JNFS
Journal of Nutrition and Food Security
Shahid Sadoughi University of Medical Sciences
School of Public Health
Department of Nutrition
Shahid Sadoughi University of Medical Sciences School of Public Health

eISSN: 2476-7425 pISSN: 2476-7417 JNFS 2025; 10(1): 23-31 Website: jnfs.ssu.ac.ir

The Comparison of Food and Nutrient Intake among Iranian Diabetic and Non-Diabetic Adults

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ARTICLE INFO

ORIGINAL ARTICLE

Article history:
Received: 24 Jul 2023
Revised: 10 Sep 2023
Accepted: 21 Oct 2023

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Keywords:
Food intake;
Nutrients;
Diabetes mellitus;
Diet;
Iran.

ABSTRACT

Background: Diabetes is known as a rising global health metabolic disorder. Eating choices are considered as a main factor in type 2 diabetes (T2D) prevention and treatment. This study aimed to investigate the comparison of food and nutrient intake among diabetic and non-diabetic adults in Iran. **Methods**: This cross-sectional study was performed on 5442 Iranian adults aged 35–70 years from Shahedieh cohort study, Yazd, Iran. Dietary intake of participants was evaluated using a validated 121-item food frequency questionnaire. All data about the amount of food groups, total energy, micronutrients, and macronutrients intake were analyzed using SPSS version 23.0. **Results**: Participants without diabetes showed significantly higher intake of grains, legumes, total meat, fats, sweets, energy, carbohydrates, total fat, total cholesterol, saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, vitamin B9, B12, A, and D in comparison with patients with diabetes. On the other hand, diabetic patients revealed significantly higher amounts of vegetables, fruits, dietary fiber, biotin, potassium, and magnesium consumption compared to non-diabetic participants. **Conclusion:** Given that diet and nutrition are widely believed to play an important part in the development of T2D, significant differences were found in dietary habits of diabetic patients in comparison with participants without diabetes. These findings suggest that emphasis on education is required to improve the current dietary behaviors to assist in the prevention of disease complications.

Introduction

Diabetes mellitus is one of the most common global health issues (Zimmet *et al.*, 2016). During the last few decades, the prevalence of diabetes mellitus has risen dramatically (Zimmet *et al.*, 2016). There were approximately 171 million diabetic patients worldwide in 2000, and it is expected that this number will rise to 366 million by 2030 (Wild *et al.*, 2004). Type 2 diabetes (T2D) is a progressive endocrine and metabolic disease with a wide spectrum of pathologic conditions including insulin resistance, hyperglycemia, oxidative stress, body inflammation, and lipid

This paper should be cited as: Maayeshi N, Mozaffari-Khosravi H, Khayyatzadeh SS, Fallahzadeh H**. *The Comparison of Food and Nutrient Intake among Iranian Diabetic and Non-Diabetic Adults.*** *Journal of Nutrition and Food Security (JNFS)*, 2025; 10 (1): 23-31.

[DOI: 10.18502/jnfs.v10i1.17753]

profile abnormalities (Abou-Seif and Youssef, 2004). Long term complications such as nephropathy, neuropathy, and retinopathy would be predictable in the absence of timely treatment for T2D (Nathan, 1993). There is a mutual relationship between T2D and diet composition, pointing toward the importance of recognizing healthy nutritional habits as a critical component of T2D self-management (Mann and Te Morenga, 2013).

There is a comprehensive literature on diet and diabetes management (Wheeler *et al.*, 2012). A healthful dietary behavior is intended to help control the modifiable risk factors of T2D such as blood glucose level and thereby reduce the burden of related metabolic disorders (Nöthlings *et al.*, 2011). According to previous studies, a significant reduction in glycated hemoglobin after intensified nutrition therapy has been observed in patients with longstanding T2D whose oral hypoglycemic or insulin treatment had been optimized (Coppell *et al.*, 2010). Given that the majority of people at risk of or live with T2D are overweight or obese, it is no wonder that weight loss (typically 5% of initial body weight) has historically been the most consistent nutrition-related determinant of positive outcomes (Lindström *et al.*, 2006). The most explicit dietary recommendations for T2D patients are detailed in terms of nutrient composition of the diet, with an emphasis on carbohydrate, dietary fat and cholesterol intake (American Diabetes Association, 2007). In this regard, it has been suggested that the intake of saturated fatty acids may increase risk of diabetes by altering cell membrane structure and reduced insulin receptor activity (Colditz *et al.*, 1992). Other researchers have proposed that fiber intake may decrease the risk of developing diabetes via enhancing peripheral insulin sensitivity (Anderson and Bryant, 1986). Several experimental studies have revealed that the intake of magnesium, potassium, and calcium may play an important role in increasing insulin secretion and lowering the concentration of blood glucose in T2D individuals (Durlach and Collery, 1984, Károlyi, 1987, Sjögren *et al.*, 1988). Therefore, with regard to the importance of nutrition therapy in diabetes management, we hypothesized that food and nutrient intake differs between individuals with and without diabetes. Thus, this study aimed to investigate this hypothesis in a large prospective study of Iranian population.

Materials and Methods

Study participants and data collection

This cross-sectional study was performed in the context of the baseline data of Shahedieh cohort study, as a part of the PERSIAN cohort; this cohort aimed to investigate the predisposing factors of non-communicable diseases among Iranian adults aged 35-70 years (Poustchi *et al.*, 2018). Briefly, at the first stage, all 10194 adults, aged 35–70 years, living in two municipal areas of Yazd city (Zarch and Shahedieh) Yazd province, Iran, were invited to take a part in Shahedieh study during 2015-2016. Inclusion criteria were age between 35-75 years and residence in Shahedieh district at least for 9 months each year. Blood samples, anthropometric and blood pressure measurements, general characteristics, dietary intake, smoking, and other lifestyle related data were then collected from the eligible individuals by trained assistants. For the present study, data on 10143 adults were provided. Participants with incomplete information (n=367), without any established diagnosis of T2D (n=489), under or over report of dietary intake (daily energy intake less than 800 kcal/day or more than 4200 kcal/day) (n=3677), and missing data (n=168) were excluded. A total of 5442 participants remained for this study.

Assessment of dietary intakes

The study participants were interviewed to fill a validated 121-item food frequency questionnaire (FFQ) which was designed based on Iranian food items to assess the frequency and amount of consumption for each food item over the past 12 months (Mirmiran *et al.*, 2010). Then, all reported intakes were converted to g/day via household portion sizes of consumed food (Ghaffarpour *et al.*, 1999). Daily nutrient intake of all individuals was calculated using the United States Department of Agriculture Department of Agriculture (USDA) national nutrient database (Ahuja *et al.*, 2012).

[DOI: 10.18502/jnfs.v10i1.17753]

Measurement of anthropometric indices

Anthropometric parameters (weight, height) were measured by a trained investigator according to the US National Institutes of Health protocols (Janssen *et al.*, 2002). Body weight was assessed while the participants were in light clothing and without shoes to the nearest 0.1 kg using an electronic digital scale (SECA, model 755, Germany). Participants' height was measured via a standard stadiometer, with a precision nearest to 0.5 cm. The body mass index (BMI) was calculated by dividing weight (kg) by height (meter) square. Waist circumference (WC) was assessed as the minimum abdominal circumference between the last gear and elliptical bone to the nearest 0.5 cm. Central obesity was defined as WC ≥ 102 cm in men and ≥ 88 cm in women, according to the cutoff points for Caucasians. All anthropometric indices were measured in a fasting situation at the morning in order to reduce measurement error.

Ethical considerations

The procedure of the present study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran (IR.SSU.SPH.REC.1398.003).

Data analysis

All data analyses were done using SPSS version 23.0. The Kolmogorov-Smirnov test was used to assess the normality of data. Qualitative variables were compared using chi-square test. In order to make comparison between two groups, independent t or Mann–Whitney U tests were used. P-value<0.05 was considered to be statistically significant.

Results

General characteristics of participants are reported in **Table 1**. A total of 5442 participants were included in this study. The mean age of participants was 48.57±9.77 years, and 58.7% were female. The prevalence of diabetes and non-diabetes among study subjects was 19.7% and 80.3%, respectively.

Table 1. General characteristics of the study participants.

Variables	Total (n=5442)	Diabetes (n=1073)	No diabetes (n=4369)	P-value[a]
Gender				
Female	3196 (58.7)[b]	680 (63.4)	2516 (57.6)	0.001
Male	2246 (41.3)	393(36.6)	1853 (42.4)	
Age (year)	48.57±9.77[c]	55.43±8.50	46.94±9.38	<0.001
Weight (kg)	74.48±13.67	75.62±13.28	74.21±13.72	0.003
Height (cm)	161.91±9.44	159.84±9.67	162.41±9.28	<0.001
BMI (kg/m^2)	28.45±4.91	29.64±4.89	28.16±4.88	<0.001
WC (cm)	95.70±11.73	100.14±10.82	94.55±11.70	<0.001
FBG (mg/dl)	107.73±43.83	158.88±64.97	94.97±23.07	<0.001

[a]*: Obtained from the independent sample t-test for quantitative and Chi-squared test for qualitative variables;* [b]*: n (%);* [c]*: Mean±SD;* ***BMI****: Body mass index;* ***WC****: Waist circumference;* ***FBG****: Fasting blood glucose.*

Dietary intakes of food groups in subjects with or without diabetes are reported in **Table 2**. Non-diabetic individuals had significantly higher intake of grains compared to patients with diabetes (622.46±270.73, 599.05±301.24 g/day, *P*=0.02). Also, the median intake of legumes was significantly higher in non-diabetic participants in comparison with T2D patients (24.59, 22.48 g/day, *P*=0.004). Moreover, non-diabetic participants showed significantly higher consumption of total meat and fat compared to patients with diabetes (81.53, 66.17 g/day, *P*<0.001; 34.22, 29.55 g/day, *P*=0.03, respectively). In addition, the median intake of sweets was significantly higher in non-diabetic participants in comparison with T2D patients (83.76, 39.90 g/day, *P*<0.001). On the other hand, patients with diabetes revealed significantly higher consumption of vegetables and fruits compared to non-diabetic participants (331.45,

[DOI: 10.18502/jnfs.v10i1.17753]

301.85 g/day, *P*<0.001; 400.40, 358.79) g/day, *P*<0.001, respectively). There was no statistically significant difference regarding dairy intake in both study groups.

Table 2. Dietary intakes of food groups in individuals with or without diabetes.

Food groups (g/day)	Total (n=5442)	Diabetes (n=1073)	No diabetes (n=4369)	P-value[a]
Grains	617.85±27.14[b]	599.05±301.24	622.46±270.73	0.02
Legumes	24.09 (23.45)[c]	22.48 (23.07)	24.59 (23.74)	0.004
Total meat	78.47 (54.51)	66.17 (50.44)	81.53 (54.20)	<0.001
Fats	33.34 (28.59)	29.55 (25.14)	34.22 (29.37)	0.03
Dairy	264.04 (231.90)	261.38 (229.99)	264.92 (232.69)	0.88
Vegetables	306.89 (195.88)	331.45 (231.83)	301.85 (187.08)	<0.001
Fruits	367.82 (320.74)	400.40 (356.06)	358.79 (312.08)	<0.001
Sweets	74.62 (96.72)	39.90 (59.57)	83.76 (102.34)	<0.001

[a]: Obtained from the independent sample t- test for Grains and Mann-Whitney U test for others; [b]: Mean ± SD; [c]: Median (Interquartile range).

Total energy and nutrients intake in individuals with or without diabetes are reported in **Table 3**. There was a significantly higher intake of energy and carbohydrates in non-diabetic participants compared to T2D patients (2811.93±761.92, and 2662.61±825.66 kcal/day, *P*=0.03; 442.65±134.69, and 417.44±146.39 g/day, *P*=0.007, respectively). No statistically significant difference was observed regarding the protein intake in both study groups. Non-diabetic participants showed significantly higher intake of total fat and total cholesterol compared to diabetic patients (83.97±24.52, and 80.40±25.92 g/day, *P*=0.01; 231.68 (142.61), and 198.91 (128.00) mg/day, *P*< 0.001, respectively). Non-diabetic individuals had significantly higher amount of SFA consumption compared to T2D patients (25.55±7.76, 24.34±8.30 g/day, *P*=0.04). A statistically significant higher intake of Monounsaturated Fatty Acids (MUFA) (29.97±9.30, 28.48±9.57 g/day, *P*=0.03) and Polyunsaturated Fatty Acids (PUFA) (17.47±6.39, 16.42±6.31/day g, *P*<0.001) was observed in non-diabetic participants compared to diabetic subjects. However, diabetic patients revealed significantly higher consumption of dietary fiber consumption compared to non-diabetic individuals (45.21±20.72, vs 42.17±18.11 g/day, *P*<0.001). There was no statistically significant difference regarding trans-fatty acid intake in participants with or without diabetes.

Table 3. Total energy and nutrients intake in individuals with or without diabetes.

Nutrients	Total (n=5442)	Diabetes (n=1073)	No diabetes (n=4369)	P-value[a]
Total energy (kcal/day)	2782.49±777.10[b]	2662.61±825.66	2811.93±761.92	0.003
Dietary Fiber (g/day)	42.77±18.69	45.21±20.72	42.17±18.11	< 0.001
Protein (g/day)	95.31±29.97	93.83±31.97	95.67±29.45	0.08
Carbohydrates (g/day)	437.68±137.42	417.44±146.39	442.65±134.69	0.007
Total fat (g/day)	83.26±24.84	80.40±25.92	83.97±24.52	0.01
SFA (g/day)	25.31±7.88	24.34±8.30	25.55±7.76	0.04
MUFA (g/day)	29.67±9.37	28.48±9.57	29.97±9.30	0.03
PUFA (g/day)	17.26±6.39	16.42±6.31	17.47±6.39	< 0.001
Trans fatty acids (g/day)	0.003 (0.00)[c]	0.003 (0.00)	0.003 (0.00)	0.13
Cholesterol (mg/day)	225.06 (143.02)	198.91 (128.00)	231.68 (142.61)	< 0.001

*[a]: Obtained from the independent sample t- test for Grains and Mann-Whitney U test for others; [b]: Mean ± SD; [c]: Median (Interquartile range); **SFA**: Saturated fatty acids; **MUFA:** Monounsaturated fatty acids; **PUFA**: Polyunsaturated fatty acids.*

[DOI: 10.18502/jnfs.v10i1.17753]

Vitamins intake in individuals with or without diabetes are reported in **Table 4**. A statistically significant higher intake of vitamin B9 and vitamin B12 was observed in non-diabetic participants compared to patients with diabetes (588.79±167.09, 569.61±184.65 μg/day, *P*=0.002; 3.81 (2.52), 3.36 (2.43) μg/day, *P*<0.001, respectively). There was also significantly higher rate of vitamin A and vitamin D consumption in non-diabetic participants compared to T2D patients (434.62 (282.73), 409.83 (272.94) μg/day, *P*=0.01; 0.76 (0.89), 0.63 (0.80) μg/day, *P*=0.02, respectively). However, diabetic patients revealed significantly higher rate of biotin intake compared to non-diabetic participants (48.27±19.57, 46.57±18.31 μg/day, *P*=0.01). There was no statistically significant difference regarding the consumption of vitamin B1, B2, B3, B5, B6, C, E, and K in individuals with or without T2D.

Moreover, the amount of recommended dietary allowance (RDA) provided from the intake of water-soluble vitamins including pyridoxine, folic acid, and cobalamin was significantly higher in non-diabetic individuals in comparison with T2D patients (149.38±46.31, 139.90±47.24 percent, *P*<0.001; 147.19±41.77, 142.40±46.16 percent, *P*=0.002; 158.89 (104.84), 140.14 (101.25) percent, *P*<0.001, respectively). The percentage of RDA provided from vitamin A and vitamin D consumption was also higher in non-diabetic individuals compared to T2D participants (55.64 (36.24), 54.09 (34.61) percent, *P*=0.01; 5.06 (5.91), 4.24 (5.35) percent, *P*=0.006, respectively). Yet, patients with diabetes showed a greater amount of RDA provided from biotin and vitamin K intake in comparison with non-diabetic group (160.90±65.25, 155.23±61.06 percent, *P*=0.01; 90.48 (64.69), 85.89 (57.62) percent, *P*=0.01, respectively).

Minerals intake in individuals with or without diabetes are shown in **Table 4**. There was a significantly higher rate of potassium and magnesium intake in diabetic participants compared to non-diabetic individuals (4043.55±1317.14, 3921.88±1172.72 mg/day, *P*=0.006; 594.29±252.89, 577.65±224.64 mg/day, *P*=0.04, respectively). There was no statistically significant difference regarding the intake of sodium, calcium, phosphorus, iron, zinc, copper, and selenium in people with or without diabetes.

Furthermore, the amount of RDA provided from the intake of potassium, magnesium, and iron was significantly greater in patients with diabetes compared to non-diabetic participants (86.03±28.02, 83.44±24.95 percent, *P*=0.006; 168.43±74.70, 161.12±65.12 percent, *P*=0.003; 251.51±126.38, 219.12±119.02 percent, *P*<0.001, respectively). Non-diabetic individuals revealed a higher amount of RDA provided from sodium and calcium consumption compared to the diabetic participants (341.72 (183.53), 318.55 (164.29) percent, *P*=0.006; 98.67±37.38, 95.95±39.20 percent, *P*=0.04, respectively).

Discussion

To the best of our knowledge, this study was the first effort to investigate the comparison of food and nutrient intake in diabetic and non-diabetic individuals in Shahedieh cohort study, Yazd, Iran.

Legumes are plant foods with low energy density and glycemic index which are rich in dietary fiber, plant protein, oligosaccharides and contain bioactive and phenolic compounds (Messina, 1999). Several prospective and cross-sectional studies have shown that high intake of legumes and legume-based foods are inversely related to the incidence of obesity, and T2D (Venn and Mann, 2004, Villegas *et al.*, 2008). The biological mechanism of this association is still unclear, but it may be based on metabolic health, inflammation modulation, and modified endothelial function (Giugliano *et al.*, 2006).

[DOI: 10.18502/jnfs.v10i1.17753]

Table 4. Vitamins and mineral intake and the percentage of RDA provided from vitamins in individuals with or without diabetes

Vitamins and minerals	Daily intake				The percentage of RDA			
	Total (n=5442)	Diabetes(n=1073)	No diabetes(n=4369)	P-value[a]	Total (n=5442)	Diabetes(n=1073)	No diabetes(n=4369)	P-value[a]
Thiamine (mg/day)	2.65±1.05[b]	2.63±1.14	2.65±1.02	0.54	232.14±91.66	231.48±101.05	232.31±89.22	0.79
Riboflavin (mg/day)	2.10±0.72	2.07±0.74	2.10±0.71	0.14	177.72±60.22	176.60±62.76	177.99±59.58	0.51
Niacin (mg/day)	27.37±10.12	27.21±11.00	27.42±9.89	0.56	184.67±68.10	184.72±74.95	184.66±66.32	0.98
Pantothenic acid (mg/day)	6.65±2.02	6.63±2.14	6.66±1.99	0.66	133.13±40.45	132.63±42.97	133.25±39.81	0.66
Pyridoxine (mg/day)	2.07±0.62	2.08±0.68	2.07±0.61	0.61	147.51±46.65	139.90±47.24	149.38±46.31	<0.001
Biotin (µg/day)	46.90±18.58	48.27±19.57	46.57±18.31	0.01	156.35±61.94	160.90±65.25	155.23±61.06	0.01
Folic acid (µg/day)	585.01±170.85	569.61±184.65	588.79±167.09	0.002	146.25±42.71	142.40±46.16	147.19±41.77	0.002
Cobalamin (µg/day)	3.74 (2.55)[c]	3.36 (2.43)	3.81 (2.52)	<0.001	156.09 (106.09)	140.14 (101.25)	158.89 (104.84)	<0.001
Ascorbic acid (mg/day)	97.53 (72.17)	98.33 (78.52)	97.10 (70.74)	0.29	120.73 (89.55)	123.57 (98.65)	120.23 (86.85)	0.12
Vitamin A (µg/day)	429.19 (282.34)	409.83 (272.94)	434.62 (282.73)	0.001	55.29 (36.09)	54.09 (34.61)	55.64 (36.24)	0.01
Vitamin D (µg/day)	0.73 (0.88)	0.63 (0.80)	0.76 (0.89)	0.02	4.88 (5.81)	4.24 (5.35)	5.06 (5.91)	0.006
Vitamin E (mg/day)	15.26 (8.37)	15.22 (8.44)	15.27 (8.42)	0.09	101.74 (55.81)	101.49 (56.26)	101.83 (56.15)	0.09
Vitamin K (µg/day)	87.29 (57.22)	88.26 (65.87)	87.16 (55.80)	0.15	86.74 (59.35)	90.48 (64.69)	85.89 (57.62)	0.01
Sodium (mg/day)	4590.02 (2323.79)	4619.37 (2501.21)	4584.37 (2276.82)	0.97	322.32 (169.65)	318.55 (164.29)	341.72 (183.53)	0.006
Potassium[a] (mg/day)	3945.87±1203.41	4043.55±1317.14	3921.88±1172.72	0.006	83.95±25.60	86.03±28.02	83.44±24.95	0.006
Calcium (mg/day)	1017.16±375.76	1030.80±391.49	1013.81±371.76	0.19	98.14±37.76	95.95±39.20	98.67±37.38	0.04
Magnesium (mg/day)	580.93±230.55	594.29±252.89	577.65±224.64	0.04	162.56±67.17	168.43±74.70	161.12±65.12	0.003
Phosphorus (mg/day)	1858.93±653.21	1871.50±706.74	1855.85±639.43	0.50	256.59±93.31	267.35±100.96	265.12±91.34	0.50
Iron (mg/day)	22.38±8.67	22.37±9.52	22.38±8.45	0.97	225.50±121.18	251.51±126.38	219.12±119.02	<0.001
Zinc (mg/day)	16.09±5.74	15.77±6.04	16.17±5.67	0.05	174.58±65.62	175.70±70.35	176.80±64.41	0.64
Copper (mg/day)	2.24±0.84	2.23±0.90	2.24±0.82	0.86	249.32±93.75	248.86±100.67	29.44±91.98	0.86
Selenium (µg/day)	188.40±94.25	189.49±103.45	188.13±91.86	0.69	342.55±171.36	344.53±188.10	342.06±167.02	0.69

[a]: *Obtained from the independent sample t- test for Grains and Mann-Whitney U test for others;* [b]: *Mean ± SD;* [c]: *Median (Interquartile range).*

[DOI: 10.18502/jnfs.v10i1.17753]

Findings of a cross-sectional study on 9,111 patients with T2D showed that people with higher consumption of red meat and meat products had higher blood sugar. According to the results of this study, red meat consumption was positively associated with the occurrence of hyperglycemia and hyperinsulinemia (van Dam *et al.*, 2002). However, a study by Kasayan *et al*. showed that higher intake of vegetables may positively be related to lower fasting blood glucose (FBG) (Kasaeyan *et al.*, 2002).

Fruits are one of the most important components of diets that play an important role in human nutrition by providing growth regulators necessary to maintain natural health (Liu *et al.*, 1999). Fruits prevent deficiencies in vitamins such as C (Liu *et al.*, 1999). In addition, fruits and vegetables contain insoluble cellulose fibers. Food high in insoluble fiber can play a significant role in managing diabetes (Barzegar Nazari *et al.*, 2020, Liu *et al.*, 1999). Insoluble fiber slows the absorption of glucose from small intestine and can prevent a rapid rise in blood glucose after mealtime (Trinidad *et al.*, 2006).

The results of a study by Maillard *et al*. showed a strong inverse relationship between the amount of carbohydrates in diet composition and WC in girls (Maillard *et al.*, 2000). In line with that study, it has been documented that WC may act as a predictable factor for T2D (Olinto *et al.*, 2004). Previous investigations have reported that macronutrients, especially fats, may affect changes in insulin levels in the body (Storlien *et al.*, 1996). Specifically, MUFA may improve the intracellular insulin receptor signaling procedure (Storlien *et al.*, 1996). A cross-sectional study showed that there was an inverse relationship between MUFA intake and a direct relationship between saturated fat consumption and fasting blood sugar levels in people with T2D (Feskens *et al.*, 1994). In a study conducted on 35,988 elderly women, after 11 years, 1,890 of them developed T2D. The analysis of food questionnaires showed that PUFA use was negatively associated with a risk of developing T2D (Meyer *et al.*, 2001).

Epidemiological studies have shown that low intake of antioxidants and reduction of their plasma concentration may increase blood pressure in people with diabetes (Zozaya, 2000). Furthermore, it has been shown that in vitamins C, E, and magnesium deficiencies, supplementation with these micronutrients will be helpful in preventing and improving diabetes complications (Bonnefont-Rousselot, 2004). Moreover, it has been reported that magnesium can be indirectly effective in reducing oxidative stress in diabetic patients through glycemic control (Bonnefont-Rousselot, 2004). In fact, magnesium cell deficiency is associated with dysfunction of enzymes, such as ATPase. These enzymes are involved in glucose metabolism and need magnesium as a cofactor (Paolisso *et al.*, 1990). In addition, past observations have suggested that biotin administration ameliorates abnormal glucose metabolism in diabetic patients, presumably by enhancing the activity of biotin-dependent enzyme, pyruvate carboxylase, and a subsequent promotion of glucose utilization for the entry into the tricarboxylic acid cycle (Maebashi *et al.*, 1993).

This study has several strengths, including its large sample size with a wide age range of participants. We also acquired questionnaire-based data through a face-to-face interview to increase the precision of information. Nevertheless, when interpreting results, some limitations of the study should be considered. First, because of the cross-sectional nature of this study, it is fundamentally difficult to determine whether the observed relationships are causal. Hence, these results are essential to be confirmed by prospective cohort studies. Finally, similar to other epidemiological studies, random error in reporting food intake is an important limitation although a validated FFQ was applied for the evaluation of food intake.

Conclusion

Given that diet and nutrition are widely believed to play an important part in the development of T2D, valuable differences were found in dietary habits of diabetic patients in comparison with participants without diabetes. These findings suggest that emphasis on education is needed to

[DOI: 10.18502/jnfs.v10i1.17753]

improve the current dietary behaviors to assist in the prevention of the disease complications.

Acknowledgment

We would like to thank the authorities of Shahedieh cohort study to let us work on that dataset. The authors wish to thank all residents of Shahedieh region, Yazd, Iran, who kindly participated in the study.

Authors' contributions

N Maayeshi involved in writing the original draft of manuscript, data curation, formal analysis, software, visualization, review & editing. H Mozaffari-Khosravi and SS Khayyatzadeh participated in conceptualization, supervision, data curation, project administration and writing the original draft of manuscript. H Fallahzadeh participated in statistical data analysis and validation and review & editing of manuscript. All authors read and verified the final version of manuscript.

Conflict of interests

The authors have no competing interests to declare.

Funding

This study was funded by Shahid Sadoughi University of Medical Sciences.

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[DOI: 10.18502/jnfs.v10i1.17753]