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The Association of Food Insecurity, Inflammation, and Several Socioeconomic Factors with Type 2 Diabetes: A Case-Control Study

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ABSTRACT

Background: Considering that food insecurity can be a precursor to health and nutrition problems, determining its associated factors seems necessary in any society. The purpose of this case-control study was to determine the food insecurity, c-reactive protein (CRP), and some socio-economic factors in type 2 diabetic patients. **Methods:** The present study was conducted on 200 people with type 2 diabetes mellitus (T2DM) and 200 healthy individuals within the age range of 30 to 59 years. Food security was assessed using the US Department of Agriculture Household Food Security questionnaire. Anthropometric index, physical activity, and biochemical factors were measured by questionnaire and blood test. **Results:** The prevalence of food insecurity was 71% within the diabetic patients, of which, 65.5% had food insecurity without hunger, 3.5% had food insecurity with moderate hunger, and 2% had food insecurity with severe hunger. In addition, 24.9% of the participants were healthy. The level of fasting blood glucose and inflammatory factors (CRP, WBC) were significantly higher in food insecure participants compared to the healthy individuals ($P < 0.05$). Multivariate logistic analysis showed that food insecurity, BMI > 25, occupational status, economic status, and education level were significantly correlated with T2DM ($P < 0.001$). **Conclusion:** As a result, health care providers should take measures to reduce the food insecurity in the community, specifically within T2DM patients. To this end, the individuals' economic status should be improved and the household food patterns should be modified.

Keywords: *Acute phase protein; Diabetes; Food insecurity; Inflammation; Socio-economic variables*

Introduction

Diabetes mellitus is a group of metabolic disorders associated with an increase in blood glucose level. This increase is due to the impaired secretion of insulin, insulin function, or both (Franz, 2008). The International Federation for Diabetes (IDF) estimates the prevalence of

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diabetes about 642 million individuals by year 2040. For example, the prevalence of diabetes was reported as 9.9% in Iran, which was estimated to increase to 10.1% by 2035 (Whiting *et al.*, 2011). The range of food insecurity varies from anxiety about access to food at the household level to a high degree of hunger among children who have no food to eat (Frongillo and Nanama, 2006, Kendall *et al.*, 1995). The increased levels of the household income, parents' level of education, their occupational status, their age, the number of working family members, the socioeconomic status of the family, and the effective factors on diet (such as the nutritional habit of the region) had a significant relationship with the food security status of the households (Hakim *et al.*, 2011, Hakimi *et al.*, 2012, Mohammadzadeh *et al.*, 2010a, Ramesh *et al.*, 2010, Saadi and Vahdat, 2013). According to the studies conducted in Iran, the prevalence of food insecurity was 23.2% in the whole country (Mohammadi *et al.*, 2008). Moreover, the prevalence of food insecurity was reported to be 20%, 32%, and 44% in Tehran (Qasemi and Kimiagar, 1998), Yazd (Ramesh, 2009), and Shiraz (Karam Soltani, 2004), respectively. People with food insecurity are at the risk of lower food variety, low quality diets, reduced intake of micronutrients, as well as less reception of fruits and vegetables (Adams *et al.*, 2003, Dixon *et al.*, 2001, Frongillo and Nanama, 2006, Nord *et al.*, 2005).The high prevalence of food insecurity and type 2 diabetes (T2DM) have been reported in Iran. Furthermore, no study has ever investigated the relationship between inflammatory factor and food insecurity in Iran. Therefore, the present study was conducted to examine the association of food insecurity, inflammation, and some socioeconomic factors with type 2 diabetes.

Materials and Methods

Participants and design: The present study was conducted on 200 people with T2DM and 200 healthy individuals within the age range of 30 to 59 years. The inclusion criteria for the intervention group were having diagnosed diabetes by a diabetic specialist and a medical electronic record since 2016, showing that they continued their treatment for a long time under the supervision of a diabetic specialist. The control group included healthy individuals randomly by the random sampling method from comprehensive health centers of Shohada and Minoodar in Qazvin in 2017. All participants were homogenized in terms of age and gender. Considering the significance level of 5% and at least 90% of test power, the sample size was estimated as 200 for each group based on the Najibi and Khosravi's study (Hasan-Ghomi *et al.*, 2015, Kendall *et al.*, 1996).

The criteria for entering the study were being within the age range of 30-60 years, having no metabolic, infectious, and inflammatory diseases, consuming no estrogen hormones (both groups of study), having T2DM (with a fasting blood glucose standard of greater than 126 mg/dl), and having no change in the treatment and medication procedure at least over the past two months (case group). Exclusion criteria included pregnancy and lactation, lack of satisfaction to enter the research, people with a specific diet or diet changes over the past 2 months due to the history of heart diseases or heart strokes, cancer, and acute renal diseases.

Measurements: The participants' weight was measured in light clothing without shoes using the Seca scale (Hamburg, Germany) to the nearest 100 g. Furthermore, the participants' height was measured by a tape meter mounted on the wall with a precision of 0.5 cm using the standard instructions. Later, the participants' body mass index (BMI) was calculated by dividing the weight (kg) by the height (m^2).

The patients were tested at Shohada laboratory. The latest information on biochemical tests, including fasting blood sugar (FBS) and lipid profile, was read from the patient's records and recorded in a questionnaire.

Household food security was assessed using Household Food Security questionnaire entailing 18 items (USDA, 2015). Validity and reliability of the mentioned questionnaire were confirmed by Rafiei et al. (Rafiei, 2009). All questionnaires were completed by a trained person. The Bikel method was applied and the participants were divided into

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four groups of food secure, food insecure without hunger, food insecure with moderate hunger, and food insecure with severe hunger, based on their scores achieved from the questionnaire (Bickel *et al.*, 2000):.

The participants' physical activity level was measured by completing the standard physical activity questionnaire (IPAQ) after interviewing with the patients. This questionnaire examines the status of a person's physical activity and classifies it into the weak, moderate, and severe levels. This questionnaire was used in various studies in Iran, which confirmed its validity and reliability (Moghaddam *et al.*, 2012).

In this study, such variables as age, gender, marital status, education, occupation, household dimension, and economic status were collected for all participants. The latest information with regard to the biochemical tests (sugar and fat) were collected from the participants' electronic records and recorded in the questionnaire. In order to measure the serum CRP, immunoturbidimetric method and hs-CRP quantitative diagnostic kit (Pars Test, Karaj, Iran) were utilized. Systolic and diastolic blood pressure were measured by a trained nurse from the patients' right arm in the sitting calm position after 5 minutes of rest using a Mercury barometer. The Korotkoff sound technique was used three times with a 5-minute interval and the average score was recorded. The participants' food intake was analyzed via the Nutritionist IV software.

All data were analyzed by SPSS (version 16) and the results were reported. Qualitative variables were reported in absolute and relative frequency tables and quantitative variables were reported by mean and standard deviation. Moreover, independent t-test was applied to determine the relationship between quantitative variables. Mann-Whitney test was run to compare the means of two independent groups. Finally, multiple logistic regression was used to investigate the effect of confounding variables. The significance level for all calculations was considered as P-value < 0.05.

Ethical considerations: This study was approved by the ethic research committee of the School of Public Health in Yazd University of Medical Sciences with the Ethics Code of IR.SSU.SPH.REC.1397.018. Written consents were also collected from all participants.

Results

The participants' characteristics are shown in **Table 1**. No significant difference was observed between the two groups in terms of age, gender, marital status, household dimension, and number of working people. The two groups were significantly different with respect to occupation ($P = 0.005$), economic status ($P < 0.001$), education ($P = 0.01$), number of life assets ($P < 0.001$), and BMI ($P < 0.001$). The prevalence of food insecurity was 24.9% and 71%, in the control and intervention groups, respectively. Of the reported rates, 65.5% were food insecure without hunger, 3.5% were food insecure with moderate hunger, and 2% were food insecure with severe hunger. The prevalence of food insecurity in the intervention and control groups was statistically significant ($P < 0.001$). The studied groups did not reveal any significant difference in terms of age and gender, which indicated that the two groups were homogenized accurately in terms of age and gender. The results of **Table 2** show the relationship of biochemical factors, inflammation, and blood pressure with food insecurity. The level of blood glucose in food insecure individuals was 1.16 times higher than that of the food secure individuals, this difference was significant ($P = 0.02$). No statistically significant difference was observed between the insecure food and secure food groups with regard to the serum level of lipid profiles and blood pressure ($P < 0.05$). The rate of inflammatory factors was significantly higher in food insecure individuals than the secure food individuals ($P < 0.001$). **Table 3** represents results of the final model of logistic regression. The final independent variables affecting T2DM were food insecurity, BMI, occupational status of the individual responsible for household food supply, number of life assets, economic status, and education. Results of the logistic regression model demonstrated that

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prevalence of the people with food insecurity was 4.74 times more than the participants with food security. Furthermore, risk of T2DM was 1.13 times more in individuals with overweight and obesity than the normal-weight individuals. The risk of T2DM was 3.5% higher among the unemployed individuals responsible for the household food supply (or their spouses) than the employed. Households with fewer than 3 assets of life were 1.78% more likely to develop T2DM than those with more than 3 life assets. The risk of T2DM was 1.66 times higher in households with a weak and average economic status than households with good economic status. Households with a diploma and sub-diploma educational degrees were 1.02 times more probable to develop T2DM than individuals with higher levels of education.

Table 1. Comparison of some study variables between case and control groups

Variables	Control	Case	P-value
Age (y)	46.32 ± 8.64	47.14 ± 8.20	0.34
Body mass index (kg/m^2)	26.50 ± 4.6	29.7 ± 4.5	0.001[a]
Gender	N (%)	N (%)	
Male	85 (42.5)	91 (45.5)	0.54[a]
Female	115 (57.5)	109 (54.5)	
Occupation			0.005[b]
unemployed	70 (35.5)	111(55.5)	
Employed	130 (65.0)	89 (44.5)	
Economic status of household			0.001[b]
Poor and average	92 (46.0)	134 (67.0)	
Good	108 (54.0)	66 (33.0)	
Education			0.01[b]
Under diploma	105 (52.5)	147 (73.5)	
Diploma	74 (37.0)	39 (19.5)	
Bachelor's degree	12 (6.0)	11 (5.5)	
Masters' degree and higher	10 (5.0)	2 (1.0)	
Marital Status			0.62[b]
Single	1(0.5)	2 (1.0)	
Married	194 (97.0)	190 (95.0)	
Widow	8 (4.0)	5 (2.5)	
Household dimension			0.44[b]
Less than 3	145 (72.5)	148 (74.0)	
More than 3	55 (27.5)	52 (26.0)	
Number of employed individuals			0.7[b]
0	13 (6.5)	14 (7.0)	
1	165 (82.5)	166 (83.0)	
2 and more	22 (11.0)	20 (10.0)	
Number of items of life			<0.001[b]
3 <	73 (36.5)	129 (64.5)	
≤ 3	127 (63.5)	71 (35.5)	

[a]: Student t-test1; [b]: Chi-square test

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Table 2. Relationship between biochemical factors, blood pressure, and food insecurity

Variables	B	S.E	P-value	OR
Fasting blood sugar (mg/dl)	0.015	0.007	0.02	1.01
Cholesterol (mg/dl)	0.078	0.414	0.80	1.08
Triglyceride (mg/dl)	0.035	0.083	0.60	0.90
High density lipoprotein (mg/dl)	-0.068	0.414	0.80	0.90
Low density lipoprotein (mg/dl)	0.074	0.414	0.80	0.90
Systolic blood pressure (mmHg)	0.004	0.013	0.70	0.90
Diastolic blood pressure (mmHg)	0.003	0.018	0.80	1.03
C- reactive protein (mg/dl)	0.820	0.150	< 0.001	2.70
Wight blood cell	0.370	0.100	< 0.001	1.45

Table 3. The final model of multivariate logistic regression in investigating the relationship of food insecurity and socio-economic variables with diabetes

Variables	B	S.E	p-value	OR
Food insecurity	1.550	0.250	< 0.001	4.74
Body mass index	0.125	0.029	< 0.001	1.13
Occupational status	1.110	0.302	< 0.001	3.05
Individual responsible for Household food supply				
Number of items of life	-0.164	0.078	< 0.001	1.78
The economic status	-1.090	0.185	0.005	1.66
Education	-0.508	0.260	0.005	1.02

Discussion

The present study was conducted on the middle aged in Qazvin. Its results showed a direct significant relationship between food insecurity and T2DM. Based on the findings, 71% of people with T2DM and 24.9% of the controls had mild to severe food insecurity and a statistically significant relationship was found between T2DM and food insecurity. Our findings were consistent with those of Aria et al. (Aria, 2015) in reporting a significant relationship between food insecurity and T2DM. Moreover, an association was observed between food insecurity and T2DM, so that prevalence of diabetes in food secure, mild food insecure, and severe food insecure groups were 11.7%, 10%, and 16.1%, respectively. These results were also supported by other studies (Seligman *et al.*, 2007). After adjusting for the factors related to the social demography and physical activity, the prevalence of diabetes was observed to be higher in individuals with severe food insecurity compared to those with mild food insecurity and those without food insecurity. (Seligman *et al.*, 2011). Khosravi et al. showed no significant relationship between gestational diabetes and food insecurity (Khosravi *et al.*, 2015). Hasn-Qomi et al. revealed no significant difference between individuals' suffering from diabetes and the control group in terms of the level of food security, which is in contrast with the results of our study (Hasan-Ghomi *et al.*, 2015). Kendall et al. showed that underlying causes such as low economic status and food insecurity led people to buy cheaper foods, reduce their food intake, and change their type of food. Therefore, food diversity decreases and consumption of high-calorie foods increases (Kendall *et al.*, 1995). The high-calorie foods include refined grains and trans or saturated fat, which are nutritionally low in quality and cheaper than their substitutes with the same amount of calorie (Xie and Du, 2011). These nutritional patterns cause obesity, high blood pressure, increased blood lipids, and diabetes. A significant relationship was observed between T2DM and low economic status. In

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general, findings of the present study justified that unfavorable socio-economic status could limit the individuals' access to nutrients and energy. As a result, people are faced with a lack of choice and compulsion to change their food habits. So, economic constraints are considered as another aspect of food insecurity.

It can be argued that the economic status increases the risk of T2DM indirectly through food insecurity. In the current study, a significant relationship was found between T2DM and unemployment. In individuals with and without T2DM, individuals responsible for the household food supply were 55.5% and 35.5% unemployed, respectively. Therefore, job status can lead to T2DM indirectly through food insecurity. The results of this study were in line with those of previous studies, mentioning that a significant relationship was detected between food insecurity and occupation status)Mohammadzadeh *et al.*, 2010b)). Unemployment and low income affects the lifestyle. Employed people have a better economic status; so, the likelihood of food insecurity and its consequences is reduced among them. T2DM had a significant relationship with overweight and obesity. Most studied individuals with T2DM were overweight and obese compared to the controls (BMI $\geq$ 25). Results of several studies were consistent with our findings, which showed a positive significant correlation between high BMI and T2DM (Narmaki *et al.*, 2017). . In few studies, obesity was not associated with diabetes, but other factors such as physical activity level and low levels of insulin affected incidence of diabetes (Santos *et al.*, 2001). Obesity, either independently or by producing free fat acids, can lead to insulin resistance. Obesity increases the peripheral resistance to insulin and causes T2DM by removing insulin-mediated glucose (Santos *et al.*, 2001). On the other hand, obesity and overweight are indirectly related to T2DM through food insecurity. The results of this study are consistent with those of previous studies (Hakim *et al.*, 2011, Narmaki *et al.*, 2017); in finding a positive and significant correlation between food insecurity and high BMI. People with food insecurity are at risk of overweight and obesity due to consuming cheap and high-calorie diets. Moreover, food deprivation in low-income families causes over-eating (excessive consumption of food at a time when food is available) and under-eating (limitation in food intake when there is not enough food). Consequently, this dietary misconduct can lead to weight gain and weight loss, overweight, and obesity. The level of fasting blood glucose had a positive significant relationship with food insecurity. Drewnowski et al. stated that food insecure people eat cheap foods that are inadequately nutritious but have high energy density (Drewnowski and Darmon, 2005)). For instance, food insecure people eat less fruit and vegetable, but consume higher calories from refined carbohydrates and saturated fats. This type of diet can be associated with increased levels of glucose in food insecure people and increase the risk of T2DM (Ford and Mokdad, 2001). A positive significant correlation was found between CRP inflammation factor level, WBC, and food insecurity. Gowda et al. demonstrated that nutritional deficiencies and inadequate energy intake of the insecure people change their diet patterns and dietary preferences (Gowda *et al.*, 2012). When individuals are deprived of important nutrients, their bodies become more vulnerable to infection; as a result, physiologic expression and immunity will start to fight infection. This reaction stimulates the body to release large amounts of white blood cells and CRP. Indeed, CRP is a classic acute phase protein for inflammatory reactions. Its biomarker has a significant correlation with several chronic diseases, including T2DM. The results of this study may indicate that food insecure individuals are more susceptible to inflammation, which may lead to non-communicable diseases such as diabetes, hypertension, and cardiovascular disease.

To the best of our knowledge, this study was the first case-control research in Iran on the food

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insecurity and inflammatory factors. Our findings can be served as a basis for wider research. We also adjusted for the effect of potential confounding factors in multivariate regression logistic model, which is considered as strength of this study. However, the existing limitations should be taken into account. In this study, cross-sectional data were used to identify the relationship between food security and the likelihood of T2DM, in which the cause and effect relationship as well as the temporary or chronic nature of the food insecurity were not determined in households. Consequently, future researchers are recommended to study the impact of food security on diabetes in different age groups by cohort studies.

Conclusion

Food insecurity, fasting blood glucose, and inflammatory factors had a significant relationship with incidence of T2DM. Therefore, planners are recommended to reduce the food insecurity in the community, especially within women by improving the economic status and modifying the household food patterns.

Conflicts of interest

There was no conflict of interest in this study.

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Authors' contributions

Janzadeh H performed the study and collected the data as well as writing the manuscript; Mozaffari-Khosravi H and Javadi M contributed in designing and conducting the project, analyzing and interpreting the data and writing the manuscript.

References

Adams EJ, Grummer-Strawn L & Chavez G 2003. Food Insecurity Is Associated with Increased Risk of Obesity in California Women. *Journal of nutrition.* **133 (4)**: 1070-1074.

Aria M 2015. The Comparison of Food Insecurity between Patients with Type 2 Diabetes Mellitus and Non-Diabetic Controls Referred to Rural Health Centers in Abadan in 2014. In *Nutrition department*. Ahvaz University of medical sciences: Ahvaz.

Bickel G, Nord M, Price C, Hamilton W & Cook J 2000. Guide to measuring household food security lexandria. Department of Agriculture Food and Nutrition Service. Revised.

Dixon LB, Winkleby MA & Radimer KL 2001. Dietary Intakes and Serum Nutrients Differ between Adults from Food-Insufficient and Food-Sufficient Families: Third National Health and Nutrition Examination Survey, 1988–1994. *Journal of nutrition.* **131 (4)**: 1232-1246.

Drewnowski A & Darmon N 2005. The economics of obesity: dietary energy density and energy cost–. *American journal of clinical nutrition.* **82 (1)**: 265S-273S.

Ford ES & Mokdad AH 2001. Fruit and vegetable consumption and diabetes mellitus incidence among US adults. *Preventive medicine*. **32 (1)**: 33-39.

Franz MJ 2008. Medical nutrition therapy for diabetes mellitus and hypoglycemia of nondiabetic origin. *Krause's food.*

Frongillo EA & Nanama So 2006. Development and Validation of an Experience-Based Measure of Household Food Insecurity within and across Seasons in Northern Burkina Faso. *Journal of nutrition.* **136 (5)**: 1409S-1419S.

Gowda C, Hadley C & Aiello AE 2012. The association between food insecurity and inflammation in the US adult population. *American journal of public health.* **102 (8)**: 1579-1586.

Hakim S, Dorosty A & Eshraqian M 2011. Relationship between food insecurity and some of socioeconomic factors with BMI among women in Dezfoul. *Iranian journal of school of public health.* **2**: 55-66.

[DOR: 20.1001.1.24767417.2020.5.1.6.1]
[DOI: 10.18502/jnfs.v5i1.2317]

Hakimi S, Dorosti A & Eshraghian M 2012. Prevalence of food insecurity and its correlates. *Payesh.* **11 (6)**: 791-797.

Hasan-Ghomi M, et al. 2015. Relationship of food security with type 2 diabetes and its risk factors in Tehranian adults. *International journal of preventive medicine.* **6**.

Karam Soltani Z 2004. The study of association between obesity and food insecurity among primary school students in Yazd [dissertation]. In *Tehran: Tehran University*.

Kendall A, Olson CM & Frongillo Jr EA 1995. Validation of the Radimer/Cornell measures of hunger and food insecurity. *Journal of nutrition.* **125 (11)**: 2793-2801.

Kendall A, Olson CM & Frongillo Jr EA 1996. Relationship of hunger and food insecurity to food availability and consumption. *Journal of American dietetic association.* **96 (10)**: 1019-1024.

Khosravi S, Alavi Naeini AM, Ghorbani M & Shateri Z 2015. Association between food insecurity and gestational diabetes mellitus: A case-control study. *Journal of school of public Hhalth and institute of public health research.* **13 (3)**: 73-84.

Moghaddam MHB, et al. 2012. The Iranian Version of International Physical Activity Questionnaire (IPAQ) in Iran: Content and Construct Validity, Factor Structure, Internal Consistency and Stability. *World applied sciences journal*. **18 (8)**: 1073-1080.

Mohammadi F, Omidvar N, Houshiar Rad A, Mehrabi Y & Abdollahi M 2008. Association of food security and body weight status of adult members of Iranian households. *Iranian journal of nutrition sciences & food technology*. **3 (2)**: 41-53.

Mohammadzadeh A, Dorosty A & Eshraghian M 2010a. Household food security status and associated factors among high-school students in Esfahan, Iran. *Public health nutrition.* **13 (10)**: 1609-1613.

Mohammadzadeh A, Dorosty Motlagh A & Eshraghian M 2010b. The association of food security with socio-economic factors and weight status among adolescents. *Iranian journal of nutrition sciences & food technology*. **5 (1)**: 55-62.

Narmaki E, Shirasb F, Qorbani M & Sotoudeh G 2017. Association between food security and anthropometric measurements, body composition, blood pressure in women attending municipality sports clubs in west of tehran. *Iranian journal of diabetes and metabolism.* **16 (2)**: 103-110.

Nord M, Andrews M & Carlson S 2005. Household food security in the United States, 2006. Food Assistance and Nutrition Research Program. *Economic research services, USDA, economic research report.* **11**.

Qasemi H & Kimiagar M 1998. Food security programme in Islamic Republic of Iran. Tehran: Institute of Food and Nutrition Research.

Ramesh T 2009. The Prevalence of food insecurity and some associated factors among Shirazian households in 2009. In *Tehran shahid beheshti University of medical sciences*.

Ramesh T, Dorosty Motlagh A & Abdollahi M 2010. Prevalence of household food insecurity in the City of Shiraz and its association with socio-economic and demographic factors, 2008. *Iranian journal of nutrition sciences & food technology*. **4 (4)**: 53-64.

Saadi H & Vahdat MH 2013. Assessment of female-headed household's food security and the affecting factors; Case Study: Women in Razan City. pp. 411-426.

Santos JL, Pérez-Bravo F, Carrasco E, Calvillán M & Albala C 2001. Low prevalence of type 2 diabetes despite a high average body mass index in the Aymara natives from Chile. *Nutrition.* **17 (4)**: 305-309.

Seligman H, Laraia B & Kushel M 2011. chronic disease among low-income NHANES participants. J Nutr. 140: 304-10. *Journal of nutrition.* **140 (2)**: 304-310.

Seligman HK, Bindman AB, Vittinghoff E, Kanaya AM & Kushel MB 2007. Food insecurity is associated with diabetes mellitus: results from the National Health Examination

[DOR: 20.1001.1.24767417.2020.5.1.6.1]
[DOI: 10.18502/jnfs.v5i1.2317]

and Nutrition Examination Survey (NHANES) 1999–2002. *Journal of general internal medicine*. **22 (7)**: 1018-1023.

USDA N 2015. The plantss database (http://plants. usda. gov, May 2011). National Plant Data Team, Greensboro. NC.

Whiting DR, Guariguata L, Weil C & Shaw J 2011. IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030. *Diabetes research and clinical practice*. **94 (3)**: 311-321.

Xie W & Du L 2011. Diabetes is an inflammatory disease: evidence from traditional Chinese medicines. *Diabetes, obesity and metabolism*. **13 (4)**: 289-301.

[DOR: 20.1001.1.24767417.2020.5.1.6.1]

[DOI: 10.18502/jnfs.v5i1.2317]