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Developing and Assessing the Validity and Reliability of an Iranian Food Security Questionnaire

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Abstract

Background: Food insecurity has a considerable impact on the social, physical, and psychological well-being of people and there is no food security assessment tool specific for Iranians. This study aimed to develop and assess the validity and reliability of an Iranian-specific food security questionnaire.

Methods: The food security questionnaire was developed by five food security specialists by evaluating all available questionnaires (not specific to Iranians) in terms of applicability to Iranians. Furthermore, questions were developed from interviews conducted with ten families who were below the poverty threshold to understand how they described their food status. This questionnaire was administered to 200 households from different parts of Isfahan, Iran. Households were selected by multi-stage cluster randomized sampling. Households were categorized into 4 groups based on their score on the questionnaire; food secure (total score 0), mildly (total score 1–2), moderately (total score 3–7) and severely food insecure (total score 8–18). In the second stage of the study, 25 households were selected from each food security status group to evaluate the reliability and validity of the questionnaire by assessing sociodemographic, anthropometric, nutritional and biochemical parameters.

Results: The prevalence of food security and mildly, moderately and severely food insecure were 24%, 33%, 27% and 16%, respectively. Content and face validity of the questionnaire was evaluated by experts, and latent class analysis confirmed construct validity. The developed questionnaire had good internal consistency (Cronbach's $\alpha = 0.91$) and showed significant differences in hypothesized directions in food security status for sociodemographic factors. The prevalence of mothers, but not fathers or children, who had hemoglobin, mean corpuscular volume (MCV) and hematocrit less than the normal ranges increased ($P = 0.04$, $P = 0.02$, $P = 0.02$; respectively) with food insecurity.

Conclusion: Our findings indicated that the developed questionnaire was a valid and reliable instrument to measure household food insecurity of Iranian families.

Keywords: Food security, Questionnaire development, Reliability, Validity

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Introduction

Food security is defined as the sufficient and culturally appropriate access to enough food by all people, at all times, to allow for a healthy lifestyle.[1,2] Food insecurity occurs in four stages: (*i*) anxiety about food, (*ii*) reductions in food variety and quality, (*iii*) reductions in the amount of food consumed at meals, (*iv*) hunger and/or consistently missing meals.[3] As of 2016, 815 million people worldwide were chronically food insecure and malnourished.[4] Many factors influence the risk of food insecurity, including: age, education, household income, job loss, unemployment, number of parents, ethnicity and household size.[2,3,4-9] Due to persisting gender inequalities, women on average are at higher risk of being food insecure compared to men.[10] In Iran, a recent systematic review showed that 49% of households were food insecure, with the prevalence of food insecurity in children and mothers being 67% and 61%, respectively.[11]

Since food insecurity affects physical, social and psychological health, properly assessing and monitoring food security status is important.[8] There are numerous questionnaires to measure food security, including Radimer/Cornell, the household food insecurity access scale (HFIAS), and the US household food security survey model (US-HFSSM).[12-15] To date, several studies have been conducted to evaluate reliability and validity of these questionnaires in different countries.[16-25] These developed questionnaires may have cross-cultural validity,

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as demonstrated by studies in Ethiopia,[16] Tanzania[17] and Caribbean communities.[18] However, it has been strongly recommended that questionnaires should be developed taking into consideration cultural and societal differences, so as to maximize the accuracy of the questionnaire.[13]

To the best of our knowledge, there is no study which has validated a food security questionnaire specific for Iranians. Previous food security studies in Iran have used more general questionnaires, such as the Radimer/Cornell,[22] HFIAS[20,23] and US-HFSSM questionnaires.[25] Thus, the objective of the present study was to develop and evaluate the validity and reliability of an Iranian-specific food security questionnaire.

Materials and Methods

Food Insecurity Questionnaire Development

An Iranian food security questionnaire with 18 questions was developed (Table 1) by first having five food security experts evaluate questions from the Radimer/Cornell, HFIAS and US-HFSSM food security questionnaires for applicability to the Iranian context. To further refine the questionnaire, in collaboration with the Komiteh Emdad Imam Khomeini (KEIK), interviews were conducted with 10 Iranian families living in poverty, to properly understand how the families describe their food status in Iran. As shown in Table 1, there were subscales of the questionnaire for the household (4 questions) children (7 questions) and adults (7 questions). Lastly, face and content validity were assessed through having five nutritionists complete the food security questionnaire.

Study Population and Sampling

For this cross-sectional study, 200 households from the city of Isfahan were selected by multistage cluster random sampling. This sample size was chosen based on the rationale of 10 households being selected per question of the questionnaire. In the first stage of cluster random sampling, all of the health centers in each of the urban geographic regions (North, South, East, West, and Central) were identified and an equal number of health centers from each region were randomly selected. From the randomly selected health centers, 40 households were selected in each geographic region through a systematic random sampling method. Household selection criteria were being of Iranian descent, non-immigrant and having at least one child.

Based on the scores obtained from the responses to the questionnaire, households were categorized into four categories based on the criteria of the US-HFSSM questionnaire[15]:

1. A food secure household was defined as answering 'never' or 'no' for all items on the questionnaire.
2. Households with mild food insecurity were defined as answering one to two questions with any of the following: 'yes', 'most days in months', 'several days per month', 'most days in some months', 'a few days in some months', 'some months but not every month', 'every month', 'only for one to two months', 'often', 'sometimes' or 'rarely'.
3. Moderate food insecurity for a household was defined as answering three to seven questions with one of the above listed answers in category 2.
4. Households with severe food insecurity were defined as answering eight to eighteen questions with one of the above listed answers in category 2.

Table 1. Iranian Food Security Questionnaire Items

Question (during last year)
Household item
Q1. I have been worried that food runs out before I have enough money in my hand. (agree, quite agree, never)
Adult items
Q2. I couldn't afford to eat enough foods from all the food groups (dairy, bread & cereals, vegetables, fruits, meat). (agree, quite agree, never)
Q3. Did (you/ other adults in your household) cut the size of your meals or skip meals because there wasn't enough money for food? (yes, no)
Q4. [if yes above] How often did this happen? (most days per month, several days per month, most days in only some months, a few days in only some months)
Q5. Did you ever eat less or go hungry because there wasn't enough money to buy food? (yes, no,)
Q6. Did you lose weight because there wasn't enough money to buy food? (yes, no)
Q7. Did (you/ other adults in your household) ever not eat for a whole day because there wasn't enough money for food? (yes, no,)
Q8. [if yes above] How often did this happen? (some months but not every month, every month, only for one to two months)
Child items
Q9. We prepared only a limited number of low-cost food to feed our children, due to lack of money. (often, sometimes, never)
Q10.We couldn't provide a balanced and adequate meal to our children, due to lack of money. (often, sometimes, never)
Q11. Did you ever cut off your child's meals because there wasn't enough money for food? (yes, no)
Q12. Did your child ever skip meals because there wasn't enough money for food? (yes, no)
Q13. [if yes above] How often did this happen? (some months but not every month, every month, only for one to two months)
Q14. Have your children ever not had any food to eat? (yes, no)
Q15. Did your children ever not eat for a whole day because there wasn't enough money? (yes, no)
Household items
Q16. Did you or one of your family members eat the same food for several days in a row because there wasn't enough money? (often, sometimes, rarely, never)
Q17. Did you or one of your family members only eat bread because there wasn't enough money? (often, sometimes, rarely, never)
Q18. Did you buy your food on credit because there wasn't enough money? (often, sometimes, rarely, never)

Demographics, Nutrient Intake and Anthropometrics

After a month, 25 households were randomly selected from each of the above 4 categories of food security (100 households total). Adults in these households then completed questionnaires evaluating socio-economic and demographic characteristics including: income, education, family size, number of children, number of employed people in the home, occupations, head of household, sex and age of the head of household, renting or owning the residence, the number of rooms in the residence and the food costs of the household in a month. To evaluate the food and nutrient consumption of each household, a 168-question Iranian validated food frequency questionnaire (FFQ) was used.[26] Using a scale and a measuring tape, weight and height for each member of the household was measured following the International Standards for Anthropometric Assessment.[28] In this study, for households with more than one child, the first child was considered as representative of the other children in the household.

Biochemical Measures

During malnutrition, total serum protein and several complete blood count (CBC) factors including white blood cells (WBC), platelets and albumin were below healthy ranges.[27] Therefore, CBC and serum albumin were measured for all individuals in each household. To assess CBC, 2 mL venous blood samples were taken into vacutainer tubes containing EDTA anticoagulant, and all hematologic indices were analyzed by Sysmex® Hematology instrument (Kobe, Japan). Serum albumin was determined in whole blood using a fluorescence immunoassay. The values obtained were compared with healthy concentration ranges based on age and sex.[28,29]

Statistical Analysis

Data were coded and entered into SPSS 16.0 (SPSS Inc. Chicago, USA). Assessment of external and internal reliability was conducted. For external reliability, the degree of concordance for the household's responses between the two times of completing the questionnaire were compared by Kappa coefficient. For internal reliability, internal consistency was assessed using Cronbach's alpha (95% CI), and intraclass correlation coefficients (ICC). Cronbach's alpha (95% CI) was also calculated for each of the subscales (household, adults and children) of the questionnaire.

Validity was assessed in four areas: face validity, content validity, construct validity and criteria validity. Face and content validity were assessed through offering questionnaire to five nutritionists. Construct validity was evaluated with the entire sample of 200 households through latent class analysis (LCA). Criterion validity was assessed by ranking the 100 households (25 households from each food security category) based on the socio-demographic questionnaire, FFQ, cost of food questionnaire, anthropometrics and the biochemical measures.

One-way ANOVA was used to test for differences among the household food security statuses for the daily consumption of food groups and nutrients. Differences in biochemical measures and sociodemographic variables among food security statues were assessed using a chi-square test.

Results

As shown in Figure 1, 24% of households were food secure and 33%, 27% and 16% had mild, moderate and severe food insecurity, respectively. The average household size was 5. The mean±SD age of father was 44.7 ± 8.8, and for mother and first child were 40.4 ± 8.2 years and 16.0 ± 7.4 years, respectively. Girls represented 55% of first born.

Affirmative responses of 200 households to the eighteen food insecurity items ranged from 2.5% to 57.5% (Table 2). The questions with the greatest proportion and least proportion of affirmative answers was question 1 ('I have been worried that food runs out before I have enough money in my hand.') and question 15 ('Did your children ever not eat for a whole day because there wasn't enough money?'), respectively.

Face and content validity were assessed through offering questionnaire to five nutritionists. Some experts had minor corrective comments which was applied to the questionnaire. To evaluate construct validity, latent class analysis (LCA) was used. Table 3 presents the constructed classes and distribution of participants' responses to different questions of the developed questionnaire in each class. The entire sample (200 households) was divided into 4 classes: food secure, mild food insecurity, moderate food insecurity and severe food insecurity.

Criterion-Related Validity

The FFQ showed that daily consumptions of vegetable, fruit, meat, and sweets in households (father, mother and first child) was inversely associated with food insecurity.

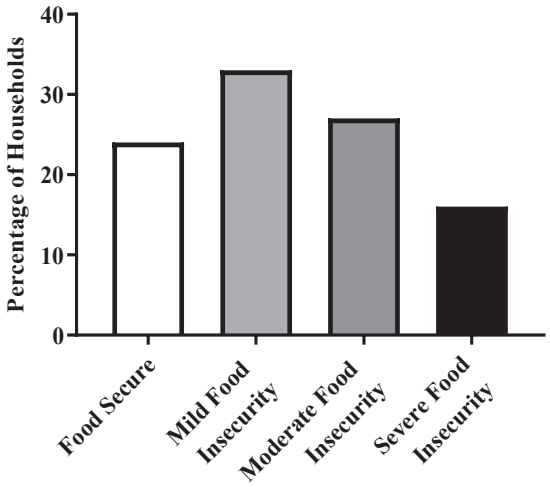

Figure 1. Percentage of Households in Each Food Security Category (N = 200 households).

Table 2. Affirmative Responses to Items on the Iranian Food Security Questionnaire (n = 200 households)

Question (During Last Year)	No. (%)
Q1. I have been worried that food runs out before I have enough money in my hand.	115 (57.5)
Q2. I couldn't afford to eat enough foods from all the food groups (dairy, bread & cereals, vegetables, fruits, meat).	109 (54.5)
Q3. Did (you/ other adults in your household) cut the size of your meals or skip meals because there wasn't enough money for food?	41 (20.5)
Q4. [if yes above] How often did this happen?	41 (20.5)
Q5. Did you ever eat less or go hungry because there wasn't enough money to buy food?	50 (25)
Q6. Did you lose weight because there wasn't enough money to buy food?	24 (12)
Q7. Did (you/ other adults in your household) ever not eat for a whole day because there wasn't enough money for food?	8 (4)
Q8. [if yes above] How often did this happen?	7 (3.5)
Q9.We prepared only a limited number of low-cost food to feed our children, due to lack of money.	59 (29.5)
Q10. We couldn't provide a balanced and adequate meal to our children, due to lack of money.	51 (25.5)
Q11. Did you ever cut off your child's meals because there wasn't enough money for food?	19 (9.5)
Q12. Did your child's ever skip meals because there wasn't enough money for food?	14 (7)
Q13. [if yes above] How often did this happen?	16 (8)
Q14. Have your children ever not had any food to eat?	12 (6)
Q15. Have your children ever not to eaten for a whole day because there was not enough money?'	5 (2.5)
Q16. Did you or one of your family members eat same food for several days in a row because there wasn't enough money?	82 (41)
Q17. Did you or one of your family members only eat bread because there wasn't enough money?	41 (20.5)
Q18. Did you give your food on credit because there wasn't enough money?	64 (32)

"Agree" and ''quite agree'' are affirmative response to questions 1 and 2; yes is the affirmative response to question 3, 5, 6, 7, 11, 12, 14 and 15;'most days per month', 'several days per month', 'most days in only some months', 'a few days in only some months', 'some months but not every month', 'every month' and 'only for one to two months 'are affirmative response to questions 4, 8 and 13; ''often'', 'sometimes' and' rarely' are affirmative response to questions 9 ,10, 16, 17 and 18.

Consumption of bread and cereals by mothers and fathers was lower in food-secure households than in food-insecure households. Daily intakes of legumes, nuts and dairy products by mothers and the first child in families was positively associated with food security (Table 4). Mean intakes of vitamin C and zinc in households (father, mother and first child) and mean intake of iron in mothers were inversely associated with food insecurity, but carbohydrate and thiamin intake in fathers and mothers was positively associated with food insecurity (Table 5).

The assessment of biochemical parameters (Table 6) showed that with increasing food insecurity, the number of mothers who had hemoglobin, hematocrit and MCV less than normal values increased ($P = 0.04$, $P = 0.02$, $P = 0.02$; respectively). Other biochemical parameters did not show any significant differences among food security categories. None of biochemical parameters showed significant differences among food security categories for fathers or for the first child in each family (Table 6).

Table 7 depicts the relationship between socio-demographic factors, body mass index (BMI) and the developed food security questionnaire. The number of rooms, number of cars, and number of computers all significantly differed based on food security status ($P \leq 0.001$), with food secure families having greater numbers of each. Food secure families also spent significantly more money on food ($P \leq 0.001$) and had smaller household size, more employed persons, higher monthly income and higher education level of both parents. Also with worsening food security status, the prevalence of underweight in the households (mother, father and first child) significantly increased, while the prevalence of overweight and obesity decreased.

External and Internal Reliability

To examine external reliability, we examined the test-retest correlation coefficients between respondent scale measures by Kappa coefficient (>0.7 was acceptable, maximum = 1). There was a strong correlation between the first and the second time completing the food security questionnaire (Table 8). The findings of this evaluation had a Cronbach's α of 0.91 and the sum of ICC was 0.97, which showed high internal consistency for the questionnaire. Cronbach's α for the household subscale was 0.78 (n = 4 items), for the adult subscale was 0.86 (n = 7 items) and for child subscale was 0.87 (n = 7 items).

Discussion

This is the first study to develop a food security questionnaire specific to Iranians. The developed food security questionnaire was shown to have content and face validity. Criterion-related validity showed that the households in different food security categories differed based on income strata, the mean daily intake of nutritious foods (legumes, vegetable, fruit, meat, dairy product and nut), cost of food per month and other socio-economic characteristics. Based on biochemical parameters, mothers may be more affected by household food insecurity than fathers or children. Lastly, the questionnaire was shown to have strong internal and external reliability. Findings from this study highlight that the developed food security questionnaire has potential as a simple and cost-effective tool for the assessment of severity

Table 3. The Percentage of Participant Responses in Each Food Security Category to Questions of the Food Security Questionnaire (n = 200)

	Classes (Class Size)			
Questions	**Food Secure (%) (n=50)**	**Mild Food Insecurity (%) (n=50)**	**Moderate Food Insecure (%) (n=50)**	**Severe Food Insecurity (%) (n=50)**
Q1				
-	59	0	12	15
+	40	99	87	84
Q2				
-	65	0	19	0
+	34	99	80	99
Q3				
-	99	1	99	8
+	0	98	0	91
Q4				
-	99	1	99	8
+	0	98	0	91
Q5				
-	87	29	95	19
+	12	70	4	80
Q6				
-	99	82	88	31
+	0	17	11	68
Q7				
-	99	94	99	73
+	0	5	0	26
Q8				
-	99	99	99	73
+	0	0	0	26
Q9				
-	95	87	0	0
+	4	12	99	99
Q10				
-	99	93	2	4
+	0	6	97	95
Q11				
-	99	99	96	31
+	0	0	3	68
Q12				
-	99	99	96	50
+	0	0	3	49
Q13				
-	99	99	96	42
+	0	0	3	57
Q14				
-	99	99	99	54
+	0	0	0	45
Q15				
-	80	80	99	99
+	19	19	0	0
Q16				
-	77	41	33	0
+	22	58	66	99
Q17				
-	98	76	60	4
+	1	23	39	95
Q18				
-	88	70	27	0
+	11	29	72	99

Table 4. The Daily Consumption (in grams) of Food Groups Among Fathers, Mothers and the First Child in Families in Each Food Security Status

Food Groups	Household Status								*P* Value
	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Father's									
Bread & cereals	279	73	303	64	327	58	331	66	0.021
Legumes	23	12	19	9	17	9	14	8	0.320
Vegetables	299	90	266	84	226	79	220	95	0.005
Fruit	291	184	173	75	173	117	159	104	<0.001
Meat	77	39	67	33	67	27	52	18	0.038
Eggs	14	12	15	10	16	9	14	13	0.799
Dairy products	314	139	310	126	255	154	224	138	0.069
Fats	17	15	18	23	16	22	22	30	0.819
Sugars	36	28	25	25	33	19	33	25	0.478
Sweets	40	57	18	9	27	29	16	14	0.046
Beverages	683	398	644	430	5	377	522	417	0.453
Nuts	16	22	7	8	6	4	9	11	0.053
Miscellaneous	54	42	62	58	63	39	49	25	0.634
Ice cream	35	64	24	21	34	44	12	13	0.177
Mother's									
Bread & cereals	278	77	295	72	299	55	335	79	0.021
Legumes	23	15	18	8	16	7	15	8	0.320
Vegetables	332	66	3170	77	257	111	225	83	0.005
Fruit	186	95	134	68	175	77	113	60	<0.001
Meat	95	35	89	19	77	26	45	19	0.038
Eggs	14	12	15	10	17	9	14	13	0.799
Dairy products	339	156	321	136	225	148	215	147	0.069
Fats	15	9	23	29	12	9	24	32	0.819
Sugars	28	15	28	16	28	15	27	14	0.478
Sweets	22	11	17	8	16	10	14	9	0.046
Beverages	586	352	524	316	546	141	536	407	0.453
Nuts	16	21	10	9	6	5	6	6	0.053
Miscellaneous	57	38	57	55	52	21	50	25	0.634
Ice cream	30	65	21	20	23	31	13	13	0.177
First child									
Bread & cereals	264	82	281	65	304	56	307	56	0.021
Legumes	28	15	19	8	18	12	15	10	0.320
Vegetables	304	81	240	66	215	63	211	54	0.005
Fruit	271	199	147	104	138	136	119	100	<0.001
Meat	90	41	86	100	55	25	40	21	0.038
Eggs	16	11	14	11	18	8	11	13	0.799
Dairy products	321	157	309	174	228	129	161	131	0.069
Fats	18	8	13	10	12	7	15	7	0.819
Sugars	22	18	23	17	20	18	16	14	0.478
Sweets	29	22	19	10	15	9	14	12	0.046
Beverages	629	361	592	311	722	376	480	234	0.453
Nuts	29	15	20	14	12	8	12	11	0.053
Miscellaneous	40	15	32	13	35	13	32	11	0.634
Ice cream	33	59	25	32	11	8	10	9	0.177

P values are from one-way ANOVAs, and *P* values <0.05 denote a significant effect of food insecurity on food group intake.

and prevalence of food insecurity in Iran.

Using LCA, this study separated households into four classes of food security. These classes (food secure, mild food insecurity, moderate food insecurity and severe food insecurity) have been well established in previous literature[24] to make distinctions around food security. Visual inspection highlighted that answers to questions from food secure category likely differed from the food insecure households. However, there were multiple questions where mild to severe food insecure households answered similarly. These questions included 'I have been worried that food runs out before I have enough money in my hand' and were questions that identified milder aspects of food insecurity. This means that it is expected that the vast majority of food insecure households would answer affirmatively to these questions. Overall, findings of this study showed that 24% of households were food secure, and this is similar to previous work in urban Iran which used the HFIAS (21%).[24] However, this

Table 5. The Daily Consumption of Nutrients Among Fathers, Mothers and the First Child in Families in Each Food Security Status

Nutrient	Household Status								*P* Value
	Food Secure		Mild Food Insecurity		Moderate Food Insecurity		Severe Food Insecurity		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Father's									
Protein (g)	71	14	67	12	6	11	62	9	0.46
Carbohydrate (g)	460	179	487	279	555	240	704	451	0.033
Iron (mg)	17.3	4.0	15.6	3.7	16.1	3.4	16.2	3.9	0.434
Zinc (mg)	9.1	2.2	8.1	1.4	7.5	1.5	7.4	1.8	0.006
Vitamin A (RE)	2010	902	2063	729	1837	632	1848	661	0.648
Vitamin C (mg)	304	138	203	95	203	96	174	64	<0.001
Thiamin (mg)	1.3	0.5	1.4	0.3	1.6	0.3	1.6	0.4	0.43
Mother's									
Protein (g)	67	18	62	15	63	12	59	12	0.263
Carbohydrate (g)	342	186	383	178	581	197	620	282	<0.001
Iron (mg)	17.5	3.3	15.2	4.4	14.9	4.3	13.4	4.3	0.008
Zinc (mg)	8.3	2.7	8.1	1.9	7.8	1.8	7.1	1.7	0.051
Vitamin A (RE)	2034	765	1714	650	1782	815	1582	624	0.176
Vitamin C (mg)	215	111	164	94	150	72	136	90	0.023
Thiamin (mg)	1.2	0.3	1.2	0.4	1.2	0.3	1.6	0.4	0.002
First child									
Protein (g)	55	12	53	12	51	16	51	12	0.779
Carbohydrate (g)	451	201	370	201	452	210	546	268	0.073
Iron (mg)	12.6	2.9	13.4	3.3	13.1	3.2	12.4	3.2	0.668
Zinc (mg)	8.3	2.6	7.0	2.1	5.9	1.9	5.6	1.7	<0.001
Vitamin A (RE)	1567	580	1431	567	1367	443	1184	394	0.089
Vitamin C (mg)	188	92	124	82	107	51	101	47	<0.001
Thiamin (mg)	1.2	0.3	1.1	0.2	1.2	0.3	1.3	0.3	0.081

P values are from one-way ANOVA, and *P* values < 0.05 denote a significant effect of food insecurity on food group intake.

proportion differs from the recent meta-analysis studies in Iran showing food insecurity was on average 49% (95% CI: 40–59%).[11] Interestingly, the prevalence of food insecurity in the review paper was influenced by both the study year and the sample size, where more recent studies (2014 and 2015) and those with smaller sample sizes (<1000) had higher reported food insecurity, with averages around 60% with the upper limit of 95% CI between 70 and 80%. Even though the studies in this review paper are from different regions, the studies used different questionnaires and were conducted in different populations. These above mentioned results, with consideration of the study year and sample size, align with the current study.

Validation aspects of the current study highlight relationships of food security with sociodemographic, anthropometric and nutritional measures. First, as may be expected, food security was significantly related to higher parental education level, greater income, number of people employed, number of rooms in houses, amount of money spent on food and smaller household size. This finding is consistent with several previous studies.[2,3,7,21] including a recent report from Lebanon showing that food security was positively associated with mother's and father's education level, number of cars and electrical appliances in the household and household income.[21] Many nutritional outcomes are related to food insecurity, including higher carbohydrate intake and lower intake of fruits, vegetables, meat and multiple micronutrients. Similarly, Perez-Escamilla et al revealed that the level of food insecurity was strongly associated with the likelihood of daily consumption of vegetables, fruit, and meat,[25] likely directly related to income.[19] Further work in Iran has agreed with results of the present study, showing that carbohydrate and thiamin intakes in food insecure households were higher than food secure households.[20] Though there were also a greater proportion of underweight mothers, fathers and children in the severely food insecure group, it is unclear if this was primarily driven by lower caloric intake or differences in macronutrient intakes. Dastgiri et al in Iran and Sarlio-Lahteenkorva et al in Finland have reported similar relationships between BMI and food insecurity.[31,32] Interestingly, results from American studies showed that mild or moderate food insecurity may actually be related to increased risk of obesity, especially in women.[33,34] It has been previously hypothesized that this increased obesity risk is due to fear of running out of food and increased caloric density and/or decreased nutrient density of food being consumed by these food insecure individuals.[33] The current study did not observe this relationship of food insecurity and overweight/obesity possibly due to the sample size being underpowered to assess this outcome.

This was the first Iranian study that investigated how CBC factors and serum albumin related to food security status. Interestingly, when looking at differences in biochemical

Table 6. Relationships Among Food Security Status and Serum Albumin and CBC Factors (No. %) in Mothers, Fathers and the First Child in Families

Laboratory Tests	Households Status				*P* Value
	Food secure	Mild Food Insecurity	Moderate Food Insecurity	Severe Food Insecurity	
Mother's	***n* = 19**	***n* = 17**	***n* = 18**	***n* = 21**	
Serum albumin					
Low	5 (26%)	6 (35.3%)	5 (27.8%)	12 (57.1%)	0.155
Normal	14 (73.7%)	11 (64.7%)	13 (72.2)	9 (42.9%)	
High	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
WBC					
Low	0 (0%)	1 (5.9%)	1 (5.6%)	2 (9.5%)	0.608
Normal	19 (100%)	16 (94.1%)	17(94.4%)	18 (87.7%)	
High	0 (0%)	0(0%)	0 (0%)	1 (4.8%)	
RBC					
Low	1 (5.3%)	2 (11.8 %)	1 (5.6%)	1 (4.8%)	0.638
Normal	16 (84.2%)	15 (83.3%)	16 (83.35%)	18 (85.7%)	
High	2(10.5%)	0 (0%)	1 (5.6%)	2 (9.5%)	
Hb					
Low	8 (42.1%)	5 (29.4%)	12 (66.7%)	18 (85.7%)	0.004
Normal	11 (57.9%)	12 (70.6%)	6 (33.3%)	2 (9.5%)	
High	0 (0%)	0 (0%)	0 (0%)	1 (4.8%)	
Htc					
Low	2(10.5%)	5 (29.4%)	6 (33.3%)	13 (61.9%)	0.021
Normal	14 (73.7%)	11 (64.7%)	12 (66.7%)	7 (33.3%)	
High	3 (15.8%)	1 (5.9%)	0 (0%)	1 (4.8%)	
M.C.V					
Low	7 (36.8%)	8 (47.1%)	12 (66.7%)	17 (81%)	0.024
Normal	12 (63.2%)	9 (52.9%)	6 (33.3%)	4 (19%)	
High	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
M.C.H					
Low	3 (15.8%)	2 (11.8%)	7 (38.9%)	8 (38.1%)	0.184
Normal	16 (84.2%)	15 (83.3%)	11 (61.1%)	12 (57.1%)	
High	0 (0%)	0 (0%)	0 (0%)	1 (4.8%)	
M.C.H.C					
Low	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0.456
Normal	19(100%)	17 (100%)	18 (100%)	21 (100%)	
High	0 (0%)	0 (0%)	0 (0%)	1 (4.8%)	
Platelets					
Low	0 (0%)	0 (0%)	1 (5.6%)	1 (4.8%)	0.519
Normal	19 (100%)	17 (100%)	16 (83.35%)	20 (95.2)	
High	0 (0%)	0 (0%)	1 (5.6%)	0 (0%)	
RDW					
Low	2(10.5%)	0 (0%)	1 (5.6%)	3 (14.3%)	0.461
Normal	17 (89.5%)	17 (100%)	17 (94.4%)	17 (81%)	
High	0 (0%)	0 (0%)	0 (0%)	1 (4.8%)	
Father's	***n* = 7**	***n* = 6**	***n* = 6**	***n* = 6**	
Serum albumin					
Low	0 (0%)	1 (16.7%)	1 (16.7%)	2 (33.3%)	0.544
Normal	6 (85.7%)	5 (83.3%)	5 (83.3%)	4 (66.7%)	
High	1 (14.3%)	0 (0%)	0 (0%)	0 (0%)	
WBC					
Low	0 (0%)	1 (16.7%)	2 (33.3%)	2 (33.3%)	0.373
Normal	7 (100%)	5 (83.3%)	4 (66.7%)	4 (66.7%)	
High	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
RBC					
Low	1 (14.3%)	1 (16.7%)	0 (0%)	0 (0%)	0.561
Normal	5 (71.4%)	5 (83.3%)	6 (100%)	6 (100%)	
High	1 (14.3%)	0 (0%)	0 (0%)	0 (0%)	
Hb					
Low	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0.10
Normal	7 (100%)	6 (100%)	6 (100%)	6 (100%)	
High	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Htc					
Low	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0.610
Normal	2 (28.6%0	2 (33.3%)	1 (16.7%)	4 (66.7%)	
High	5 (71.4%)	4 (66.7)	5 (83.3%)	2 (33.3%)	

Table 6. Continued

Laboratory Tests	Households Status				*P* Value
	Food secure	Mild Food Insecurity	Moderate Food Insecurity	Severe Food Insecurity	
M.C.V					
Low	2 (28.6%)	2 (33.3%)	2 (33.3%)	4 (66.7%)	0.654
Normal	4 (57.1%)	2 (33.3%)	3 (50%)	2 (33.3%)	
High	1 (14.3%)	2 (33.3%)	1 (16.7%)	0 (0%)	
M.C.H					
Low	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0.475
Normal	6 (85.7%)	4 (66.7%)	5 (83.3%)	6 (100%)	
High	1 (14.3%)	2 (33.3%)	1 (16.7%)	0 (0%)	
M.C.H.C					
Low	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0.475
Normal	6 (85.7%)	5 (83.3%)	6 (100%)	4 (66.7%)	
High	1 (14.3%)	1 (16.7%)	0 (0%)	2 (33.3%)	
Platelets					
Low	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0.10
Normal	7 (100%)	6 (100%)	6 (100%)	6 (100%)	
High	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
RDW					
Low	0 (0%)	0 (0%)	0 (0%)	1 (16.7%)	0.18
Normal	7 (100%)	6 (100%)	6 (100%)	4 (66.7%)	
High	0 (0%)	0 (0%)	0 (0%)	1 (16.7%)	
Frist child's	***n* = 8**	***n* = 16**	***n* = 9**	***n* = 13**	
Serum albumin					
Low	0 (0%)	0 (0%)	2 (22.2%)	4 (30.8%)	0.162
Normal	8 (100%)	15 (93.8%)	6 (66.7%)	8 (61.5%)	
High	0 (0%)	1(6.2%)	1 (11.1%)	1 (7.7%)	
WBC					
Low	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0.064
Normal	0 (0%)	2 (12.5%)	4 (44.4%)	5 (38.5%)	
High	8 (100%)	14 (87.5%)	5 (55.6%)	8 (61.5%)	
RBC					
Low	0 (0%)	0 (0%)	1 (11.1%)	4 (30.8%)	0.119
Normal	8 (100%)	15 (93.8%)	7 (77.8%)	9(69.2%)	
High	0 (0%)	1(6.2%)	1 (11.1%)	0 (0%)	
Hb					
Low	0 (0%)	0 (0%)	0 (0%)	1 (7.7%)	0.198
Normal	7 (87.5%)	16 (100%)	7 (77.8%)	12 (92.3%)	
High	1 (12.5%)	0 (0%)	2 (22.2%)	0 (0%)	
Htc					
Low	0 (0%)	2 (12.5%)	1 (11.1%)	1 (7.7%)	0.854
Normal	6 (75%)	12 (75%)	6 (66.7%)	11 (84.6%0	
High	2 (25%)	2 (12.5%)	2 (22.2%)	1 (7.7%)	
M.C.V					
Low	3 (37.5%)	9 (56.2%)	4 (44.4%)	3 (23.1%)	0.050
Normal	5 (62.5%)	7 (43.8%)	5 (55.6%)	6 (46.2%)	
High	0 (0%)	0 (0%)	0 (0%)	4 (30.8%)	
M.C.H					
Normal	8 (100%)	15 (93.8%)	8 (88.9%)	9 (69.2%)	0.127
High	0 (0%)	1(6.2%)	1 (11.1%)	4 (30.8%)	
M.C.H.C					0.10
Normal	8 (100%)	16 (100%)	9 (100%)	13 (100%)	
Platelets					
Low	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0.10
Normal	8 (100%)	16 (100%)	9 (100%)	13 (100%)	
High	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
RDW					
Low	2 (25%)	2 (12.5%)	2 (22.2%)	4 (30.8%)	0.683
Normal	6 (75%)	14 (87.5%)	6 (66.7%)	9 (69.2%)	
High	0 (0%)	0 (0%)	0 (0%)	0 (0%)	

Abbreviations: WBC, White blood cell; RBC, Red blood cell; Hb, Hemoglobin; Htc, Hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration, RDW, red cell distribution width.
P values for each factor are from chi-square test and *P* values <0.05 denote a significant effect of food insecurity on food group intake.

Table 7. Relationships Among Food Security Status and Sociodemographic Characteristics and BMI in Households (No. (%))

	Household Status				
	Food Secure (*n* = 25)	**Mild Food Insecurity (*n* = 25)**	**Moderate Food Insecurity (*n* = 25)**	**Severe Food Insecurity (*n* = 25)**	***P* Value**
Household size					
3	8 (32%)	4 (16%)	8 (32%)	4 (16%)	
4	6 (24%)	19 (76%)	10 (40%)	12 (48%)	0.017
5	11 (44%)	2 (8%)	6 (24%)	7 (28%)	
6	0 (0%)	0 (0%)	1 (4%)	2 (8%)	
The number of employed persons					
1	9 (36%)	19 (76%)	21 (84%)	20 (80%)	.001
2	16 (64%)	6 (24%)	4 (16%)	5 (20%)	
Monthly income (Toman)					
<600 000	0 (0%)	0 (0%)	1 (4%)	6 (24%)	
600 000-800 000	0 (0%)	1 (4%)	6 (24%)	16 (64%)	<0.001
800 000-1 000 000	5 (20%)	5 (20%)	13(52%)	3 (12%)	
1 000 000-2 000 000	11 (44%)	14 (56%)	5 (20%)	0 (0%)	
>2 000 000	9 (36%)	5 (20%)	0 (0%)	0 (0%)	
Status of house ownership					0.394
Landlord	11 (44%)	15 (60%)	12 (48%0	13 (52%)	
Rent/Mortgage	11 (44%)	10 (40%)	11(44%)	12 (48%)	
Free/organizational	3 (12%)	0 (0%)	2 (80%)	0 (0.0)	
Number of cars					
0	1 (4%)	3 (12%)	12 (48%)	13 (52%)	<0.001
1	18 (72%)	19 (76%)	13 (52%)	12 (48%)	
≥2	6 (24%)	3 (12%)	0 (0.0)	0 (0.0)	
Cost of food per month (Tooman)* for family	66937 ± 175808	47843 ± 99981.70	31451 ± 64317.70	15859 ± 65372.97	<0.001
Number of rooms					
0	0 (0%)	0 (0%)	0 (0%)	1 (4%)	
1	0 (0%)	1 (4%)	13 (52%)	11 (44%)	<0.001
2	9 (36%)	20 (80%)	9 (36%)	13 (52%)	
3	10 (40%)	4 (16%)	3 (12%)	0 (0%)	
4	4 (16%)	0 (0%)	0 (0%)	0 (0%)	
5	2 (8%)	0 (0%)	0 (0%)	0 (0%)	
Number of computers					
0	0 (0%)	6 (24%)	12 (48%)	11 (44 %)	<0.001
1	15 (60%)	16 (64%)	13 (52%)	14 (56%)	
2	10 (40%)	3 (12%)	0 (0%)	0 (0%)	
Father's age*	45.84 ± 10.14	45.84 ± 8.70	42.48 ± 7.84	44.8 ± 8.4	0.490
Father's education					
Illiterate	5 (20%)	0 (0%)	1 (4%)	0 (0%)	
<12 yr	7 (28%)	4 (16%)	6 (24%)	18 (72%)	<0.001
12 yr	2 (8%)	9 (36%)	9 (36%)	7 (28%)	
12-16 yr	7 (28%)	10 (40%)	8 (32%)	0 (0%)	
>16 yr	4 (16%)	2 (8%)	1 (4%)	0 (0%)	
Father's job status					
Jobholder	12 (48%)	8 (32 %)	13 (52%)	0 (0%)	
Self-employed	8 (32)	17 (68%)	7 (28%)	8 (32%)	<0.001
Labor	3 (12%)	0 (0%)	5 (20 %)	12 (48%)	
Jobless	0 (0%)	0 (0%)	0 (0%)	5 (20%)	
Doctor	2 (8%)	0 (0%)	0 (0%)	0 (0%)	
Father's BMI**					
Underweight	0 (0%)	1 (4%)	3 (12%)	8 (32%)	0.004
Normal	6 (24%)	6 (24%)	10 (40%)	9 (36%)	
Overweight	12(48%)	16 (64%)	9 (36%)	6 (24%)	
Obese	7 (28%)	2 (8%)	3 (12%)	2 (8%)	
Mother's age*	41.84 ± 8.97	41.84 ± 8.62	42.84 ± 7.38	44.8 ± 8.40	0.405

Table 7. Continued

	Household Status				
	Food Secure (*n* = 25)	**Mild Food Insecurity (*n* = 25)**	**Moderate Food Insecurity (*n* = 25)**	**Severe Food Insecurity (*n* = 25)**	***P* Value**
Mother's education					
Illiterate	1 (4%)	0 (0%)	2 (8%)	0 (0%)	
<12 yr	4 (16%)	0 (0%)	7 (28%)	16 (64%)	<0.001
12 yr	5 (20%)	15 (60%)	10 (40%)	9 (36%)	
12-16 yr	13 (52%)	8 (32%)	6 (24%)	0 (0%)	
>16 yr	2 (8%)	2 (8%)	0 (0%)	0 (0%)	
Mother's Job status					
Jobholder	13 (52%)	5 (20%)	0 (0%)	0 (0%)	
Self-employed	3 (12%)	1 (4 %)	1 (4%)	0 (0%)	<0.001
Labor	0 (0%)	0 (0%)	3 (12%)	3 (12%)	
Homemaker	9 (30%)	19 (79.2%)	21 (84%)	22 (88%)	
Mother's BMI**					
Underweight	2 (8%)	4 (16%)	12 (48%)	16 (64%)	
Normal	10 (40%)	9 (36%)	4 (16%)	7 (28%)	<0.001
Overweight	8 (32%)	10 (40%)	8 (32%)	1 (4%)	
Obese	5 (20%)	2 (8%)	1 (4%)	1 (4%)	
First child age*	16.08 ± 9.37	17.56 ± 6.42	14.88 ± 7.30	15.64 ± 6.15	0.631
First child sex					
Boy	48%	44%	54.2%	32%	0.455
Girl	52%	56%	45.8%	68%	
First child BMI**					
Underweight	2 (8%)	2 (8%)	5 (20%)	11 (44%)	
Normal	0 (0%)	2 (8%)	1 (4%)	1 (4%)	0.030
Overweight	7 (28%)	3 (12%)	3 (12%)	2 (8%)	
Obese	16 (64%)	18 (72%)	16 (64%)	11 (44%)	

P values for each factor are from chi-square test and *P* values < 0.05 denote a significant effect of food insecurity on food group intake.
*Mean ± SD
** Underweight: BMI <18.5, normal: BMI 18.5-24.9, overweight: BMI 24.9-29.9, obese: BMI > 29.9.

outcomes among food security categories, only mothers had worsening outcomes (hemoglobin, MCV and hematocrit) with food insecurity. This finding agrees with previous work that has established women are likely at higher risk of food insecurity, or more severe food insecurity, than men due to gendered roles in households and mother's prioritization to feed other family members ahead of themselves.[10] Differences in hemoglobin, hematocrit and MCV among categories of mothers are possibly related to dietary iron intake decreasing with increased severity of food insecurity. There were no differences in iron intake for children or for fathers among food security categories. Since ferritin and total iron binding capacity were not assessed, it was not possible to assess the iron stores of the different food security categories for women. However, low MCV is suggestive of microcytic anemia, likely caused by iron deficient anemia.[35] Outcomes related to iron status in women should be investigated in further studies in Iran, especially in women planning to have children and in pregnant women, due to the importance of iron for the developing fetus.[36]

Table 8. The Test-Retest Correlation Coefficients Between Respondent Scale Measures by Kappa Coefficient

Questions	Kappa Value	*P*
Q1_1 * Q1_2	0.70	<0.001
Q2_1 * Q2_2	0.81	<0.001
Q3_1 * Q3_2	0.88	<0.001
Q4_1 * Q4_2	0.78	<0.001
Q5_1 * Q5_2	0.86	<0.001
Q6_1 * Q6_2	1	<0.001
Q7_1 * Q7_2	1	<0.001
Q8_1 * Q8_2	1	<0.001
Q9_1 * Q9_2	0.80	<0.001
Q10_1 * Q10_2	1	<0.001
Q11_1 * Q11_2	1	<0.001
Q12_1 * Q12_2	1	<0.001
Q13_1 * Q13_2	0.810	<0.001
Q14_1 * Q14_2	1	<0.001
Q15_1 * Q15_2	1	<0.001
Q16_1 * Q16_2	1	<0.001
Q17_1 * Q17_2	1	<0.001
Q18_1 * Q18_2	1	<0.001

Reliability in the current study was assessed by the Kappa coefficient and Cronbach's α. With 11 of the questions having Kappa coefficients of 1 and all coefficients being 0.7 to 1, the developed questionnaire had strong test-retest reliability. This correlation between administrations of the questionnaire is stronger than previous work in Lebanon assessing the reliability of the HFIAS (intra-class correlation of 0.58).[21] Though previous studies in Iran did not use correlation coefficients to measure test-retest reliability,[20,21,23,24] multiple studies did evaluate internal

consistency of questionnaires using Cronbach's α, with values ranging from 0.8[22] to 0.95.[23] With Cronbach's α ≥0.70 usually thought of as acceptable, and higher values showing greater internal consistency,[37] the overall value of 0.91 and subscale values from 0.78–0.87, the questionnaire in the current study shows high internal consistency that aligns with previous work in Iran using other questionnaires.[22,23]

Though the current study had multiple strengths, there were also limitations. First, the sample size was relatively small and taken from one urban setting, so results from this study are not representative of the entire country. Also, due to the sample size, study location and inclusion criteria, it is unclear if this questionnaire will be as reliable and valid in other regions of the country or with adults who do not have children. Due to lack of a 'gold standard' measure of food insecurity, the validity of this questionnaire faces greater challenge for interpretation. Lastly, this study assumed that the first child in a family was representative of all children in the family. This should be further investigated in Iran as previous research in older children from poorer families may be more food insecure than younger children.[38]

In conclusion, the results of this study demonstrated that the developed food security questionnaire is valid and reliable for assessing food insecurity in this Iranian population. Further work is needed in other parts of the country to assess how cultural factors could influence the application and validity of the tool. The availability of an Iranian food insecurity assessment tool is the first step towards the formulation of new policies and programs aimed at alleviating the burden of food insecurity in the country.

Authors' Contribution

LA, AE, AF and SPM designed the study, SPM collected data, SPM and LA wrote the manuscript, AF analyzed data, NB and NRB edited the manuscript and contributed to interpretation of the results.

Conflict of Interest Disclosures

The authors have no conflicts of interest.

Ethical Statement

This study was supported by Isfahan University of Medical sciences and approved by Isfahan ethics committee (ethics number: IR.MUI.REC.1395.3.069).

References

1. Core indicators of nutritional state for difficult-to-sample populations. J Nutr. 1990;120 Suppl 11:1559-600. doi: 10.1093/jn/120.suppl_11.1555.
2. Kendall A, Olson CM, Frongillo EA, Jr. Validation of the Radimer/Cornell measures of hunger and food insecurity. J Nutr. 1995;125(11):2793-801. doi: 10.1093/jn/125.11.2793.
3. Thornton LE, Pearce JR, Ball K. Sociodemographic factors associated with healthy eating and food security in socio-economically disadvantaged groups in the UK and Victoria, Australia. Public Health Nutr. 2014;17(1):20-30. doi: 10.1017/s1368980013000347.
4. State of Food Insecurity in the World. 2015. Available from http://www.fao.org/hunger/en/. Accessed April 2016.
5. Radimer KL, Olson CM, Campbell CC. Development of indicators to assess hunger. J Nutr. 1990;120 Suppl 11(suppl_11):1544-8. doi: 10.1093/jn/120.suppl_11.1544.
6. Campbell CC. Food insecurity: a nutritional outcome or a predictor variable? J Nutr. 1991;121(3):408-15. doi: 10.1093/jn/121.3.408.
7. Radimer KL, Olson CM, Greene JC, Campbell CC, Habicht J-P. Understanding hunger and developing indicators to assess it in women and children. J Nutr Educ. 1992;24(1 Suppl 1):36S-44S. doi: 10.1016/S0022-3182(12)80137-3.
8. Funmilola Fausat A, Naphtali J. Socioeconomic characteristics and food diversity amongst high income households: a case study of Maiduguri metropolis, Borno state, Nigeria. American Journal of Social and Management Sciences. 2014;5(1):19-26. doi: 10.5251/ajsms.2014.5.1.19.26.
9. Frongillo EA, Nanama S. Development and validation of an experience-based measure of household food insecurity within and across seasons in northern Burkina Faso. J Nutr. 2006;136(5):1409s-19s. doi: 10.1093/jn/136.5.1409S.
10. Ivers LC, Cullen KA. Food insecurity: special considerations for women. Am J Clin Nutr. 2011;94(6):1740s-4s. doi: 10.3945/ajcn.111.012617.
11. Behzadifar M, Behzadifar M, Abdi S, Malekzadeh R, Arab Salmani M, Ghoreishinia G, et al. Prevalence of Food Insecurity in Iran: A Systematic Review and Meta-analysis. Arch Iran Med. 2016;19(4):288-94. doi: 0161904/aim.0012.
12. Barrett CB. Measuring food insecurity. Science. 2010;327(5967):825-8. doi: 10.1126/science.1182768.
13. Webb P, Coates J, Frongillo EA, Rogers BL, Swindale A, Bilinsky P. Measuring household food insecurity: why it's so important and yet so difficult to do. J Nutr. 2006;136(5):1404s-8s. doi: 10.1093/jn/136.5.1404S.
14. Wolfe WS, Frongillo EA. Building household food-security measurement tools from the ground up. Food Nutr Bull. 2001;22(1):5-12. doi: 10.1177/156482650102200102.
15. Carlson SJ, Andrews MS, Bickel GW. Measuring food insecurity and hunger in the United States: development of a national benchmark measure and prevalence estimates. J Nutr. 1999;129(2S Suppl):510s-6s. doi: 10.1093/jn/129.2.510S.
16. Gebreyesus SH, Lunde T, Mariam DH, Woldehanna T, Lindtjorn B. Is the adapted Household Food Insecurity Access Scale (HFIAS) developed internationally to measure food insecurity valid in urban and rural households of Ethiopia? BMC Nutr. 2015;1(1):2. doi: 10.1186/2055-0928-1-2.
17. Leyna GH, Mmbaga EJ, Mnyika KS, Klepp KI. Validation of the Radimer/Cornell food insecurity measure in rural Kilimanjaro, Tanzania. Public Health Nutr. 2008;11(7):684-9. doi: 10.1017/s1368980007001267.
18. Gulliford MC, Mahabir D, Rocke B. Reliability and validity of a short form household food security scale in a Caribbean community. BMC Public Health. 2004;4:22. doi: 10.1186/1471-2458-4-22.
19. Gulliford MC, Nunes C, Rocke B. The 18 Household Food Security Survey items provide valid food security classifications for adults and children in the Caribbean. BMC Public Health. 2006;6:26. doi: 10.1186/1471-2458-6-26.
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 Nutr. 2012;15(1):149-57. doi: 10.1017/s1368980011001376.
21. Naja F, Hwalla N, Fossian T, Zebian D, Nasreddine L. Validity and reliability of the Arabic version of the Household Food Insecurity Access Scale in rural Lebanon. Public Health Nutr. 2015;18(2):251-8. doi: 10.1017/s1368980014000317.
22. 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 Nutr. 2007;10(8):855-61. doi: 10.1017/s1368980007441465.

23. Salarkia N, Abdollahi M, Amini M, Neyestani TR. An adapted Household Food Insecurity Access Scale is a valid tool as a proxy measure of food access for use in urban Iran. Food Secur. 2014;6(2):275-82. doi: 10.1007/s12571-014-0335-7.
24. 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. doi: 10.1186/1475-2891-8-28.
25. Perez-Escamilla R, Segall-Correa AM, Kurdian Maranha L, Sampaio Md Mde F, Marin-Leon L, Panigassi G. An adapted version of the U.S. Department of Agriculture Food Insecurity module is a valid tool for assessing household food insecurity in Campinas, Brazil. J Nutr. 2004;134(8):1923-8. doi: 10.1093/jn/134.8.1923.
26. 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 Nutr. 2010;13(5):654-62. doi: 10.1017/s1368980009991698.
27. Marfell-Jones M, Olds T, Stewart A, Carter L. International standards for anthropometric assessment. Potchefstroom, South Africa: International Society for the Advancement of Kinanthropometry (ISAK); 2006.
28. University of California San Francisco. Lab Manual for UCSF Clinical Laboratories. Available from: http://labmed.ucsf.edu/labmanual/db/data/tests/1424.html.
29. Vajpayee N, Graham SS, Bem S. Basic examination of blood and bone marrow. In: McPherson RA, Pincus MR, eds. Henry's Clinical Diagnosis and Management by Laboratory Methods. Philadelphia, PA: Elsevier Saunders; 2007:465-8.
30. Hoffbrand AV, Catovsky D, Tuddenham EGD, Green AR. Postgraduate Haematology. 6th ed. USA: Wiley-Blackwell; 2011
31. Dastgiri S, Tutunchi H, Ostadrahimi A, Mahboob S. Sensitivity and specificity of a short questionnaire for food insecurity surveillance in Iran. Food Nutr Bull. 2007;28(1):55-8. doi: 10.1177/156482650702800106.
32. Sarlio-Lahteenkorva S, Lahelma E. Food insecurity is associated with past and present economic disadvantage and body mass index. J Nutr. 2001;131(11):2880-4. doi: 10.1093/jn/131.11.2880.
33. 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. doi: 10.1093/jn/131.6.1738.
34. Olson CM. Nutrition and health outcomes associated with food insecurity and hunger. J Nutr. 1999;129(2S Suppl):521s-4s. doi: 10.1093/jn/129.2.521S.
35. Demir A, Yarali N, Fisgin T, Duru F, Kara A. Most reliable indices in differentiation between thalassemia trait and iron deficiency anemia. Pediatr Int. 2002;44(6):612-6.
36. Scholl TO. Iron status during pregnancy: setting the stage for mother and infant. Am J Clin Nutr. 2005;81(5):1218s-22s. doi: 10.1093/ajcn/81.5.1218.
37. Henerson ME, Morris LL, Fitz-Gibbon CT. How to measure attitudes. Newbury Park, Calif: Sage Publications; 1987.
38. Moffitt RA, Ribar DC. Child age and gender differences in food security in a low-income US inner-city population. Eur Econ Rev. 2018;109:23-41. doi: 10.1016/j.euroecorev.2018.04.005.