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Challenges of Food Insecurity Indicators, Diet Quality and Weight Outcomes in Women: A Cross-Sectional Study

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ABSTRACT: Household food insecurity (FI) is a complex and multidimensional phenomenon. Despite much debate on FI, during the past decades several unaccounted aspects that are assumed to affect the FI of women still remain. Reducing the FI requires understanding its determinants. During this cross-sectional study (Jun to May of 2017), 188 women (19 ~64 years of age) were recruited in Sardrood-Tabriz, North-East Iran using cluster, random, and systematic sampling methods. Outcomes included socio-demographics, body compositions, anthropometric incidences, degree of FI, and five-item healthy eating scores (HES-5). Food security was classified as follows: high, marginal, low, and very low (HFS, MFS, LFS, and VLFS, respectively). Based on multiple logistic regression scores, significant relationships were found between household food security status and occupation, education level of household supervisor, number of girls and boys in the family, the household income level, and HES-5 [odds ratios (OR)=2.92; P=0.02, OR=46.57; P=0.03, OR=2.43; P=0.02, OR=2.56; P=0.005, OR=3.84; P=0.009, and OR=1.67; P<0.001, respectively], after adjusting for other factors. Influences inversely affecting diet quality and anthropometric indices may contribute to poor health status in affected women.

Keywords: food insecurity, socio-demographic determinants, weight outcomes, women

INTRODUCTION

Food insecurity (FI), defined as constrained food availability, accessibility, and utilization, reflects a growing public health problem (Tarasuk et al., 2015). FI is a complex and multidimensional phenomenon that may have social, psychological, and cultural dimensions, as well as affecting quantity and quality of life (Casey et al., 2006; Lang and Heasman, 2015). Assessing FI is one approach to identify women at risk of poor nutritional status. Reducing FI requires understanding its determinants. Despite much debate on FI, over the past decades several unaccounted aspects that are thought to affect the chance of women of being FI still remain (Franklin et al., 2012; Piaseu et al., 2004; Gundersen and Ziliak, 2014).

One of the main determinants of health, in high-, middle-, and low-income countries, is thought to be socioeconomic status (SES) (Wagner and Brath, 2012). The nutrition transition, whereby high prevalence of obesity now affects high-SES individuals and populations living in developing countries (Popkin et al., 2012; Moore et al., 2010). There is evidence that FI is associated with obesity among women, although these findings are still inconsistent (Leung et al., 2012; Finney Rutten et al., 2010; Larson and Story, 2011).

Diet quality is an essential measure for understanding FI because of the synergistic nature of micro- and macronutrients (Gerber, 2001). The five-item healthy eating score (HES-5) is a reformed version of the United States Department of Agriculture (USDA) HEI-2005 which is used to quickly evaluate general diet quality. It assesses the type and quantity of foods people consume and whether their diets comply with the Dietary Guidelines and the Food Guide Pyramid (Champagne et al., 2007; Shams-White et al., 2019).

It has also been suggested that low food security contributes to weight gain in women via consumption of high calorie and energy dense foods. Further, even marginally food secure (MFS) individuals may experience extra weight gain compared to those with high food security

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(HFS) (Dhurandhar, 2016).

Although FI was assumed to be an independent risk factor for increasing body mass index (BMI), it is not clear which factors may affect weight outcomes with respect to household FI and its determinants in communities that face transition from under nutrition to over nutrition. Thus, identification of factors associated with FI and the relationship between household' FI and the weight outcomes of women, in particular body composition and anthropometric incidences, remain an important factor to elucidate the burden of FI on the prevalence of metabolic diseases and quality of life.

FI has long been a concern for the most vulnerable populations in various communities, including people in sub-urban area with relatively heterogeneous populations. Residents of sub-urban regions have greater rates of FI compared with other populations (Dallmann et al., 2015). Sardrood is a recently urbanized residential area with remarkable heterogeneity in terms of socio-demographic determinants. Residents face an accelerated epidemiologic transition where dietary behaviors are affected by numerous elements, such as cultural customs, socioeconomic status of households, and the other demographic factors. Given the growing prevalence of obesity in Iran, a comprehensive understanding of the relationship between FI, diet quality, and anthropometric outcomes is critical for implementing policies to improve public health status. This research was therefore carried out to: I) explore factors affecting household FI with respect to socio-demographic determinants within a middle-income community, and II) evaluate the relationship between household FI and weight outcomes of women in the community. Our findings should help identify modifiable risk factors of household FI and lead to development of targeted and more functional interventions promoting food security and well-being for women and other vulnerable populations around the world, especially those in low- and middle-income countries.

MATERIALS AND METHODS

Study population and sampling method determination of socio-demographic characteristics

This was a cross-sectional study that enrolled 188 women (19～64 years of age) in Sardrood-Tabriz city, North-East Iran form June to May 2017. Subjects were recruited and interviewed through a combination of cluster, random, and systematic sampling approaches. Subjects were selected from 4 health centers (clusters) in Sardrood, and 2 health centers were randomly selected. A systematic random sampling method was then used to select areas and households at each health center. The lady of the house in each household was interviewed. Trained interviewers carried out the pre-tested questionnaires to identify socio-demographic characteristics of the women by face-to-face interviews. To recognize the economic situation, the status of 3 indicators was investigated as follows: residential home infrastructure, number of living residents, and home ownership status. Interviewers were trained and regularly controlled throughout the data collection process.

Household food security status

We assessed each household food security status over the past 12 months through using a locally validated, 18-item USDA Household Food Security Survey Module developed by the USDA Food and Nutrition Service to measure FI and hunger (Rafiei et al., 2009). The results should identify if a selected behavior occurred or a targeted condition existed during the last 12 months because of financial constraints. Ten items focus on adults, and the remaining items refer to children in the household. The module helps to categorize household food security status to four classes as follows: HFS, MFS, low food security (LFS), and very low food security (VLFS) (Rabbitt et al., 2016).

Dietary assessment

HES-5 scores were calculated from the five dietary components to score the quality of a participant's diet on a scale from 0 to 25. HES-5 scores are derived from the frequency of consumption of fruit, vegetables, whole grains, dairy, and fish over the past week. The quantity of each item consumed is quantified, aided by provided pictures to assist in portion size estimations. Fruits included all forms except juice, grains included beans and peas, and dairy included all milk products. A higher score indicated higher food consumption.

Anthropometric measurements

Subject weight and height were measured by a balance beam scale (SECA, Birmingham, UK) and a portable stadiometer, with an accuracy of ±0.1 cm and ±0.1 kg, respectively. During measurements, subjects were they scantily clothed without shoes. Waist circumference (WC) was measured to the nearest 0.1 cm using a flexible tape by a single trained measurer. Subsequently, waist-to-hip ratio (WHR) was determined (Habib, 2013).

Body composition analyses

We used a hand-to-hand impedance analyzer (OMRON BF511, OMRON ELECTRONICS GmbH, Langenfeld, Germany) for body composition analysis, as well as fat mass (FM) and skeletal muscle mass (SMM). In brief, body composition analysis was carried out in the morning after fasting overnight; during measurements, subjects wore light indoor clothes and were requested to empty

their bladders beforehand. Subjects held the device with both arms horizontally positioned in front of the body. Details of age, gender, weight, and height inputted into the device. (Mialich et al., 2014).

Data analysis

Statistical analysis was carried out using SPSS version 24 (SPSS Inc., Chicago, IL, USA). To calculate the household food security index, responses were scored in accordance with the USDA Food and Nutrition Service criteria (Ajao et al., 2010). For descriptive variables, distribution of household food security and basic demographic characteristics was calculated and expressed as frequencies and percentages. Logistic regression was used to analyze the data. Variables associated with household food security status in the univariate analysis were included in multiple logistic regression models. The *P*-values for entry and removal of variables in the logistic regression model were 0.05 and 0.1, respectively. The significant variables of univariate analysis and confirmatory factors were used to calculate multiple logistic regression models, after adjusting for other factors. Odds ratios (OR) with 95% confidence intervals (CI) were determined. *P*-values <0.05 were considered statistically significant.

Ethical considerations

The ethical committee of Tabriz university of Medical Sciences, Tabriz, Iran, certified the study protocol (reference number: IR.TBZMED.REC.1396.291). Before entering the study, all the subjects received a clear explanation of the research proposal and provided signed informed consent.

RESULTS AND DISCUSSION

A total of 188 women with a mean age of 38.74±8.54 years participated in this study (data not shown). Table 1 shows descriptive information of the subjects by food security status. Overall, 71.3% of the households had FI. According to the FI measures, 11.7% of households had VLFS, 33.0% had LFS, 26.6% had MFS, and 28.7% had HFS. Most subjects with FI were overweight or obese. The frequency of FI in households with moderate economic status was 49.5%.

In the current study, we found that more than half of subjects were living in marginal and moderate food insecure households (71.3%), which is in line with recent evidence that Middle-East and North Africa (Kamrava et al., 2012) is one of the most food insecure regions in the world. The figure is comparable with reports from the rest of Iran, which vary from 49% in North-East (Behzadifar et al., 2016) and 59% in the North-West (Sharafkhani et al., 2010) to 86% in the South (Kaldeh et al., 2010). However, as expected, the incidence of FI is much higher than the developed world; for example, FI is 10% in Canada (Tarasuk et al., 2014) and 14.3% in the US (Coleman-Jensen et al., 2014).

Our results show that 86% of the subjects living in households with VLFS and 73% of subjects living in households with LFS were overweight or obese. Further, compared with HFS households, subjects with FI had more WC. Similar to our findings, Vedovato and colleagues (2016) found adults and children with FI were likely to be overweight or obese, respectively.

We showed that education level and occupation of household supervisor were significantly linked with household food security status (OR=51.12, P=0.04 and OR=3.65, P=0.01, respectively; Table 2). We found a significant relationship between the number of children in the family with FI (OR=2.93, P=0.01 and OR=3.12, P<0.001, respectively). Further, we found a significant relationship between food security status and HES-5 (OR=1.79; P<0.001).

The current study demonstrates that occupation and education level of the household supervisor are significant factors affecting the rate of FI. More specifically, employment contributes to one's likelihood of being food secure by 3.65-fold compared with those who are unemployed. Further, education, at least at secondary school level, significantly increased the odds of being food secure (OR=51.12). Households with lower incomes were also more likely to experience FI. There are several possible explanations for these observations. First, since food security is affected by both food production and food purchase, food security is closely connected to income (Godfray et al., 2010). Second, subjects with low levels of education may be prone to FI due to occupation-related income variations. Finally, low education may hampers nutritional attitude and ability to manage the allocation of household food resources.

Our results also show high rates of overweight and obese subjects in households with FI, however we did not find any significant relationships between food security status and BMI, WC, or WHR. Other studies have shown that FI is not strongly associated with weight gain in women (Pan et al., 2012; Leung et al., 2012; Martin-Fernandez et al., 2014). The results of a study carried out in the US showed that changes in FI status over two years were not significantly related with changes in weight (Whitaker and Sarin, 2007). However, other reports contradict these findings. Franklin et al. (2012) showed a strong positive association between FI and obesity in women. Taken together, we can conclude that FI and being overweight coexists in low-income households, which may influence data interpretation and subsequent conclusions.

Table 3 presents multiple logistic regression between

Table 1. Subject characteristics by household food insecurity distribution (n=188) [unit: n (%)]

Variable	HFS	MFS	LFS	VLFS
Women's age				
≤29	12 (22.2)	9 (18.0)	7 (11.3)	1 (4.5)
30~59	41 (75.9)	40 (80.0)	55 (88.7)	21 (95.5)
≥60	1 (1.9)	1 (2.0)	0	0
Age of household supervisor				
≤29	4 (7.4)	1 (2.0)	1 (1.6)	0
30~59	48 (88.9)	47 (94.0)	53 (86.9)	22 (100.0)
≥60	2 (3.7)	2 (4.0)	7 (11.5)	0
Home size (m^2)				
<50	3 (5.7)	1 (2.0)	7 (11.5)	3 (13.6)
50~100	25 (47.2)	30 (60.0)	34 (55.7)	16 (72.7)
>100	25 (47.2)	19 (38.0)	20 (32.8)	3 (13.6)
Family size				
2	8 (14.8)	4 (8.0)	5 (8.1)	2 (9.1)
3~5	44 (81.5)	44 (88.0)	54 (87.1)	17 (77.3)
>5	2 (3.7)	2 (4.0)	3 (4.8)	3 (13.6)
Employed number				
None	1 (1.9)	0 (0)	4 (6.5)	2 (9.1)
1	46 (85.2)	42 (84.0)	53 (85.5)	18 (81.8)
>1	7 (13.0)	8 (16.0)	5 (8.1)	2 (9.1)
Women's occupation				
Housewife	46 (85.2)	44 (88.0)	58 (93.5)	20 (90.9)
Part time job	8 (14.8)	6 (12.0)	4 (6.5)	2 (9.1)
Occupation of household supervisor				
Jobless	3 (5.6)	1 (2.0)	9 (14.5)	4 (18.2)
Worker	19 (35.2)	27 (54.0)	39 (62.9)	14 (63.6)
Employee	4 (7.4)	4 (8.0)	2 (3.2)	0 (0)
Other	28 (51.9)	18 (36.0)	12 (19.4)	4 (18.2)
Women's education level				
Primary school and below	21 (38.9)	22 (44.0)	33 (53.2)	15 (68.2)
Secondary school	28 (51.9)	24 (48.0)	26 (41.9)	7 (31.8)
Collegiate and above	5 (9.3)	4 (8.0)	3 (4.8)	0 (0)
Education level of household supervisor				
Primary school and below	16 (29.6)	25 (50.0)	30 (49.2)	15 (68.2)
Secondary school	31 (57.4)	23 (46.0)	29 (47.5)	7 (31.8)
Collegiate and above	7 (13.0)	2 (4.0)	2 (3.3)	0 (0)
Household's income level				
Low	2 (3.7)	7 (14.0)	9 (14.5)	6 (27.3)
Medium	31 (57.4)	10 (20.0)	45 (72.6)	15 (68.2)
High	21 (38.9)	10 (20.0)	8 (12.9)	1 (4.5)
BMI				
Normal weight	7 (14.0)	11 (22.9)	12 (21.1)	3 (13.6)
Over weight	21 (42.0)	18 (37.5)	17 (29.8)	11 (50.0)
Obese	22 (44.0)	19 (39.6)	28 (49.2)	8 (36.4)
WC				
Normal (<90 cm)	12 (22.2)	4 (8.0)	13 (21.0)	3 (13.6)
Non normal	42 (77.8)	46 (92.0)	49 (79.0)	19 (86.4)
WHR				
Normal (<0.8)	3 (5.6)	1 (2.0)	1 (1.6)	1 (4.5)
Non normal	51 (94.4)	49 (98.0)	61 (98.4)	21 (95.5)
Food security in household				
Without children under 18 years old	15 (37.5)	8 (20.0)	13 (32.5)	4 (10.0)
With children under 18 years old	39 (26.4)	42 (28.4)	49 (33.1)	18 (12.2)

Values for categorical variables are given as frequency and percentages.
BMI, body mass index; WC, waist circumference; WHR, waist to hip ratio; HFS, high food secure; MFS, marginally food secure; LFS, low food secure; VLFS, very low food secure.

Table 2. Association between demographic, anthropometric and body composition variables with household food security status, calculated using Univariate logistic regression analysis (n=188)

Variables	OR	95% CI		*P*-value
		Lower	Upper	
Occupation of household supervisor				
Jobless[1)]	1.00			
Worker	1.64	0.26	10.32	0.59
Employee	3.65	1.26	10.55	0.01
Other	10.18	0.81	127.57	0.07
Education level of household supervisor				
Primary school and below[1)]	1.00			
Secondary school	51.12	1.20	2,178.58	0.04
Collegiate and above	9.23	0.27	315.97	0.21
Women's education level				
Primary school and below[1)]	1.00			
Secondary school	0.01	0.00	0.41	0.01
Collegiate and above	0.05	0.002	1.36	0.07
Household's income level				
Low[1)]	1.00			
Medium	3.96	0.49	31.72	0.19
High	2.96	1.01	8.70	0.04
Number of girl	2.93	1.28	6.69	0.01
Number of boy	3.12	1.49	6.54	<0.001
BMI	1.05	0.68	1.62	0.81
WC	1.02	0.90	1.15	0.74
WHR	0.01	0.00	4,382.72	0.50
FM	0.64	0.36	1.13	0.12
SMM	0.51	0.21	1.23	0.13
HES-5	1.79	1.44	2.22	<0.001

[1)]Reference category.
Dependent variable: household's food security status.
CI, confidence interval; BMI, body mass index; WC, Waist circumference; WHR, waist to hip ratio; SMM, skeletal muscle mass; FM, fat mass; HES-5, five item healthy eating score.

household food security status and HES-5, socio-economic and anthropometric indices. After adjusting for other factors, we found significant relationships between household food security status with occupation and education level of household supervisor, number of children in the family and household income level (OR=2.92; *P*=0.02, OR=46.57; *P*=0.03, OR=2.43; *P*=0.02; OR=2.56; *P*=0.005, and OR=3.84; *P*=0.009, respectively).

Moreover, we found a significant relationship between FI and HES-5 (OR=1.67; *P*<0.001). Thus, subjects with higher quality diets had a significantly greater chance of being food secure. Individuals with poor food security are expected to have inadequate food intake, and thus reduced body fat. However, a growing body of evidence shows FI paradoxically enhances incidence of being overweight and obese. Exploring reasons for this phenomenon is very important. FI compromises diet quality or quantity of dietary patterns, which is defined as "substitution effect" whereby an individual with FI choses inexpensive energy-dense foods (Seligman and Schillinger, 2010; Mbegalo and Yu, 2016). In support of this, studies show that adults living in households with FI have insufficient consumption of fruits, vegetables, and gain a high percentage of energy from carbohydrates (Berstein, 2012; Darmon and Drewnowski, 2015). Leung et al. (2014) indicated that FI was associated with more sugar-sweetened beverages and processed meat, and fewer vegetables. Further, Hanson et al. (2007) systematically reviewed links between FI and diet quality, and concluded that adults with FI consumed fewer vegetables, fruit, and dairy products.

From our findings, we can conclude that socio-economic status has a remarkable role on the high prevalence of FI in the surveyed region, and that FI inversely impacts body composition and anthropometric incidence and thus may contribute to poor health status. Further, FI is an independent risk factor for increasing BMI. Screening for FI is therefore very important for identifying individuals at risk of obesity. Considering these factors may help promote well-being of households with FI. Finally, concurrent existence of FI and the high incidence of being overweight or obese warrant future research to help develop and implement appropriate policies in socioeconomically vulnerable households.

While this study is limited by its cross-sectional nature and limited sample size, it does provide direction and in-

Table 3. Multiple logistic regression analysis of the association between FI, HES-5, and socio-economic and anthropometric indices (n=188)

Variables	OR	95% CI		*P*-value
		Lower	Upper	
Occupation of household supervisor				
Jobless	1			
Worker	1.67	0.31	9.03	0.54
Employee	2.92	1.13	7.49	0.02
Other	8.69	0.76	98.64	0.08
Education level of household supervisor				
Primary school and below	1			
Secondary school	46.57	1.32	1,636.16	0.03
Collegiate and above	12.67	0.43	371.31	0.14
Women's education level				
Primary school and below	1			
Secondary school	0.01	0.000	0.33	0.01
Collegiate and above	0.04	0.002	1.154	0.06
Household's income level				
Low	1			
Medium	7.33	1.07	50.07	0.04
High	3.84	1.40	10.50	0.009
Number of girl	2.43	1.14	5.17	0.02
Number of boy	2.56	1.33	4.95	0.005
HES-5	1.67	0.57	2.02	<0.001

Dependent variable: household's food security status.
The Hosmer-Lemeshow χ^2=14.17, degrees of freedom=8, significance=0.077.
Referent group is Food Secure group.
HES-5, five item healthy eating score; OR, odds ratio; CI, confidence interval.

sight for future studies. Additional large-scale, prospective studies could further help identify risk factors for FI among women living in a heterogeneous population of newly developed sub-Urban areas in developing countries.

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AUTHORS' CONTRIBUTIONS

MEV, LJ, and MA designed research; MEV conducted research and analyzed data; and MEV, MAL, LJ, and MA wrote the paper. The final manuscript was read and approved by all authors.

AUTHOR DISCLOSURE STATEMENT

The authors declare no conflict of interest.

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