUFA, fiber, whole grains, fruits, dark vegetables, low fat dairy, and simple sugar was not significantly differed between the food secure and insecure groups (P>0.05, Table 2).

Table 1. The comparison of participants characteristics according to food insecurity status

Characteristics	Food secure group (n=97)	Food insecure group (n=103)	*P*-value
Men	51.5	35.0	0.02
Age groups (years)			
40-49	53.5	42.7	0.14
50-59	25.8	40.8	
60-69	18.6	13.6	
≥ 70	2.1	2.9	
Body mass index			
Normal	19.8	15.6	0.05
Overweight	53.1	40.8	
Obesity	27.1	43.6	
Education			
< 12 years	27.8	50.5	<0.001
Diploma	38.2	38.8	
Academic	34.0	10.7	
Marital status			
Single	7.2	1.9	0.06
Married	83.5	83.5	
Divorced	9.3	14.6	
Occupation			
Employed	50.5	35.0	0.007
Housewives	27.9	49.5	
Retired	21.6	15.5	
Smokers	15.4	7.7	0.10

Table 2. The comparison of dietary intakes according to food insecurity status

Dietary intakes	Food secure group (n=97)	Food insecure group (n=103)	*P*-value
Energy intake (kcal)	2220±547	2093±565	0.2
Protein (% of energy intake)	16.4±13.2	15.9±10.6	0.4
Carbohydrate (% of energy intake)	54.3±13.6	54.62±11.2	0.5
Fat (% of energy intake)	29.2±7.6	29.5±7.0	0.5
SFA (% of energy intake)	10.0±5.1	9.9±4.5	0.7
PUFA (% of energy intake)	10.0±5.8	11.1±6.2	0.2
MUFA (% of energy intake)	6.2±3.9	5.9±3.7	0.3
Fiber (g/1000kcal)	19.2±7.2	17.8±6.9	0.2
Whole grain (g/1000kcal)	49.6±12.8	41.4±12.4	0.3
Fruit (g/1000kcal)	135.3±28.2	124.2±24.9	0.4
Dark vegetable (g/1000kcal)	156.3±36.2	144.6±33.1	0.4
Low fat dairy (g/1000kcal)	106±19.3	96.2±18.6	0.3
Simple sugar (g/1000kcal)	144.3±32.2	151±34.1	0.4

Individual dietary diversity had the highest score in the fruit group (1.58 ± 0.64) and the lowest score in the meat and alternative group (0.25±0.32). Significant inverse correlations were observed between the scores for food security and diversity of fruits (r=-0.201, *P*=0.004), and vegetables (r=-0.141, *P*=0.046), and total diversity (r=-0.176, *P*=0.012).

The food secure group had significantly higher total IDDS (4.74 ±1.40 vs. 5.15±1.28, *P*=0.033) and diversity of fruits (1.48±1.40 vs.1.68±1.28, *P*=0.030) comparing to food insecure group (Figure 1).

In multivariable linear regression models, food security score displayed a significant inverse association with total IDDS, diversity of fruits, and vegetables (Table 3). Higher food security score was associated with lower total IDDS (regression coefficient for a 1-unit difference in diversity score = -0.177, *P*=0.012), diversity of fruits (regression coefficient for a 1-unit difference in diversity score = -0.198, *P*=0.005), and vegetables (regression coefficient for a 1-unit difference in diversity score =-0.146, *P*=0.040). After adjusting for sex, age, BMI, energy intake, occupation, and marital status, the regression coefficients were significant for total IDDS (regression coefficient for a 1-unit difference in diversity score = -0.130, *P* = 0.040) and diversity of fruits (regression coefficient for a 1-unit difference in diversity score = -0.182, *P* = 0.010) (Table 3).

Table 3. Multivariable linear regression results with food security score as a dependent variable

	Standardized β (*P*-value)	R^2
Total		
Model 1	-0.177 (0.012)	0.031
Model 2	-0.130 (0.040)	0.350
Bread and cereals		
Model 1	0.067 (0.350)	0.004
Model 2	0.108 (0.143)	0.114
Vegetables		
Model 1	-0.146 (0.040)	0.021
Model 2	-0.118 (0.094)	0.195
Fruits		
Model 1	-0.198 (0.005)	0.039
Model 2	-0.182 (0.010)	0.200
Meat and substitutes		
Model 1	-0.120 (0.090)	0.014
Model 2	-0.014 (0.567)	0.148
Dairy		
Model 1	-0.060 (0.403)	0.004
Model 2	-0.054 (0.451)	0.158

Model 1: Crude
Model 2: Adjusted models; data were controlled for the following factors: age (continuous), sex (men, women), BMI (continuous), energy intake (continuous), occupation (employed, homemakers, retired), marital status (single, married, divorced), education (≤ 11th grade, high school graduate, academic graduate), and smoking status (smokers, non-smokers).

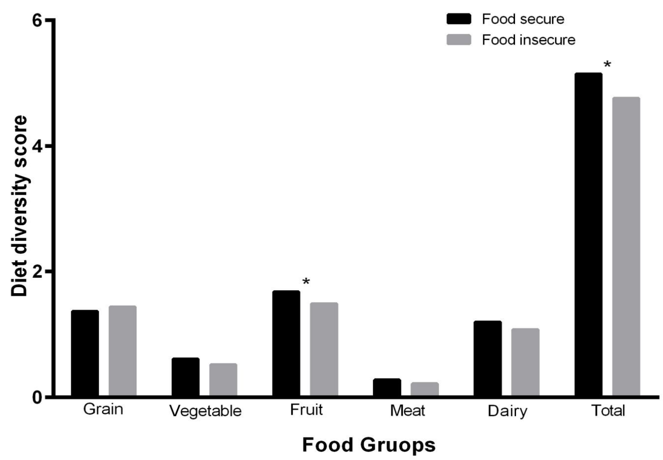

Figure 1. Mean and statndard deviation of total dietary diversity score and diversity score of food groups between the food secure and insecure groups of non-diabetic Tehranian adults.
Student *t* test was used to compare between the two groups. * P < 0.05

Discussion

In the current study conducted on a group of healthy Tehranians, there was an inverse relationship between food security score and dietary diversity score. The subjects whose diets had more diversity were likely to have more food security, and intake of varied fruits was associated with higher food security status.

In the current study, none of the macro- and micro-nutrients and food group intakes showed an association with food security. Regarding the macro-nutrients, contradictory findings have been reported. Households with children (aged 5-12 years) showed an inverse association between protein and food security (38); however, Champagne *et al*. did not observe an association between carbohydrates and protein with food security (39). Fat consumption was higher in households with food security than in households without it (40). On the other hand, studies on the association between food group intakes and dietary patterns and food security showed consistent results. For example, lower intake of fruits, vegetables, and meat (6, 9) and higher intake of fruit juices (3) are related to food insecurity. Dietary patterns with higher intake of fat and refined carbohydrates, and small amount of fruits, vegetables and whole grains, fish and chicken have been observed in food insecure households (41). Drewnowski *et al.* also observed that food insecure households had more priority to purchase unhealthy foods like refined grains, added sugars or fats, which are high-calorie and low-nutrient content foods (42). This intake pattern may lead to lower intake of expensive and healthier foods, such as lean meats, fish, fresh vegetables and fruits. It is probable that the association between food security and cardiovascular disease and its risk factors can be defined by the impact of food insecurity in selecting unhealthy dietary patterns. Similarly, food security has been studied in Iran in relation to dietary patterns and food group intakes; mean frequency of bread and potato intake was significantly higher in the food insecure group than in the food secure group, and mean frequency of rice, vegetables, fruits, meat and dairy products intake was significantly lower in the food insecure group than in the food secure group (43).

The individual dietary diversity score has been proposed as a proxy measure of food security (26), and has been associated with nutrient adequacy and increasing probability of cardiovascular risk factors (44-46). However, studies on the association between dietary diversity and food security are scarce. In this regard, valid and reliable indicators of dietary diversity that accurately predict individual nutrient adequacy in a variety of population groups and settings are needed (47). In the current study, an inverse association between total variety and fruit variety with food security was observed. Individual dietary diversity and food insecurity are both associated with the socio-economic level of households. Several studies have shown the inverse relationship between food insecurity and average household income (11, 38), food prices (48, 49), maternal education (50), and unemployment (51). Furthermore, in Iran, food insecurity was related to household income, educational level of the head of household, and mother's educational level (43, 52). Individual dietary diversity was also associated with socio-economic status, including maternal education level (53) and food price (54). It is, hence, evident that dietary diversity and food security have underlying factors, which have effects on both simultaneously. The potential of household-level dietary diversity indicators to accurately reflect household food security and overall socioeconomic status needs to be confirmed. Specific indicators will need to be developed for each of these purposes, but in both cases, it will be necessary to address the various measurement issues identified in this review.

Our study has several noteworthy limitations. Firstly, our cross-sectional study does not answer the question of which event is primary, that is whether food security precedes an increase of dietary diversity, or vice versa. Secondly, since the number of participants was low, the association of different levels of food insecurity with dietary diversity could not be studied. Finally, cross-sectional design of the study could not identify the long time or transit households' food insecurity. However, the strength of the present study is its reliance on a sample of subjects from a large community-based prospective cohort study of general population (TLGS), so the current findings could be generalized to general population in Tehran.

Conclusion: The results of the present study imply that dietary diversity, specifically the variety of 'fruits and vegetables' as an indicator of healthy nutrition is associated with food security. Low dietary diversity indicates potential risk for food insecurity. The household food insecurity status can be determined accurately through the measurement of food diversity proxies. Therefore, to develop appropriate policy and program options, the association between food security and diet diversity is important for researchers and policy makers, as well as governmental and non-governmental agencies.

Acknowledgements

The authors wish to acknowledge Ms. Niloofar Shiva for critical editing of English grammar and syntax of the manuscript.

Financial disclosure

We have no financial relationships relevant to this article, nor do we have conflicts of interest to disclose.

Funding/Support

This work was funded by the Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, I.R. Iran.

References

1. Bickel G, Nord M, Price C, Hamilton W, Cook J. Guide to measuring household food security. Alexandria Department of Agriculture Food and Nutrition Service. 2000.
2. Coleman-Jensen A, Nord M, Andrews M, Carlson S. Household food security in the United States in 2010. USDA-ERS Economic Research Report. 2011(125).
3. Mello JA, Gans KM, Risica PM, Kirtania U, Strolla LO, Fournier L. How is food insecurity associated with dietary behaviors? An analysis with low-income, ethnically diverse participants in a nutrition intervention study. J Am Diet Assoc. 2010;110(12):1906-11.
4. Drewnowski A, Specter SE. Poverty and obesity: the role of energy density and energy costs. Am J Clin Nutr. 2004;79(1):6-16. Epub 2003/12/20.
5. Mohammadzadeh A, Dorosty A, Eshraghian M. Household food security status and associated factors among high-school students in Esfahan, Iran. Public health nutrition. 2010;13(10):1609-13.
6. Tarasuk VS. Household food insecurity with hunger is associated with women's food intakes, health and household circumstances. J Nutr. 2001;131(10):2670-6. Epub 2001/10/05.
7. Bhattacharya J, Currie J, Haider S. Poverty, food insecurity, and nutritional outcomes in children and adults. J Health Econ. 2004;23(4):839-62.
8. Dixon LB, Winkleby MA, Radimer KL. Dietary intakes and serum nutrients differ between adults from food-insufficient and food-sufficient families: Third National Health and Nutrition Examination Survey, 1988-1994. J Nutr. 2001;131(4):1232-46.
9. Kendall A, Olson CM, Frongillo EA, Jr. Relationship of hunger and food insecurity to food availability and consumption. J Am Diet Assoc. 1996;96(10):1019-24; quiz 25-6.
10. Nelson K, Cunningham W, Andersen R, Harrison G, Gelberg L. Is food insufficiency associated with health status and health care utilization among adults with diabetes? J Gen Intern Med. 2001;16(6):404-11.
11. Townsend MS, Peerson J, Love B, Achterberg C, Murphy SP. Food insecurity is positively related to overweight in women. J Nutr. 2001;131(6):1738-45.
12. Alaimo K, Olson CM, Frongillo EA, Jr. Low family income and food insufficiency in relation to overweight in US children: is there a paradox? Arch Pediatr Adolesc Med. 2001;155(10):1161-7.
13. Holben DH, Pheley AM. Diabetes risk and obesity in food-insecure households in rural Appalachian Ohio. Prev Chronic Dis. 2006;3(3):A82.
14. Armour BS, Pitts MM, Lee CW. Cigarette smoking and food insecurity among low-income families in the United States, 2001. Am J Health Promot. 2008;22(6):386-92.
15. Vandevijvere S, De Vriese S, Huybrechts I, Moreau M, Van Oyen H. Overall and within-food group diversity are associated with dietary quality in Belgium. Public health nutrition. 2010;13(12):1965-73.
16. Drewnowski A, Henderson SA, Driscoll A, Rolls BJ. The Dietary Variety Score: assessing diet quality in healthy young and older adults. J Am Diet Assoc. 1997;97(3):266-71.
17. Oldewage-Theron W, Kruger R. Dietary diversity and adequacy of women caregivers in a peri-urban informal settlement in South Africa. Nutrition. 2011;27(4):420-7.
18. Azadbakht L, Mirmiran P, Esmaillzadeh A, Azizi F. Dietary diversity score and cardiovascular risk factors in Tehranian adults. Public health nutrition. 2006;9(6):728-36.
19. Jayawardena R, Byrne NM, Soares MJ, Katulanda P, Yadav B, Hills AP. High dietary diversity is associated with obesity in Sri Lankan adults: an evaluation of three dietary scores. BMC Public Health. 2013;13:314.
20. Mohammadi F, Omidvar N, Houshiar-Rad A, Khoshfetrat MR, Abdollahi M, Mehrabi Y. Validity of an adapted Household Food Insecurity Access Scale in urban households in Iran. Public health nutrition. 2012;15(1):149-57.
21. Barrett CB. Measuring food insecurity. Science. 2010;327(5967):825-8.
22. Thorne-Lyman AL, Valpiani N, Sun K, Semba RD, Klotz CL, Kraemer K, et al. Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. The Journal of Nutrition. 2010;140(1):182S-8S.
23. Bernstein MA, Tucker KL, Ryan ND, O'Neill EF, Clements KM, Nelson ME, et al. Higher dietary variety is associated with better nutritional status in frail elderly people. J Am Diet Assoc. 2002;102(8):1096-104.
24. Lee MS, Huang YC, Su HH, Lee MZ, Wahlqvist ML. A simple food quality index predicts mortality in elderly Taiwanese. J Nutr Health Aging. 2011;15(10):815-21.
25. Marshall TA, Stumbo PJ, Warren JJ, Xie XJ. Inadequate nutrient intakes are common and are associated with low diet variety in rural, community-dwelling elderly. J Nutr. 2001;131(8):2192-6.
26. Lo Y-T, Chang Y-H, Lee M-S, Wahlqvist ML. Dietary diversity and food expenditure as indicators of food security in older Taiwanese. Appetite. 2012;58(1):180-7.
27. Swindale A, Bilinsky P. Household dietary diversity score (HDDS) for measurement of household food access: indicator guide. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development. 2006.
28. Azizi F, Rahmani M, Emami H, Mirmiran P, Hajipour R, Madjid M, et al. Cardiovascular risk factors in an Iranian urban population: Tehran lipid and glucose study (phase 1). Soz Praventivmed. 2002;47(6):408-26.

29. Azizi F, Ghanbarian A, Momenan AA, Hadaegh F, Mirmiran P, Hedayati M, et al. Prevention of non-communicable disease in a population in nutrition transition: Tehran Lipid and Glucose Study phase II. Trials. 2009;10:5.
30. Mirmiran P, Esfahani FH, Mehrabi Y, Hedayati M, Azizi F. Reliability and relative validity of an FFQ for nutrients in the Tehran lipid and glucose study. Public health nutrition. 2010;13(5):654-62.
31. Esfahani FH, Asghari G, Mirmiran P, Azizi F. 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(2):150-8.
32. Asghari G, Rezazadeh 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(6):1109-17.
33. Ghaffarpour M, Houshiar-Rad A, Kianfar H. The manual for household measures, cooking yields factors and edible portion of foods. Tehran: Nashre Olume Keshavarzy. 1999:1-40.
34. Azar M, Sarkisian E. Food composition table of Iran. Tehran: National Nutrition and Food Research Institute, Shaheed Beheshti University. 1980;65.
35. Haines PS, Siega-Riz AM, Popkin BM. The Diet Quality Index revised: a measurement instrument for populations. J Am Diet Assoc. 1999;99(6):697-704.
36. Rafiei M, Nord M, Sadeghizadeh A, Entezari MH. Assessing the internal validity of a household survey-based food security measure adapted for use in Iran. Nutr J. 2009;8:28.
37. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care. 2003;26 Suppl 1:S5-20.
38. Isanaka S, Mora-Plazas M, Lopez-Arana S, Baylin A, Villamor E. Food insecurity is highly prevalent and predicts underweight but not overweight in adults and school children from Bogota, Colombia. J Nutr. 2007;137(12):2747-55.
39. Champagne CM, Casey PH, Connell CL, Stuff JE, Gossett JM, Harsha DW, et al. Poverty and food intake in rural America: diet quality is lower in food insecure adults in the Mississippi Delta. J Am Diet Assoc. 2007;107(11):1886-94.
40. Melgar-Quinonez HR, Zubieta AC, MkNelly B, Nteziyaremye A, Gerardo MF, Dunford C. Household food insecurity and food expenditure in Bolivia, Burkina Faso, And the Philippines. J Nutr. 2006;136(5):1431S-7S.
41. van Dam RM, Rimm EB, Willett WC, Stampfer MJ, Hu FB. Dietary patterns and risk for type 2 diabetes mellitus in U.S. men. Ann Intern Med. 2002;136(3):201-9.
42. Drewnowski A, Darmon N. The economics of obesity: dietary energy density and energy cost. Am J Clin Nutr. 2005;82(1 Suppl):265S-73S.
43. Zerafati Shoae N, Omidvar N, Ghazi-Tabatabaie M, Houshiar Rad A, Fallah H, Mehrabi Y. Is the adapted Radimer/Cornell questionnaire valid to measure food insecurity of urban households in Tehran, Iran? Public health nutrition. 2007;10(8):855-61.
44. Mirmiran P, Azadbakht L, Azizi F. Dietary diversity within food groups: an indicator of specific nutrient adequacy in Tehranian women. J Am Coll Nutr. 2006;25(4):354-61.
45. Azadbakht L, Mirmiran P, Azizi F. Dietary diversity score is favorably associated with the metabolic syndrome in Tehranian adults. Int J Obes (Lond). 2005;29(11):1361-7.
46. Azadbakht L, Mirmiran P, Azizi F. Variety scores of food groups contribute to the specific nutrient adequacy in Tehranian men. Eur J Clin Nutr. 2005;59(11):1233-40.
47. Ruel MT. Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. Food Nutr Bull. 2003;24(2):231-2.
48. Zhang Q, Jones S, Ruhm CJ, Andrews M. Higher Food Prices May Threaten Food Security Status among American Low-Income Households with Children. J Nutr. 2013.
49. Martin-Prevel Y, Becquey E, Tapsoba S, Castan F, Coulibaly D, Fortin S, et al. The 2008 food price crisis negatively affected household food security and dietary diversity in urban Burkina Faso. J Nutr. 2012;142(9):1748-55.
50. Ben-Davies ME, Kinlaw A, Estrada Del Campo Y, Bentley ME, Siega-Riz AM. Risk factors associated with the presence and severity of food insecurity in rural Honduras. Public health nutrition. 2013:1-9.
51. Pardilla M, Prasad D, Suratkar S, Gittelsohn J. High levels of household food insecurity on the Navajo Nation. Public health nutrition. 2013:1-8.
52. Dastgiri S, Mahdavi R, TuTunchi H, Faramarzi E. Prevalence of obesity, food choices and socio-economic status: a cross-sectional study in the north-west of Iran. Public health nutrition. 2006;9(8):996-1000.
53. Nguyen PH, Avula R, Ruel MT, Saha KK, Ali D, Tran LM, et al. Maternal and child dietary diversity are associated in Bangladesh, Vietnam, and Ethiopia. J Nutr. 2013;143(7):1176-83.
54. Thorne-Lyman AL, Valpiani N, Sun K, Semba RD, Klotz CL, Kraemer K, et al. Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. J Nutr. 2010;140(1):182S-8S.