



Association of Food Insecurity and Type II Diabetes in the Southwest of Iran

Mohammad Ariya¹, Majid Karandish^{2*}, Mohammad Hossien Haghhighizadeh³

1. MSc in Nutrition, Nutrition and Metabolic Diseases Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

2. Professor, Nutrition and Metabolic Diseases Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

3. Department of Biostatistics, School of Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

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ABSTRACT

Introduction: Type II diabetes is currently considered to be health priority in Iran. Recent studies have confirmed the high prevalence of food insecurity in various regions in Iran. The present study aimed to investigate the association of food insecurity and some of its influential factors in the diabetic patients in the villages in Abadan, Iran.

Methods: This case-control study was conducted on 110 diabetic patients (case) and 107 non-diabetic individuals (control), who were selected randomly. Demographic characteristics and food insecurity status were evaluated using a questionnaire. Data analysis was performed in SPSS version 16 using Chi-square, t-test, and logistic regression analysis.

Results: The prevalence of food insecurity in the case and control groups was 85.3% and 67.1%, respectively. Several risk factors were considered to be effective in the high prevalence of food insecurity, such as poor socioeconomic status, body mass index, education level, and number of family members in the household. Moreover, the odds ratio (OR) for diabetes was significantly higher in the individuals with food insecurity (OR: 3.08, 95% confidence interval: 1.26-7.5).

Conclusion: Considering the higher prevalence of food insecurity in the patients with type II diabetes compared to the control group, it is presumed that food insecurity may be associated with type II diabetes or its risk factors.

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Introduction

Food and nutrition are the fundamental needs of humans, and food supply depends on food security (1). Food insecurity is defined as the limited or uncertain availability of healthy and adequate food or the limited or uncertain ability to acquire acceptable food in socially acceptable ways (2, 3). According to the most comprehensive definition, food security is determined by answering the five questions of who (available to everyone), when (always available and sustained), how (preserved human dignity), how much food (the amount necessary for a healthy and dynamic life), and what type of food (high-quality food) (4).

Several parameters could determine the prevalence of food insecurity in the world,

including the socioeconomic status, assessment of the nutrition status variably, and using the USDA1, CCHIP2, and Radimer/Cornell questionnaires (5). According to the studies conducted in different countries, the rate of food insecurity in Canada, Malaysia, Bolivia, and Philippines is 10%, 50%, 70%, and 35%, respectively (3, 6, 7). Additionally, a report published by the Food and Agriculture Organization of the United Nations (FAO) in 2017 indicated that after African countries, Asian countries are faced with the high rate of food insecurity (8). Recent studies have also confirmed the widespread prevalence of food insecurity in Iran (1, 9, 10).

The range of food insecurity varies from

* Corresponding author: Majid Karandish, Nutrition and Metabolic Diseases Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran. Tel: 00986133738383; Email: mkarandish@yahoo.com

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anxiety for household food access to severe hunger in the children with no access to food (2). Income status is a key determinant of food insecurity and hunger. If the spent income on food is higher, the level of food insecurity has been reported to be more severe, so that if 75% of the family income is spent on food, the family is exposed to food insecurity (11). Therefore, choosing inexpensive foods with low quality, which mostly contain high fat and sugar contents, in the families with high food insecurity is considered to be a major risk factor for the development of chronic diseases, such as diabetes (12).

Diabetes mellitus refers to a set of diseases, in which the blood glucose concentration increases due to the deficiencies in insulin secretion, insulin action or both (13). Diabetes mellitus is a common metabolic disease, which has been reported to be the seventh cause of mortality worldwide and the third cause of mortality in the United States (14). The number of diabetic adults is expected to increase from 171 million cases in 2000 to 366 million cases in 2030; in other words, the prevalence of diabetes was 2.8% in 2000, which is predicted to reach 4.4% in 2030 (15). According to the estimates of the World Health Organization (WHO), the prevalence of diabetes in Iran was 5.5-5.7% during 1995-2000, which is expected to rise to 6.8% in 2025 (16). Moreover, the risk of diabetes is approximately 2.5 times higher in the individuals with extremely low food security compared to those with food security (17).

According to the literature, food insecurity may be associated with the increased risk of type II diabetes (18-21). However, some studies have not confirmed this correlation (22). As far as we know, there are only few studies in Iran in this regard (23, 24). The present study aimed to compare the level of food insecurity between diabetic patients and non-diabetic individuals in the villages in Abadan, Iran considering the risk factors of the disease.

Material and methods

Study Design and Samples

This case-control study was conducted on the individuals referring to 10 rural health centers covered by Abadan Health Center in Abadan, Iran during 2014-2015. Diabetic patients were assigned to the case group, and

the individuals with no diagnostic evidence of diabetes in their health records were assigned to the control group. All the subjects were selected randomly.

Prior to the study, a pretest was carried out on 10 diabetic patients, and eight non-diabetic individuals in order to introduce the research environment, make the required modifications in each questionnaire, and determine the sample size. Based on the pretest, the sample size in each group was determined to be 98 subjects. Finally, 110 cases and 107 controls were randomly selected and enrolled in the study.

The exclusion criteria of the study were the age range of 19-65 years and presence of heart disease, stroke, cancer, mental disorders, and diseases leading to distraction.

Experimental Measures

General and demographic data were collected using a questionnaire. The weight of the subjects was measured in kilograms (with minimum clothing and no shoes), and their height was measured in centimeters (without shoes and standing completely upright) using the RASA, an Iranian weighing scale, and a height gauge, which were attached (model: 320). The weight and height ranges were 0.1-150 kilograms and 1-200 centimeters, respectively. Based on the weight and height, the body mass index (BMI) was also measured by dividing weight (kg) to height squared (m^2). The subjects were divided into four groups to describe the data, including underweight ($BMI < 18.5 \text{ kg}/m^2$), normal ($18.5 < BMI < 24.9 \text{ kg}/m^2$), overweight ($25 < BMI < 29.9 \text{ kg}/m^2$), and obese ($BMI > 30 \text{ kg}/m^2$).

Household food security status was assessed using the 18-item questionnaire developed by the United States Department of Agriculture (USDA). The questionnaire was evaluated in 1995 by the United States Department of Agriculture and introduced as a valid instrument for epidemiological studies. It is also notable that we used the Persian version of this questionnaire, which has been validated in the previous studies in Iran (9).

After explaining the objectives of the research and obtaining written informed consent from the subjects, demographic and USDA questionnaires were completed by a

nutrition expert in an interview. The confidentiality of the information was observed at this stage. On the day after completing the questionnaire, the level of glycated hemoglobin (HbA1c) was evaluated in the case and control groups, and HbA1c of less than 6.5% was considered normal (13). The study protocol was approved by the Ethics Committee of Jundishapur University of Medical Sciences, Iran.

Rating of the Food Security Questionnaire

The ranking of the USDA questionnaire is based on the method proposed by Gary Bickel et al. (25). Accordingly, positive ratings are assigned to the responses 'Often Correct', 'Sometimes Correct', 'Almost Every Month', 'Some Months', and 'Yes' (score one), while the responses 'Not True', 'Do Not Know/Refuse', 'Only One or Two Months', and 'No' are scored zero. Based on the number of the positive responses in the questionnaire, the subjects were divided into four groups of food secure (scores 0-2), food insecure without hunger (scores 3-7), food insecure with hunger (scores 8-12), and food insecure with severe hunger (scores: 13-18). For the better comparison in the present study, the subjects were divided into two groups of food secure and food insecure and evaluated.

Measuring HbA1c

Serum HbA1c was measured using the Bio Systems kit, a spectrophotometer (made in USA; serial number: 0917199), and the photometric method. A copy of all the test responses was provided to the subjects, and blood samples (2 ml) were collected under the supervision of a physician at the health centers. All the test results were added to the medical records of the

participants.

Statistical Analysis

Data analysis was performed in SPSS version 16 using independent t-test for the quantitative variables, Chi-square for the qualitative variables, and logistic regression analysis for the significant variables and their comparison with food insecurity. In all the statistical analyses, P-value of less than 0.05 was considered significant.

Results

In this study, the case group included diabetic patients and the control group those without the diagnosis of diabetes according to their medical records. After the HbA1c test, 28 control subjects (107 non-diabetic subjects) had an HbA1c level of higher than normal ($\geq 6.5\%$), who were diagnosed with diabetes. After informing these subjects and adding the test results to their medical records, this group of individuals was excluded from the study.

In total, 79 controls (19 males and 60 females) and 110 cases (31 males and 79 females) were enrolled in the study. Age range of the participants was 20-65 years, and the majority were female (71.8% in the case group and 75.9% in the control group), housewives (81.8% in the case group and 73.4% in the control group), and married (78.2% in the case group and 94.4% in the control group).

Table 1 shows that the level of education, the status of being under supportive organizations, the status of having children under the age of 18 years, and BMI in the case and control group had a significant difference ($p < 0.05$), while there was no significant difference between income level in two groups ($P = 0.236$).

Table 1. Characteristics of Sample Populations

			Case		Control		P-value*
			N	%	N	%	
Qualitative Variables	Education Level	Illiterate**	71	64.5	25	31.6	0.000
		≥Elementary	39	35.5	54	68.4	
	Household Income (per month)	<200 \$	90	81.8	59	74.7	0.236
		≥200 \$	20	18.2	20	25.3	
	Coverage Status by Support Organizations***	Yes	41	37.3	16	20.3	0.012
		No	69	62.7	63	79.7	
	Body Mass Index (BMI; kg/m ²)	Underweight (BMI<18.5)	1	0.9	8	10.1	0.021
		Normal (18.5<BMI<24.9)	25	22.7	20	25.3	
		Overweight (25<BMI<29.9)	39	35.5	27	34.2	
		Obese (BMI>30)	45	40.9	24	30.4	
Status of Having Children Aged Less than 18 Years	Yes	42	38.2	44	55.7	0.017	
	No	68	61.8	35	44.3		
Quantitative Variables		Case Mean±SD	Control Mean±SD		P-value***		
	Age (year)	52.8±9.3	41.2±11.3		0.000		
	Number of Household Members	6.2±3	5.1±1.9		0.006		
	Number of Living Children	4.3±2.7	3.1±2.2		0.001		

*Chi-square; **No reading and writing skills; ***Organizations that provide donations or food to their covered populations; ****independent t-test; SD: standard deviation

According to the information in Table 1, mean age, the number of household members, and number of living children were significantly different in the case and control groups ($P<0.05$). In addition, the mean number of household members (6.2 ± 3 in the case group and 5.1 ± 1.9 in the control group) and mean number of living children (4.3 ± 2.7 in the case group and 3.1 ± 2.2 in the control group) were higher in the case group compared to the control groups with significant differences in this regard ($P=0.006$ and $P=0.001$, respectively).

The difference in food insecurity between the case and control groups is shown in Table 2. According to the information in this table, 85% of the diabetic patients were food insecure, while this rate was estimated at 67% in the control group. According to the results of Chi-square, the difference in this regard was significant ($P=0.003$).

Table 2. Comparison of Food Insecurity in Case and Control Groups

Status of Food Insecurity	Case		Control		P-value*
	N	%	N	%	
Food Secure	16	14.7	26	32.9	0.003
Food Insecure	93	85.3	53	67.1	
Total	109**	100	79	100	

*Chi-square; **One subject in diabetic group did not

complete the food security questionnaire

All the significant variables were evaluated using the logistic regression analysis with three models. In the first model, in addition to food security, age and BMI were analyzed, and the results indicated that the odds ratio (OR) for type II diabetes in the subjects with food insecurity was three times higher (95% CI: 1.28-7.03) compared to the subjects with food security ($P=0.011$). In the second model, in addition to the items in model one, the number of household members, marital status, and having children aged less than 18 years were analyzed. According to the obtained results, the OR for type II diabetes in the subjects with food insecurity was 2.7 times higher (95% CI: 1.18-6.53) compared to the subjects with food security ($P=0.018$). In the third model, in addition to the items in models one and two, the education level and status of coverage by support organizations were analyzed. According to the obtained results, the OR for type II diabetes in the subjects with food insecurity was three times higher (95% CI: 1.26-7.5) compared to the subjects with food security ($P=0.001$) (Table 3).

Table 3. Results of Logistic Regression Analysis on Correlations of Food Insecurity Status and Significant Demographic Variables in Case and Control Groups

Model	Status of Food Insecurity	95% CI	OR	P-value
Model 1*	Food Secure	1	-	-
	Food Insecure	1.28-7.03	3	0.011
Model 2#	Food Secure	1	-	-
	Food Insecure	1.18-6.53	2.78	0.018
Model 3#	Food Secure	1	-	-
	Food Insecure	1.26-7.5	3.08	0.013

CI: confidence interval; OR: odds ratio; *adjusted for age and BMI; #adjusted for age, BMI, number of household members, marital status, status of having children aged less than 18 years; #adjusted for age, BMI, number of household members, marital status, status of having children aged less than 18 years, education level, and status of coverage by support organizations

Discussion

The present study aimed to investigate the status of food insecurity and its association with type II diabetes and some of its risk factors in the individuals referring to 10 rural health centers in Abadan, Iran. According to the findings, 85.3% of the patients with type II diabetes and 67.1% of the controls had moderate-to-severe food insecurity. Moreover, evaluation of the significant variables using the logistic regression model indicated that the OR for type II diabetes was three times higher in the subjects with food insecurity (95% CI: 1.26-7.5) compared to those with food security. It is notable that since the current research was carried out in rural areas with poor socioeconomic status, the rate of food insecurity was expectedly higher compared to the other studies in Iran (1, 9, 10, 24).

Our findings indicated that food insecurity was associated with type II diabetes. In a cross-sectional study by Najibi et al. (2011), which was conducted on 135 newly diagnosed diabetic patients, the prevalence of food insecurity was reported to be 66.7% (23). On the other hand, the findings of Seligman et al. (2007) and Gucciardi et al. (2009) demonstrated that food insecurity was more prevalent in diabetic patients compared to non-diabetic subjects (18, 26). Other studies have also suggested that type II diabetes is more prevalent in food-insecure households (27), while food insecurity may be considered a risk factor for type II diabetes (18), and the risk of diabetes in food-insecure subjects is 2-3 times higher compared to food-secure individuals, even after adjusting other risk factors (e.g., income status, occupation status, physical activity) (18, 28).

In a review study in this regard, Gucciardi et al. (2014) observed that the diabetic individuals

living in food-insecure households had deteriorated conditions compared to the diabetics living in food-secure households (29). In a cohort study conducted by Tait et al. (2018) in Canada, the risk of the incidence of type II diabetes in the residents of food-insecure households was reported to be twice higher compared to the residents of food-secure households (21).

The results of the present study showed no significant difference in the income status between the case and control groups, while the previous studies have denoted a significant, negative correlation between food insecurity and income status, which is inconsistent with the present study (1, 4, 6, 19, 21, 23). The main difference between the current research and these studies is the sample population; in the current research, both study groups were selected from the residents of Abadan villages, and poor socioeconomic status was rather common in the subjects. In general, it could be argued that poor socioeconomic status directly leads to food insecurity, thereby causing type II diabetes due to the routine use of inexpensive, high-calorie, and non-nutritious foods or reduced volume and number of daily meals.

According to the results of the present study, type II diabetes had a significant correlation with the number of the household members and number of living children. In the other studies in this regard, the prevalence of food insecurity has been reported to be higher in the households with more children (1, 6, 10, 23, 30). Therefore, it could be concluded that the number of the household members and number of children could influence food insecurity. The higher number of household members increases the need for food; consequently, the volume and the number of meals may reduce in low-income

families, leading to food insecurity. Under such circumstances, the risk of developing type II diabetes increases due to the consumption of non-nutritious, inexpensive foods.

In the current research, a significant correlation was observed between type II diabetes and education level as a higher percentage of the subjects with type II diabetes were illiterate compared to the control group. Similar results have also been proposed in the previous studies (1, 7, 10, 22, 23, 30), while this finding is inconsistent with the study by Heerman et al. (2016) (19). Lack of literacy limits job opportunities and reduces earnings, which in turn affects the costs of the foods consumed per household (31). Furthermore, low education level could reduce the nutritional literacy of individuals and affect all the stages of the purchase, preparation, cooking, and consumption of foods, thereby leading to food insecurity in households (31). Considering the association between education level and food insecurity, its indirect correlation with the incidence of type II diabetes could be justified.

The findings of the current research indicated a significant correlation between type II diabetes and BMI, so that more diabetic subjects were overweight or obese compared to the control group. Variable findings have been proposed in the previous studies. In some studies, the status of food insecurity has been reported to be directly correlated with BMI or waist circumference (7, 10, 19-23, 32), while there have also been contradictory or even contrariwise findings in this regard, some of which imply no such association (33-35). This controversy could be attributed to the differences in the sample populations in developing and developed countries.

In another review study in this regard, Larson and Story (2011) concluded that although the findings on the correlation of food insecurity and overweight/obesity in men are highly controversial, with some studies suggesting that food insecurity in men reduces the risk of overweight and obesity, a significant association has been confirmed between food insecurity and obesity or overweight in women and the general population (36). It could be hypothesized that as food-insecure individuals need high-fat and high-calorie foods to provide their energy, they are at a higher risk of obesity

and overweight compared to food-secure households.

The present study had several limitations. First, 28 subjects were excluded from the control group since their HbA1c level was not within the normal range after the test. Second, this case-control study was conducted in rural areas, where the subjects had extremely low incomes. Considering that income status is a key influential factor in food insecurity, this may be a bias factor in the current research, and the obtained results may not be generalizable to other communities. On the other hand, the cause and effect relationship between food insecurity and diabetes could not be thoroughly explained due to the study design (case-control). Finally, the food security questionnaire estimates food insecurity over the past 12 months, which was challenging for the subjects who did not remember to report properly.

Conclusion

According to the results, several risk factors were involved in the incidence of food insecurity, such as poor socioeconomic status, BMI, education level, and the number of household members. Considering the higher prevalence of food insecurity in the patients with type II diabetic compared to the control group, it could be concluded that food insecurity is likely to be associated with type II diabetes or its risk factors even after the adjustment of significant variables; reduction of food insecurity results in the reduced incidence of type II diabetes. In addition, food insecurity had a significant correlation with high HbA1c levels, which deteriorated the quality of life of the diabetic patients and onset of the disease complications. In conclusion, it is recommended that further investigations be conducted to clarify the association of food insecurity and type II diabetes. As such, healthcare planners need to be aware that food security is likely to be effective in the control and prevention of type II diabetes and adopt proper strategies to minimize the rate of food insecurity in the community.

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