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Relationship of Food Security with Type 2 Diabetes and Its Risk Factors in Tehranian Adults

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ABSTRACT

Background: As food insecurity has negative effects on health, the aim of this study was to determine the relationship between household food security and type 2 diabetes mellitus and its related risk factors.

Methods: In this case-control study, 200 individuals with and 200 individuals without type 2 diabetes mellitus, aged over 40 years, were randomly selected from among participants of the Tehran Lipid and Glucose Study. The questionnaire on household food security proposed by the United States Department of Agriculture was completed for them by trained personnel. Logistic regression was used to determine the variable that had the most significant relationship with food security status.

Results: The average of food security score was 2.38 ± 2.0 in non-diabetic and 2.25 ± 2.0 in diabetic individuals ($P = 0.6$). In both groups, the risk for food insecurity in women was more than in men. In the diabetic group, being single and having education levels below high school increased the risk of food insecurity. In the non-diabetic group, the risk of food insecurity in obese individuals was 3.3 times higher than normal individuals (odds ratio = 2.1, 95% confidence interval: 1.2–4.1).

Conclusions: There were no significant differences in food security levels of diabetic and non-diabetic groups. However, some risk factors of type 2 diabetes including sex, marital status, educational level, and obesity were associated with food insecurity.

Keywords: Food security, obesity, Tehran Lipid and Glucose Study, type 2 diabetes mellitus

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INTRODUCTION

Diabetes is a common metabolic disease and one of the frequent causes of death reported in recent years.[1] Low-quality diet has potential influence on obesity-related chronic diseases, like diabetes.[1] Food insecurity is defined as limited or variable access to adequate nutrients and safe foods or limited or variable capacity to acquire acceptable foods by acceptable methods.[2] Food insecurity can be classified into temporary and chronic food insecurity. Temporary or transitory food insecurity is the most severe type of food insecurity which can be caused by a shock from an unexpected event such as job loss affecting income; on the other hand, chronic food insecurity is rooted in poverty and continually affects low-income households.[3]

Food insecurity has negative effects on the individual's health[4] via its impact on dietary patterns such as consumption of cheap foods with high energy density and low micronutrients,[4] lower fruit and vegetable[5,6] and milk and dairy product consumption[5] and lower physical activity levels.[7] There is a significant relationship between food insecurity and poor control of chronic diseases such as diabetes and high blood pressure[5] and the high prevalence of obesity, overweight,[8,9] and smoking.[10]

Limited studies have been conducted in Iran for determining the prevalence of food insecurity and its association with diseases and their risk factors. Ghassemi *et al*. reported that in Tehran, 20% of households did not have full satiety and 50% of them have problems in meeting their cellular satiety.[11] In Yazd, almost one-third of students suffered from food insecurity and a relationship was found between food insecurity and obesity and the low economic status of households.[12] Dastgiri *et al*. in a cross-sectional study in Tabriz reported the prevalence of food insecurity in 36.3% of individuals and observed a negative association between occupational status and educational level of households.[13]

Since there is hardly any documented study on food security status and diabetes in Iran and there is a need to draw the attention of national and local policymakers to food insecurity, particularly its relationship with non-communicable diseases, the present study was designed to investigate the association between food security and diabetes in Tehranian adults, aged over 40 years.

METHODS

Study population

This case-control study was conducted within the framework of Tehran Lipid and Glucose Study (TLGS (on 400 individuals, aged over 40 years (200 diabetic cases and 200 non-diabetic controls) in 2011.[14,15] TLGS is an ongoing prospective study aimed at identifying the risk factors for non-communicable diseases among a representative urban population of Tehran. The first phase of the TLGS began in March 1999 and data collection, at 3-year intervals, is ongoing.[14,15] Diabetes was defined in this study according to the criteria of the American Diabetes Association as fasting plasma glucose (FPG) ≥126 mg/dl or 2-h post 75 g glucose load ≥200 mg/dl or current therapy for a definite diagnosis of diabetes.[16] Controls were simultaneously selected from among sex and age-matched healthy participants; they did not have diabetes, nor did they take oral hypoglycemic agents and their fasting blood sugar and 2-h glucose test results were normal. Individuals suffering from chronic diseases such as cardiovascular, and renal diseases and malignancy or those on a weight-reducing diet during the past 12 months were excluded.

Informed written consent was obtained from all subjects. The study was conducted according to the Declaration of Helsinki and was approved by the Ethical Committee of The Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences.

Study measurements

The 18 item questionnaire proposed by United States Department of Agriculture (USDA) was used for assessing household food security status during the previous year;[17] validity and reliability have been previously assessed in urban households in Isfahan.[18] All questionnaires were completed during interviews by trained staff. The food security score of each participant was calculated by its standard method according to the number of positive responses in this questionnaire.[17] Based on the USDA cut off, subjects were divided into 4 groups: High food security (scored 0–2.32), borderline food security (scored 2.33–4.55), low food security (scored 4.56–6.52), and very low food security (scored more than 6.52); higher scores indicate lower food security status. In this study, for better comparison, subjects were divided into 2 groups, food insecure group (low, very low, and borderline food security groups), and food secure group (high food security).[17]

Demographic information including age, sex, family size, employment, education and marital status, anthropometric indices (weight and height), and food intakes of each individual was also obtained from the TLGS data bank (2009–2012). This information was collected during 12 months before conducting the study. Weight was measured with minimal clothing and without shoes using a digital scale (model 707, range 0.1–150 kg, Seca, Hamburg, Germany) to the nearest 100 g. Height was measured to the nearest 1 cm using a tape (208 Portable Body Meter Measuring Device; Seca, Hamburg, Germany) with no shoes while scapula are in normal position. Body mass index (BMI) was calculated by dividing weight (kg) to height squared (m^2).

Fasting blood samples, for the measurement of glucose were drawn after the subjects had fasted overnight. The analysis of samples was performed using Selectra 2 auto-analyzer (Vital Scientific, Spankeren, Netherlands). FPG was measured on the day of blood collection by the enzymatic colorimetric method using glucose oxidase. Inter- and intra-assay coefficient of variations was both 2.2% for FPG.

Statistical analysis

Statistical analysis was performed by SPSS software (SPSS Inc., Chicago IL. Version 15). Independent sample *t*-test or case analysis of variance was used to compare quantitative variables between groups and Chi-square analysis was used to compare the qualitative variables. Simple logistic regression was used to examine the relationship between food security status and each variable separately and fitted logistic regression was used to determine, which variable had the most significant relationship with the food security status with the presence of baseline variables including sex, age, marital status, educational level, and obesity as the potential confounders.

RESULTS

There were no significant differences between the two groups in baseline characteristics except for educational level that was significantly higher in non-diabetic individuals ($P < 0.05$). Mean of food security score according to demographics, smoking, and BMI status in diabetic and non-diabetic participants are shown in Table 1. Mean of food security scores in non-diabetic and diabetic groups were 2.38 ± 2.1 and 2.25 ± 2.1, respectively, with no statistically significant difference ($P = 0.6$). The frequency of persons with high food security, borderline food security, low food security, and very low food security were 50.0%, 36.0%, 12.5%, and 1.5% in the diabetic group and 48.5%, 35.5%, 15.5%, and 0.5% in non-diabetics, respectively. There was no significant difference in the distribution of food security status between the two diabetic and non-diabetic groups. As shown in Table 1, food security scores were significantly different between males and females, different employment statuses and educational levels in diabetic individuals ($P < 0.05$). In non-diabetic individuals, food security scores differed significantly between different educational levels and different marital statuses ($P < 0.05$).

Food insecurity odds ratio (OR) in non-diabetic women was 3.2 times higher than in men (OR = 3.2, 95% confidence interval [CI]: 1.3–7.7); this was also obvious in the diabetic group, in whom the OR of food insecurity in women was 2.4 times higher than in men (OR = 2.4, 95% CI: 1.02–5.5) [Table 2]. In both groups, the risk for food insecurity increased with increasing age, although it was not statistically significant. As shown in Table 2, OR decreased with increasing education level. Risk of food insecurity in diabetic individuals with less than high school education was 8.6 times higher than in people with university education (OR = 8.6, 95% CI: 1.9–38.6), and it remained significant after adjustment for other variables (OR = 8.3, 95% CI: 1.7–33.2). In the diabetic group, being single increased the risk of food insecurity (OR = 4.5, 95% CI: 1.7–12.1). In non-diabetic individuals, the risk of food insecurity in housewives was 3.3 times higher than employed persons (OR = 3.3, 95% CI: 1.3–8.5).

Average BMI in non-diabetics was 28.8 ± 4.0 kg/m^2 and in diabetics was 29.1 ± 5.0 kg/m^2. In the non-diabetic group, the percentages of overweight and obesity were 46.7% and 35.7% and in the diabetic group were 40.9% and 38.4%, respectively and there were no significant differences between the two groups. In the non-diabetic group, the risk of food insecurity in obese individuals was 3.3 times higher than normal individuals (OR = 2.1, 95% CI: 1.2–4.1).

DISCUSSION

In this study, the percentage of diabetic subjects with food insecurity was not significantly different to non-diabetics. There was no significant difference in the mean of food security score between diabetic and non-diabetic subjects. Our study showed that mean of food security scores in both the diabetic and non-diabetic groups in women were higher than in men.

Some papers were in agreement with our results; Stuff *et al*. showed that the prevalence of self-reported diabetes in food insecure individuals and food secure individuals was not significantly different after adjusting for race, sex, and household income.[19] Weigel *et al*. showed no significant relationship between food security status and diabetes.[20] Although Seligman *et al*. observed that the risk of self-reported diabetes in people with low food security status was not significantly different to that people with food security status after controlling for age, race/ethnicity, birth order, income, education, obesity, physical activity, and family history of diabetes as confounding factors, the risk of diabetes in people with very low food security status was significantly higher than people with food security status.[21]

In another study, Seligman *et al*. showed that food insecurity was associated with self-reported high blood pressure and hyperlipidemia, but it was not associated with diabetes; they observed no significant difference between prevalence of diabetes among people with food security and without food security. Furthermore, after

Table 1: Mean food security scores according to demographic, smoking, and obesity status in diabetic and non-diabetic participants

Variable value	Diabetic individuals	Number	Non-diabetic individuals	Number	Total	P[b]
Sex						
Male	1.92±1.98	86	2.01±2.06	100	1.97±2.02	0.96
Female	2.71±2.13	114	2.49±2.09	100	2.59±2.10	0.40
P[a]	0.014		0.09		0.003	
Age group (years)						
40-49	2.12±2.11	96	1.95±2.00	61	2.08±2.04	0.46
50-59	2.89±2.03	67	2.18±2.18	77	2.49±2.14	0.03
60-69	2.07±2.09	32	2.65±2.03	49	2.39±2.06	0.21
≥70	2.32±2.14	5	2.58±2.02	13	2.51±1.99	0.68
P	0.12		0.18		0.18	
Employment status*						
Employed	1.91±1.99	85	1.87±2.16	69	1.89±3.07	0.69
Housewives	2.96±2.09	78	2.36±2.02	79	2.66±2.05	0.05
Retired	2.20±2.12	37	2.65±2.05	50	1.82±3.14	0.43
P	0.01		0.08		0.006	
Smoking status**						
Active	3.25±1.89	16	2.65±2.26	15	2.95±2.07	0.57
Quit	2.1±2.13	14	1.95±2.26	16	2.02±2.19	0.70
Nonsmoker	2.35±2.11	167	2.27±2.05	165	2.31±3.13	0.58
P	0.30		0.53		0.17	
Marital status						
Single	2.45±2.19	33	3.13±2.19	22	2.72±2.2	0.31
Married	2.36±2.09	167	2.14±2.05	178	2.25±2.07	0.23
P	0.73		0.031		0.09	
Educational level						
Illiterate	2.50±1.96	6	2.12±2.09	10	2.26±1.99	0.96
Under diploma	3.16±2.05	73	2.66±2.13	103	2.87±2.11	0.05
Diploma	2.27±2.04	77	2.24±1.93	57	2.26±1.99	0.74
University	1.21±1.77	44	0.90±1.65	30	1.09±1.72	0.50
P	0.0001		0.001		0.0001	
BMI status†						
Normal	1.90±1.97	34	2.76±2.12	40	2.33±2.04	0.07
Overweight	2.18±2.10	93	1.93±1.92	81	2.05±1.55	0.36
Obese	2.85±2.09	71	2.28±2.18	76	2.56±2.13	0.06
P	0.05		0.11		0.02	

*In the diabetic group, two of the unemployed were excluded from this part of the study, **In each of the diabetic and non-diabetic groups, three persons were occasional smokers, and the smoking status of one individual was not clear and was excluded from analysis, †Three patients in the diabetic group and two patients in the non-diabetic group had BMI below normal, and were excluded from this part of the study, [a]Comparison of food security scores between demographic, smoking, and obesity status in diabetic and non-diabetic participants separately, [b]Comparison of food security scores between diabetic and non-diabetic groups in different demographic, smoking, and obesity status. BMI=Body mass index

testing fasting blood glucose, the prevalence of diabetes among people with food security and without food security showed no significant difference.[22]

However, a direct relationship between food insecurity and diabetes was reported in two studies;[9,23] Holben and Pheley reported a significant relationship between food insecurity (assessed by the USDA questionnaire) and diabetes; in that study most of the diabetic patients had food insecure status.[9] Results of a comparative study conducted on people with food security in contrast to people with food insecurity status, showed that there were no significant differences in random blood glucose concentration and HbA1c between the food secure and food insecure groups, indicating that self-reported diabetes maybe considered as one of the confounding factors in association between diabetes and food insecurity.[14]

Vozoris and Tarasuk showed that in households experiencing food insufficiency compared with households that receive enough food, self-reported diabetes (type 1 or 2) were more likely; however, they had different definition of food insecurity from our study;

Table 2: Results of logistic regression analysis between food security status and demographic variables in diabetic and non-diabetic participants

Variables	Unadjusted OR	95% CI	Adjusted OR*	95% CI
Diabetic group				
Sex				
Male (ref)	1	-	1	-
Female	2.4	1.02-5.5	1.87	0.8-4.2
Age groups				
40-49 years (ref)	1	-	1	-
50-59 years	1.2	0.41-3.6	1.05	0.61-2.8
60 years and older	2.4	0.86-6.9	1.6	0.73-4.0
Marital status				
Married (ref)	1	-	1	-
Single	4.5	1.7-12.1	1.6	0.91-4.7
Employment status				
Employed (ref)	1	-	1	-
Housewives	1.6	0.62-4.3	1.2	0.52-2.8
Retired	1.9	0.70-5.6	1.4	0.62-4.6
Educational level				
University (ref)	1	-	1	-
Diploma	2.1	0.42-10.6	1.4	0.52-7.3
Lower than diploma	8.6	1.9-38.6	8.3	1.7-33.2
BMI status				
Normal	1	-	1	-
Overweight	0.72	0.57-2.0	0.83	0.64-2.3
Obese	0.83	0.66-2.3	0.92	0.78-2.8
Non-diabetic group				
Sex				
Male (ref)	1	-	1	-
Female	3.2	1.3-7.7	1.07	0.88-5.8
Age groups				
40-49 years (ref)	1	-	1	-
50-59 years	1.1	0.36-3.3	1.06	0.41-2.9
60 years and older	2.02	0.88-4.6	1.33	0.69-3.5
Marital status				
Married (ref)	1	-	1	-
Single	1.5	0.60-3.9	1.06	0.42-2.7
Employment status				
Employed (ref)	1	-	1	-
Housewives	3.3	1.3-8.5	2.4	0.93-7.6
Retired	2.6	0.84-8.0	1.7	0.8-7.3
Educational level				
University (ref)	1	-	1	-
Diploma	2.8	0.31-25.0	1.8	0.88-16.6
Lower than diploma	7.0	0.90-54.3	2.14	0.9-52.1
BMI status				
Normal	1	-	1	-
Overweight	1.1	0.8-1.6	1.03	0.7-1.5
Obese	2.1	1.2-4.1	1.6	0.8-3.4

*All the variables entered in the regression model simultaneously. Ref=Reference group, OR=Odds ratio, BMI=Body mass index, CI=Confidence interval

in addition, they explained only a limited number of potential confounders such as age, sex, education, and income levels and did not distinguish between type 1 or 2 of diabetes, reporting generally that people in households with poor food sufficiency were significantly more likely to report heart disease, diabetes, high blood pressure, and food allergies.[23]

In the Jang study, a direct relationship between food security and diabetes was observed in individuals with very low food security status and was even higher than in people with borderline food security, this relationship remained after matching for obesity status, factors related to lifestyle (physical activity, smoking, alcohol, and dietary intake), family history of diabetes and multiple diseases. However, there was no relationship between low food security and risk of diabetes.[24] This relationship was not observed in our study, which may be due to low sample size. In the Jang study, maximum prevalence of food insecurity was observed in the 20–39 years age group;[24] however, there is no data reporting the relationship observed between food insecurity and diabetes in populations over 40 years.

In another study, Gucciardi *et al*. observed that prevalence of food insecurity in a population of diabetic women was higher than in non-diabetic women, but they reported no significant difference in men; they estimated that household food insecurity was more likely in people whose diabetes was diagnosed before the age of 40, and they reported the highest prevalence of food insecurity in the 12–45 years old group.[25]

On the other hand, Ward and Whiting reported that food insecurity was inversely associated with risk of diabetes. After controlling of age, sex, marital status, employment status, academic progress, number of children in household, nutritional and health risk, food consumption traditions and food sources, people in households with higher food insecurity were less likely to develop diabetes.[26]

This study has some limitations. Since this was a case-control study, authors could not describe the cause and effect relationship between diabetes and food insecurity; neither could they establish whether the food insecurity in households was temporary or chronic. In addition, due to sampling limitations, the diabetic population of this study had a history of diabetes prior to entering in this study; hence it was likely that they had changed their diet. Although authors tried to complete the validated questionnaire of determining household food security status using one interviewer, the impact of some social and cultural factors cannot be ignored; these factors may impact the interpreting of questions of the questionnaire or the answers given by responders. Moreover, in our study the number of individuals with very low levels of food security was limited and it was impossible to analyze the relationship between very low levels of food security and type 2 diabetes.

CONCLUSIONS

There is no difference in food security levels between diabetic and non-diabetic participants and we found no association between diabetes and food security. However, some risk factors of type 2 diabetes including sex, marital status, educational level, and obesity were associated with food insecurity. Although our study found no link between food security and type 2 diabetes, the evidence of possible significant associations between risk factors of type 2 diabetes and food security obtained in this study, indicated that food security may be indirectly associated with type 2 diabetes.

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