ORIGINAL ARTICLE

The Association of Food Insecurity with Type 2 Diabetes and Hypertension: A Multicenter Case-Control Study in Urban Population

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ABSTRACT

Introduction: The household food insecurity (FI) is still one of global health issues, which is related to various health and developmental problems. The aim of this study was to evaluate the relationship of the FI with type 2 diabetes and hypertension in a city in North-West of Iran. **Methods:** Study population was the Khoy city's households which refer to the primary health-care centers. The US Department of Agriculture (USDA) six-item Household Food Security Scale was used to determine food insecurity. Sample size for each case group (type 2 diabetic and hypertensive) was calculated to be 110 subjects and was doubled to be 220 subjects in the control group. Multi-stage random sampling method was applied. To control the confounding variables, the logistic regression was used. **Results:** In total, 210 subjects (47.7%) had food security and 52.3% were insecure. Seventeen percent of the study population had normal BMI (Body Mass Index) and 83% were obese or overweight (42.7% obese, 40.5% overweight). In multivariate analysis the age ($p<0.001$), BMI ($p=0.002$), and education ($p=0.002$) were significantly related to hypertension. However, food insecurity was not significantly related to diabetes and hypertension. **Conclusion:** High prevalence of FI, obesity and overweight in the population necessitate the educational interventions about healthy nutrition in families, especially from childhood. Financial and nutritional support is needed for the families with FI. Considering the indirect relationship between FI and hypertension shown in this study, it is recommended to implement interventions to reduce the FI as a risk factor of hypertension.

Keywords: Food Supply, Diabetes Mellitus, Hypertension, Obesity, Overweight

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INTRODUCTION

The role of nutrition in the health of the individuals and families is becoming increasingly clear. Nowadays, due to the changes in lifestyle in most of the communities, non-communicable and chronic diseases are considered as the dominant health issues. Food insecurity, an important social determinant of health, is defined as the limited or uncertain access to safe and sufficient food, in socially acceptable ways, in order to have an active and healthy life and meet the dietary needs and individual preferences (1-3). Food and nutrition are one of the basic human needs and the provision of healthy, adequate, and nutritious food is considered as an integral part of food security (4). It is estimated that more than half of food insecurity (FI) occurs in Asia, of which 20% are hunger (5).

Evidence suggests that FI is still a major global problem and is associated with a wide range of health and developmental consequences and lower quality of life (2,6,7). Different mechanisms about the effect of FI on health consequences are proposed. One of which is due to the consumption of cheap, non-nutritious and caloric-dense foods which may result in various health conditions including cancers, overweight or obesity, mental disorders especially depression, and lower intelligence quotient (5,8).

The income is one of important factors of FI. However, FI is a multi-factorial condition which is not completely described by poverty (5). Other determinants of FI may be the age, gender, educational level, family size, dietary habits, employment status, and belonging to an ethnic/racial minority (5). There is evidence that smokers and addicted people experience more FI (2).

On one hand, according to the recent data, the prevalence of risk factors of cardiovascular diseases including type 2 diabetes (T2D) and hypertension are

increasing, mostly in the developing countries, and especially in urban population due to sedentary life-style or modern eating habits. It is estimated that the prevalence rate of T2D in Iran is 8.9 percent (5,9). On the other hand, in spite of advances in food production, a considerable proportion of the population is still exposed to FI (2). In Iran the majority of studies about the FI in urban areas are conducted using a sample of large or megacities reporting the prevalence of FI to be 26 to 42 percent in different regions (2,4,5,9). As the FI is related to geographic, cultural, and societal factors, there are limited updated studies about FI in North-West of Iran. So, according to the importance of FI on population's health and the paucity of up-to-date evidence in small cities in in this region, this study was designed to determine the association of FI with type 2 diabetes and hypertension in an urban population.

MATERIALS AND METHODS

Study design and population

This case-control study was conducted in Khoy, a city and capital of Khoy County, which is located in West Azerbaijan Province, in North-West of Iran, with a population of 198,845 people according to the national census in 2015. In this study, urban households covered by Khoy city's primary health-care centers were studied from January to July 2019. There are eight primary health-care centers in Khoy. The case group included those with T2D or primary hypertension. The control group was those without T2D and hypertension. The inclusion criteria were absence of other chronic diseases (asthma, cardiovascular disease, cerebrovascular events and kidney disease) and the age of over 35. The exclusion criteria included secondary hypertension, cardiovascular disease, type 1 diabetes, gestational diabetes, coincidence of type 2 diabetes and hypertension and the age of less than 35 years. Type 2 diabetes and hypertension were defined according to Iran's Package of Essential Non-Communicable Disease Interventions (IraPEN) which is a national program according to the WHO-PEN in order to provide universal coverage of early detection and management of cardiovascular diseases, diabetes, chronic respiratory diseases and cancer. Body mass index (BMI) was computed as the measure of weight in kilograms divided by the square of height in meters (Kg/m2). Obesity was classified according to BMI as recommended by the World Health Organization (WHO).

Sample size and sampling method

According to previous studies that reported the frequency of FI as 36% to 58% (10,11), the average frequency of FI was considered to be 50% in order to obtain the maximum sample size. Therefore, by using the sample size formula with considering 95% confidence and 5% error, and a 10% loss of sample, the sample size was calculated to be 110 in each of the groups. In order to enhance the power, the sample size was doubled to be 220 subjects in control group.

Multi-stage randomized sampling method was used. In first stage to conduct the quota sampling, the total number of diabetic and hypertensive patients registered in health-care centers was retrieved. The proportion of 110 and 220 to total population registered in health-care centers was applied to the population of each center to obtain the number of cases and controls in each center respectively. Therefore, the ratio of 1:1:2 was met in each health-care center to select the diabetic, hypertensive and control group. In second stage, the patients list for each center was used as the sampling frame to select the members of case and control group by systematic random sampling approach.

Household food insecurity assessment

The presence or absence of FI was determined by applying the U.S. Department of Agriculture (USDA) six-item Household Food Security Scale (3), which was previously validated in Persian (10) and its sensitivity, specificity, and accuracy were 98.7%, 85.5%, and 89%, respectively, in comparison with 24-hour food-recall questionnaire. People who answered "no" to all six questions or answered "yes" to only one question were classified as food secure and those who had affirmative response to two or more questions were grouped into the FI category. A 3 category classification is defined as "food secure" or "high or marginal food security" when having one or less affirmative response, "food insecure without hunger" or "low food security" with 2-4 affirmative responses, and "food insecure with hunger" or "very low food security" in cases of 5 or 6 affirmative responses (3). The affirmative response means the answer "yes" to the questions one, three, and four; "almost every month" or "in some months" in question two; and "often" or "sometimes" in questions five and six. Questionnaires were completed by trained health-care providers.

Statistical analysis

The data were analyzed using Statistical Package for Social Sciences (SPSS) software, version 16.0 for Windows (SPSS Inc., Chicago, IL, USA) with statistical level less than 0.05. The Chi-square test was employed to compare the frequency of FI between the case and control groups. The student's t-test or one-way analysis of variance (ANOVA) was performed to compare the quantitative variables in two and more than two groups, respectively. When, the data were not normally distributed Mann–Whitney's U test was applied. Logistic regression test was used to control the confounding variables.

Ethical considerations

The study protocol was approved by ethical committee of Tabriz university of Medical Sciences, Tabriz, Iran (reference number: IR.TBZMED.REC.1397.689). All participants received a clear explanation of research

objectives before completing the questionnaire to conform the ethical considerations. Participation in this study was voluntary. The individuals were assured that they could withdraw the study at any time. The questionnaires were filled in the health-care centers anonymously to ensure the confidentiality of data.

RESULTS

In this study, 220 healthy (without hypertension or diabetes), 110 hypertensive, and 110 type 2 diabetic patients were analyzed. The minimum and maximum ages of the subjects were 35 and 89 years, respectively. The characteristics of study population are summarized in Table I. To compare the education level in case and controls, the two-by-two complementary analysis by using Chi-square test was done and showed that only the difference between the Illiterate/primary school group and high school $\chi^2(1, N=341)= 21.32$, $P<0.001$; or academic educated group $\chi^2(1, N=284)= 31.43$, $P<0.001$ was statistically significant.

Table I: Characteristics of study population by case and control group

Variables	Total	Case	Control	P-value
		N (%)		
Sex				
Female	319 (72.5)	165 (75)	154 (70)	0.240
Male	121 (27.5)	55 (25)	66 (30)	
Education				
Illiterate/ primary school	215 (48.9)	139 (63.2)	76 (34.5)	0.000
Middle school	30 (6.8)	14 (6.4)	16 (7.3)	
High school	126 (28.6)	49 (22.3)	77 (35)	
academic	69 (15.7)	18 (8.2)	51 (23.2)	
BMI classification				
Underweight	1 (0.2)	1 (0.5)	0	0.002
Normal	73 (16.6)	28 (12.7)	45 (20.5)	
Overweight	188 (42.7)	86 (39.1)	102 (46.4)	
Obesity class I	133 (30.2)	78 (35.5)	55 (25)	0.001*
Obesity class II	40 (9.1)	23 (10.5)	17 (7.7)	
Obesity class III	5 (1.1)	4 (1.8)	1 (0.5)	
Food insecurity				
Secure	210 (47.7)	106 (48.2)	104 (47.3)	0.004
Insecure without hunger	87 (19.8)	31 (14.1)	56 (25.5)	
Insecure with hunger	143 (32.5)	83 (37.7)	60 (27.3)	
		Mean (SD)		
BMI (Kg/m²)	29.1 (4.55)	29.8 (4.70)	28.5 (4.30)	0.002
Family dimension	3.5 (1.35)	3.3 (1.52)	3.7 (1.14)	0.003
Age (years)	52.9 (11.80)	58 (10.78)	47.9 (10.59)	0.000

*After deletion of one underweight subject; SD, standard deviation; BMI, body mass index.

The items of USDA Household Food Security Scale and the frequency of affirmative responses are summarized in table II.

Table II: Frequency of affirmative responses to Household Food Security Scale

Question	N (%)
1. In the last 12 months, did (you/you or other adults in your household) cut the size of meals or skip meals because of lack of money for food? (Yes, No)	194 (44.1)
2. If yes, how often did this happen? (Almost every month, some months but not every month, only 1 or 2 months)	186 (42.3)
3. In the last 12 months, did you ever eat less than you felt you should because there was not enough money to buy? (Yes, No)	210 (47.7)
4. In the last 12 months, were you ever hungry but didn't eat because you couldn't afford enough food? (Yes, No)	83 (18.9)
5. "Food didn't last, and didn't have money to get more." (Was that often, sometimes, or never true in the last 12 months?)	176 (40)
6. "I/we couldn't afford to eat balanced meals." (Was that often, sometimes, or never true for (you/your household) in the last 12 months?)	249 (56.6)

In total study population, 210 subjects (47.7%) had food security and 230 subjects (52.3%) were food insecure, of which 87 (19.8%) were without hunger, and 143 (32.5%) had FI with hunger (Table II). Further analysis indicated that in case group the odds of having food insecurity with hunger was significantly more than food insecurity without hunger, OR= 2.50, 95%CI= 1.44-4.33, p= 0.001.

BMI normality test in different education levels showed normal distribution, so the analysis of variance (ANOVA) was applied to compare BMI. The analysis showed that females had significantly higher BMI than males (Table III). Results of LSD post-hoc analysis showed that the BMI in illiterate/primary school education level (M=29.89, SD=4.78) is significantly higher than people with high school education (M=28.35, SD=4.31), $F(3,436) =3.59$, p=0.003. As shown in Table III, Spearman correlation analysis showed that BMI was not correlated with age (r= -0.001, p= 0.981), and family size (r= -0.026, p= 0.583).

Table III: The association of demographic features with body mass index

Variable	BMI Mean (SD)	P-value	Mean difference of BMI (95% CI)
Sex			
Female	29.9 (4.65)	0.000	2.81(1.99-3.63)
Male	27.1 (3.59)		Reference
Education			
Illiterate/primary school	29.8 (4.77)	0.014	29.25-30.53*
Middle school	28.6 (4.16)		27.06-30.17*
High school	28.3 (4.31)		27.59-29.12*
academic	28.6 (4.16)		27.69-29.69*
Age (years)	-	0.981	-0.001**
Family dimension	-	0.583	-0.026**

*95% Confidence Interval for Mean; **Correlation Coefficient for Spearman's rho; SD, standard deviation; BMI, body mass index; CI, confidence interval.

Analysis showed that the individual's education and BMI were significantly related to FI (Table IV). Since the independent and dependent variables cannot be specified in the relationship between FI and BMI, the logistic regression analysis was not performed. In the food insecure group (M=29.7, SD=4.39), the mean BMI was higher (p= 0.018) than that of the food secure group (M=28.6, SD=4.68). Further analysis of education groups suggested that food security was significantly higher in those having academic education than all other three education groups with OR (95% CI) of 0.16 (0.08-0.31), 0.13 (0.05-0.31), and 0.18 (0.09-0.36) compared to the illiterate/primary school, middle school, and high school education levels, respectively.

Comparison of variables in groups with and without diabetes showed that only age was significantly associated with diabetes p<0.001, OR= 1.06, 95%CI= 1.03-1.09 (Table V). Analysis showed that education, age, BMI and family size were significantly associated with hypertension, of which age (p<0.001), BMI (p=0.002), and education (p=0.002) remained significant in multivariate analysis with (Table VI).

Table IV: Characteristics of study population by their household food security status

Variable	Food secure	Food insecure	P-value
	N (%)		
Sex			
Female	148 (70.5)	171 (74.3)	0.364
Male	62 (29.5)	59 (25.7)	
Education			
Illiterate/primary school	88 (41.9)	127 (55.1)	0.000
Middle school	11 (5.2)	19 (8.3)	
High school	55 (26.2)	71 (30.9)	
academic	56 (26.7)	13 (5.7)	
	Mean (SD)		
Age (years)	53.5 (12.0)	52.5 (11.6)	0.391*
BMI (Kg/m²)	28.6 (4.68)	29.7 (4.39)	0.018*
	Median (IQR)		
Family dimension	4 (3-4)	3.5 (3-4)	0.822**

*t-test; **Mann-Whitney U test; SD, standard deviation; BMI, body mass index; CI, confidence interval; IQR, interquartile range (Q1~Q3); OR, odds ratio.

Table V: The association of covariates with type 2 diabetes

Variable	Diabetic	Non-diabetic and non-hypertensive	Univariate P-value	Multivariate	
				P-value	OR (%95 CI)
	N (%)				
Sex					
Female	80 (72.7)	154 (70)	0.607	-	-
Male	30 (27.3)	66 (30)			
Food insecure	55 (50.0)	104 (47.3)	0.640	-	-
Education					
Illiterate/primary school	58 (52.7)	76 (34.5)	0.001	0.081	1.91(0.92-3.95)
Middle school	9 (8.2)	16 (7.3)		0.147	2.20 (0.76-6.39)
High school	29 (26.4)	77 (35)		0.407	1.38 (0.64-2.95)
academic	14 (12.7)	51 (23.2)			Reference
	Mean (SD)				
Age (years)	55.5 (9.25)	47.9 (10.59)	0.000*	0.000	1.06 (1.03-1.09)
BMI (Kg/m²)	29.4 (4.56)	28.5 (4.30)	0.069*	-	-
	Median (IQR)				
Family dimension	3 (2-4)	4 (3-4)	0.010**	0.361	0.92 (0.76-1.10)

*t-test; **Mann-Whitney U test; SD, standard deviation; BMI, body mass index; CI, confidence interval; OR, odds ratio; IQR, interquartile range (Q1~Q3).

Table VI: The association of covariates with hypertension

Variable	Hypertensive	Non -hypertensive	Univariate P-value	Multivariate	
				P-value	OR (%95 CI)
	N (%)				
Sex					
Female	85 (77.3)	154 (70.0)	0.163	-	-
Male	25 (22.7)	66 (30.0)			
Food insecure	51 (46.4)	104 (47.3)	0.876	-	-
Education					
Illiterate/primary school	81 (73.6)	76 (34.5)	0.000	0.002	6.16 (1.98-19.17)
Middle school	5 (4.5)	16 (7.3)		0.038	4.93 (1.09-22.26)
High school	20 (18.2)	77 (35.0)		0.081	2.88 (0.09-1.17)
academic	4 (3.6)	51 (23.2)			Reference
	Mean (SD)				
Age (years)	60.5 (11.6)	47.9 (10.59)	0.000	0.000	1.08 (1.05-1.13)*
BMI (Kg/m²)	30.3 (4.84)	28.5 (4.30)	0.001	0.002	1.10 (1.04-1.17) *
	Median (IQR)				
Family dimension	3 (2-4)	4 (3-4)	0.000	0.107	0.85 (0.69-1.03) **

*t-test; **Mann-Whitney U test; SD, standard deviation; BMI, body mass index; CI, confidence interval; IQR, interquartile range (Q1~Q3); OR, odds ratio.

DISCUSSION

The aim of this case-control study was to investigate the association of food insecurity with type 2 diabetes and hypertension. The prevalence of FI was 52.3% in the total studied population, 52.7% in controls and 51.8% in the case group with no significant difference. However, more than half of the population suffers from FI and there is a need for intervention to improve food security especially for the families having food insecurity with hunger, which accounts for one-third (32.5%) of the population in this study.

One important result is that the rate of FI is high in both case and control group. Other studies in Iran have indicated different prevalence rates for FI including 31% in Yazd in 2005 (4), 38% in Tehran in 2011 (2), 42% in non-diabetic persons in Shiraz in 2012 (5). In Tabriz city the FI was shown to be 37% in 2007 (10), 48% in 2015 (12) and 58% in 2015 in another study (11). The prevalence of FI in a rural area, Qaresoo region of Khoy, in the same region of the country that this study was conducted, was reported as 59% in 2009 (13). Silverman et al. reported that prevalence FI in a region of USA in 2013 was 47.4% (14). According to these results it can be concluded that the prevalence of FI is high and even increasing in urban areas, which necessitates the need for long-term programs to mitigate this issue in order to prevent various health conditions. Heslot concluded that in spite of the fact that the number of Iranians who suffer from hunger is lower than before, a number of changes should be considered in making appropriate policies for future of food security in Iran. First, as a result of changing dietary trends, the community moves towards obesity.

The consumption of fruits and vegetables has dramatically decreased and replaced by carbohydrates, and fats. Second, the outdated production practices and adverse climate conditions can limit the agricultural production. Third, the international sanctions are threatening Iran's economy and its food security (15). In the era of lacking comprehensive programs in terms of food security, further projections should be carried out in light of technology, political, and market conditions to plan for preparedness and timely interventions.

Our results indicated that 83% of the total population were overweight or obese. Similarly, in a study in Tehran the prevalence of obesity and overweight in women was 35% and 21.2%, respectively (9), indicating a high majority of the community with this metabolic risk factor. In addition, mean BMI was significantly higher in women in comparison with men (29.95 vs. 27.14 Kg/m2). Similarly, studies estimated that 55% of women and 38% of men in Iran are obese or overweight (15). This finding may be due to more sedentary life-style in women, or physically active occupations in men. Additionally, it is proposed that BMI is not a good parameter to assess the obesity, as some cases with central adiposity may be missed. So, this finding should be interpreted with caution, regarding other criteria for obesity like waist-to-hip ratio.

This study showed that BMI was significantly associated with FI (P = 0.018) and the mean BMI was higher in FI group (29.6 versus 28.6 Kg/m2). Similarly, other studies have pointed out the association between overweight/obesity and household FI and subsequent chronic illnesses including diabetes and hypertension (1,14). Seligman et al. observed the relationship between FI and higher BMI only among women (16). This finding suggests that overweight/obesity may play a mediator role between the FI and various chronic diseases. However, Weaver and Fasel in a systematic review indicated that the association between FI and chronic diseases may be direct or indirect, which 15 studies by controlling the effect of BMI showed that the relationship between FI and chronic diseases is independent of obesity (7).

In this study, no significant relationship was found between FI and household dimension. Contrary to this finding, another study indicated that higher family size was associated with FI (5). Our results showed that FI was not related to age and gender of the respondent. This finding is contrary to that of Heerman et al. who stated that FI was associated with older age (17).

Additionally, we found no significant relationship between FI and hypertension or T2D, which is consistent with a cross-sectional study in USA by Berkowitz et al. that found no evidence on the association between food security and blood pressure control (18). Contrary to the present study, Irving et al. found a positive relationship between the stress of inadequate access to food, a dimension of FI, and high blood pressure, after adjustment for education, poverty and other features. They also explained that FI is associated with hypertension regardless of demographic characteristics (19). These discrepancies among studies may be the result of other covariates including the culture, socio-economic status (SES), and dietary habits which affect the family's life style.

Multivariate analysis showed a significant relationship between hypertension and education, age, and BMI. The risk of hypertension increased by 8% per year of aging (OR: 1.08; 95% CI: 1.05-1.13). In addition, for every unit of Kg/m2 increase in BMI, the risk of hypertension increased by 10% (OR: 1.10; 95% CI: 1.04-1.17). Hypertension was 6 and 5 time more likely, in subjects with illiterate/primary school and middle school education consecutively, compared to academic educational level. Similar (1) and contrary (16) results are reported in other studies.

Multivariate analysis of covariates of T2D showed that only age had a significant relationship with diabetes

and the relationship with FI, BMI, and education was not significant. Similar to our finding, Silverman et al. showed no statistically significant relationship between FI and diabetic control (14).

As the results of this study showed, FI was significantly associated with high BMI and multivariate analysis elucidated that BMI is a significant independent risk factor for hypertension, it could be concluded that FI can be considered as an indirect risk factor for high blood pressure.

The results of this study suggested that educational level was significantly related to BMI (p= 0.014), household FI (p< 0.001), and hypertension (p< 0.001). High school educated people had 53% more BMI than the group with illiterate/primary school. Similarly, an Iranian study showed that there was a statistically significant negative correlation between obesity and education (10). Additionally, the food security status was better in academic-educated group than other levels of education which is similar to another study in Iran (13). Carmichael et al. showed that FI was higher among subjects with lower education (20). So, the level of education is an important determinant of various risk factors and health conditions. Currently, individual and/or group education is delivering to catchment population in health-care centers. However, these findings elucidated the crucial need for programs tailored for the low educated groups in terms of manipulating appropriate gain-framed or loss-framed messages, and apply persuasive strategies to move beyond the knowledge and affect the nutritional attitude and performance in order to improve the health literacy to achieve effective health promotion and disease prevention. Opposed to this finding, a few studies indicated no association between FI and educational level (14,17). One of which is enrolled only subjects with low income status, so their education spectrum also may be limited to have a correct inference (14). The other study was based on 3 first items of U.S. Household Food Security Survey tool, neglecting the fact that the core module suggested to proceed to next questions if any of the first 3 questions are answered affirmatively, therefore the results of this study are not flawless in terms of measuring the food security (17).

Our study had some limitations. First, not all urban populations visit health-care centers. Therefore, this study is exposed to volunteer's bias. Second, the economic and employment status of head of the family were not considered that are important determinants of dietary decisions and life style, because of the sensitive nature of these issues, to have a valid response about the food security. Although, the educational level was analyzed as a proxy indicator of socio-economic status (SES).

CONCLUSION

Given the high prevalence of FI, obesity, and overweight in the study population, the necessity of educational interventions, especially at an early age, is highlighted to promote the consumption of healthy food in the household table. Comparison of the results with other studies indicates an increase in the rate of FI in urban areas that needs for appropriate program in future. Financial and nutritional support for households with FI is also needed. On the other hand, considering the indirect relationship between FI and hypertension in this study, interventions to reduce FI can be considered as a major component of controlling and preventing hypertension.

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