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Original Article

Evaluation of Risk Factors for Type 2 Diabetes in Population Living in City of Yazd: A Case-Control Study

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Abstract

Introduction: Diabetes Mellitus (DM) is one of the most common chronic diseases in the world and the most challenging health problems of the twenty first century. This disease is common in Yazd and has a high prevalence in the province. Due to not available analytic study, the aim of this study was to determine the risk factors of type 2 diabetes among the adult Yazd population, Iran.

Materials and Methods: This hospital base case-control study was conducted on the urban population of Yazd city, Iran from 2012 to 2013.A total of 400 subjects including 200 diabetes cases and 200 controls matched by sex and age (±2 years)were studied. Subjects were interviewed face-to-face by trained interviewers using pretested questionnaires. Data were analyzed by descriptive statistics and appropriate statistical tests such as chi- square, student t- test and multiple logistic regressions.

Results: The logistic regression model showed that family history of diabetes in first-degree relatives (OR=9.37, $P<0.0001$), history of dyslipidemia (OR=4.89, $P<0.0001$), family history of dyslipidemia (OR=2.53, $P=0.009$), type oil consumption (OR=2.16, $P=0.021$), type vegetable consumption (OR=4.81, $P<0.0001$), consumption fruit (OR=2.43, $P=0.009$), waist to hip ratio (OR=2.67, $P=0.009$), diastolic blood pressure (OR=2.99, $P=0.005$), Low HDL (OR=1.96, $P=0.047$) and History of child birth >4 kg (OR=63.89, $P=0.001$),were considered as associated risk factors for diabetes.

Conclusion: The present study showed that family history of diabetes in first-degree relatives, family history of dyslipidemia, history of dyslipidemia, Waist-hip ratio, consumption of fruit, Consumption of vegetables, Type of oil consumption, History of child birth >4 kg and low HDL were positively associated with diabetes.

Keywords: Diabetes mellitus, Risk factors, Case-control study

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Introduction

Diabetes Mellitus (DM) is one of the most common chronic diseases in the world and the most challenging health problems of the twenty first century [1]. It is estimated that by the 2030 the number of people with diabetes will increase to more than 366 million, more than twice the number in 2000 [2, 3]. Most of these new cases are from developing countries and it seems that the Middle East is among the regions that will have the largest increase in prevalence of diabetes by 2030 [3].

In 2011 it was estimated that 366 million people worldwide had diabetes [4], but its prevalence is increasing rapidly because of increasing age of the population and surge of obesity in many countries including Iran. In Iran, about 10% of the general population had diabetes mellitus or impaired fasting glucose in 2008 [5].

Type 2 diabetes is a chronic disease characterized by hyperglycemia and dyslipidemia due to underlying insulin resistance. The condition commonly progresses to include micro vascular and macro vascular complications [6, 7]. The disease results from the combination of genetic and environmental factors [8]. Genetic factors play an important role in the development of diabetes, but mode of transmission is not known yet [9]. Although genes, that predispose an individual to diabetes, are considered to be an essential factor in the development of the disease, activation of a genetic predisposition requires the presence of environmental and behavioral factors, particularly those associated with lifestyle. There are strong evidences to suggest that modifiable risk factors such as obesity and physical inactivity are the non-genetic determinants of the diabetes [10, 11].

The occurrence of rapid and major lifestyle changes in the many countries has increased the prevalence of obesity and other non-communicable disease risk factors such as hypertension and dyslipidemia, which have been reported to be the major etiologic factors the rising incidence of type 2 diabetes around the globe [12].

The prevalence of diabetes in the Middle Eastern countries including Iran is known to be high and is approaching epidemic proportion. The prevalence of type 2 diabetes in Iran is 4-4.5% and in population aged above 30 years is greater than 14%. Also in the national survey showed the prevalence of diabetes in Iran to be 7.7% in subjects 25–65 years. The prevalence of diabetes varies in different areas of Iran, so the prevalence of type 2diabetes in Yazd is higher than other province of Iran [13-15]. And in the recent study in Yazd, the prevalence rate of known diabetes and impaired fasting glucose was 16.3% and 11.9% respectively [16].

Diabetes Mellitus Because of the prevalence, costs, and consequences of its effects on one's life, is one of the biggest issues in health care in the Yazd province, Iran. Now, diabetes is not curable but it is manageable and preventable and

should be managed. There are different factors which are related to early onset of type 2 diabetes mellitus. The factors related to life style are preventable. Identifying this risk factors and intervention are considered the basic steps in the management of diabetes and its complications. The aim of this study was to determine the association between the lifestyle habits and environmental risk factors associated with type 2 diabetes in the adult Yazd population, Iran.

Materials and Methods

This hospital base case-control study was conducted on the urban population of >30 years residing in the Yazd city, Iran from 2012 to 2013. A total of 400 subjects including 200 diabetic cases and 200 controls matched by sex and age (±2 years) were included to the study. Cases were selected from Yazd diabetes research center. The criterion for the cases selection were; to being native of Yazd city, having confirmed diagnosis of diabetes Type of 2 by through the medical history and laboratory FBS value of >126 mg/dl along with a maximum history of the diabetes elapsed 3 years (new cases). Non-native cases, type I diabetes and those cases with chronic severe systemic disease such as cancers, cardiovascular disease, chronic renal disorders, as well as pregnant women excluded from the study. Controls were recruited from subjects coming to the Yazd Central Laboratory who had no history of diabetes along with rule out the disease by through laboratory sugar testes. The study was approved by the Medical Ethics Committee of Shahid Sadoughi University of Medical Sciences and Health Services of Yazd. Informed consent was obtained from all participants, which were carried out in accordance with the Declaration of Helsinki.

Subjects were interviewed face-to-face by trained interviewers using pretested questionnaires. Information concerning age, sex, history of hypertension and dyslipidemia, family history of diabetes and hypertension and dyslipidemia, level of education, occupational and marital status, eating habits, cigarette smoking, physical activity, consumption of vegetable and fruit and other information was collected by questionnaire. Anthropometric measures included height, weight; waist and hip circumference were measured according to standard protocols and were recorded.

Height was measured in a standing position, without shoes; using a tape stadiometer with a minimum measurement of 1cm. Weight was measured with each subject wearing light clothing in kilograms by using digital scales (0.5 kg accuracy). Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. BMI was categorized according to WHO recommendation as acceptable weight (BMI≤25), overweight (25<BMI<30) and obese subjects (BMI≥30) [17].

Waist circumference (WC) was recorded to the nearest 0.1 cm at the umbilical level and hip circumference at the maximal level over light clothing, using an unstretched tape meter,

without pressure on the body surface. The waist-to-hip ratio (WHR) was calculated as WC divided by hip circumference. Waist hip ratio cut-off points used were≥ .9 for men and ≥ .85 for women. This classification was conforming to ATP III (Adult Treatment Panel III) guidelines [18].

Systolic and diastolic blood pressures were measured twice in a seated position in the left arm by digital pressure gauge and the mean value was considered as the subject's blood pressure. Hypertension was defined, according to the JNC7 report (the report Joint National Committee 7), as a systolic blood pressure≥140 mm Hg and/or diastolic blood pressure≥90 mm Hg, or current use of an antihypertensive medication[19].

Hypertriglyceridemia and hypercholesterolemia was defined as triglyceride (TG) concentration more than 150 mg/dl and Cholesterol concentration more than 200 mg/dl respectively. HDL cholesterol less than 50mg/dl in females and less than 40 mg/dl in males and also LDL more than 100 mg/dl was considered to be abnormal. This classification was conforming to ATP III (Adult Treatment Panel III) guidelines [18].

Statistical Analysis: Data analysis was done using the Statistical Package for Social Sciences (SPSS) for Windows version 16. The Student t-test was used to assess differences between mean values of two continuous variables. Chi-square analysis was performed to test the differences in proportions of categorical variables between two or more groups. In2×2 tables, the Fisher exact test (two-tailed) replaced the X^2 test if the assumptions underlying X^2 were violated, namely in case of small sample size or when the expected frequency was less than 5 in any of the cells. Logistic regression analyses were performed to quantify the association between type 2 diabetes and categorical variables. The odds ratios (ORs) of type 2 diabetes and their 95 % confidence intervals (CI95%) were estimated. The level P value less than 0.05 was considered significant for all test.

Results

In this study, 200 patients with type 2 diabetes mellitus (age> 30 years) and 200healthy controls (age>30 years) were studied. These controls were individually matched to the patients by gender and age (±2 years). Table 1 shows the descriptive Socio-demographic data of diabetic cases and non diabetic controls. Results of the study showed significantly more Diabetic subjects had less income level (37.9% vs. 27%, P=.02).

In the group of women, significantly, women with diabetes had a more history of birth > 4 kg than women in the other group (22% vs. 6.3%, P = .002). Also the history of gestational diabetes and polycystic ovary syndrome (POCs) in women with diabetes were significantly more (P= .03).

Table 1: Socio-demographic data of diabetic and non diabetic

Variable	Total	Case	Control	OR (CI 95%)	P-value
Age >30	400(100)	200(100)	200(100)	Matched	
Gender					
Female	200(50)	100(50)	100(50)	Matched	
Male	200(50)	100(50)	100(50)		
Current marital status					
Married	386(96.5)	191(95.5)	195(97.5)	1	
Single	14(3.5)	9(4.5)	5(2.5)	1.83(.60-5.58)	.276
Education level					
University	50(12.5)	23(11.5)	27(13.5)	1	
Diploma	77(19.2)	45(22.5)	32(16)	1.65(.86-3.38)	.17
Secondary	25(6.3)	17(8.5)	8(4)	2.49(.91-6.83)	.07
Primary	248(62)	115(57.5)	133(66.5)	1.01(.55-1.86)	.962
Job					
Self-employment	76(19)	40(20)	36(18)	1	
Professional	55(13.8)	29(14.5)	26(13)	1(.5-2.01)	.99
Technician	9(2.2)	5(2.5)	4(2)	1.25(.28-4.5)	.86
Worker	23(5.8)	12(6)	11(5.5)	.98(.38-2.49)	.96
Housekeeper	237(59.2)	114(57)	123(61.5)	.83(.49-1.39)	.49
Income level					
>5000000 Rials	251(67.8)	108(62.1)	143(73)	1	
<5000000 Rials	119(32.2)	66(37.9)	53(27)	1.64(1.06-2.55)	.02
Age of marriage*					
<15	63(32)	29(29)	34(35.1)	1	
15-20	117(59.4)	59(59)	58(59.8)	1.19(.64-2.20)	.57
>20	17(8.6)	12(12)	5(5.2)	2.81(.88-	.07
Age pregnant first child bearing*					
<20	148(75.9)	77(77)	71(74.7)	1	
>20	47(24.1)	23(23)	24(25.3)	1.13(.58-2.81)	.71
Number of children*					
≤2	26(13.4)	14(14)	12(12.8)	1	
3-5	117(60.3)	53(53)	64(68.1)	.71(.30-1.66)	.43
>5	51(26.3)	33(33)	18(19.1)	1.57(.60-4.11)	.35
Abortion history*					
No	126(63)	60(60)	66(66)	1	
Yes	74(37)	40(40)	34(34)	1.29(.73-2.3)	.38
Weight of previous birth >4 kg*					
No	167(85.6)	78(78)	89(93.7)	1	
Yes	28(14.4)	22(22)	6(6.3)	4.18(1.61-10.84)	.002
History Menstrual irregularities*					
No	150(75)	74(74)	76(76)	1	
Yes	50(25)	26(26)	24(24)	1.11(.58-2.11)	.74
History Gestational Diabetes*					
No	188(95.4)	92(92)	96(99)	1	
Yes	9(4.6)	8(8)	1(1)	8.34(1.02-68.06)	.035
History of PCOs*					
No	179(89.5)	85(85)	94(94)	1	
Yes	21(10.5)	15(15)	6(6)	2.76(1.02-7.44)	.038

Abbreviation: OR=odds ratio, CI=confidence interval, PCOs= polycystic ovary syndrome

*only in female subjects

The basic lifestyle habits, family history and clinical information among the diabetic cases and non diabetic controls are shown in the categorical levels in table 2and 3. The family history of diabetes, hypertension and dyslipidemia were significantly more frequent among the diabetes group (P<.05), so that the Self reported family history of diabetes in first-degree relatives was higher in diabetic than non-diabetic subjects and showed a highly significant difference (OR=6.61, 95 % confidence interval (CI) =4.27-10.23 and P>0.001).

Table 2: Family history and clinical information among the diabetic and non diabetic

Variable	Total	Case	Control	OR (CI 95%)	P-value
Family history of diabetes(first degree)					
No	198(71.5)	55(27.5)	143(71.5)	1	
Yes	202(50.5)	145(72.5)	57(28.5)	6.61(4.27-10.23)	.000
History of hypertension					
No	243(60.8)	105(52.5)	138(69)	1	
Yes	157(39.2)	95(47.5)	62(31)	2.01(1.33-3.03)	.001
Duration of hypertension					
<2years	78(49.7)	39(41.1)	39(62.9)	1	
>2years	79(50.3)	56(58.9)	23(37.1)	2.43(1.26-4.69)	.007
Family history of hypertension (first degree)					
No	160(40)	59(29.5)	101(50.5)	1	
Yes	240(60)	141(70.5)	99(49.5)	2.43(1.61-3.67)	.000
History of dyslipidemia					
No	197(49.2)	65(32.5)	132(66)	1	
Yes	203(50.8)	135(67.5)	86(34)	4.03(2.65-6.11)	.000
Duration of dyslipidemia					
<2 years	128(63.1)	80(59.3)	48(70.6)	1	
>2 years	75(36.9)	55(40.7)	20(29.4)	1.65(.88-3.07)	.11
Family history of dyslipidemia(first degree)					
No	225(56.2)	98(49)	127(63.5)	1	
Yes	175(43.8)	102(51)	73(36.5)	1.81(1.21-2.7)	.003
BMI					
<25	93(23.2)	31(15.5)	62(31)	1	
25-30	150(37.5)	74(37)	76(38)	1.94(1.13-3.33)	.014
>30	157(39.2)	95(47.5)	62(31)	3.06(1.79-5.24)	.000
WHR					
Normal	94(23.5)	26(13)	68(34)	1	
Obese	306(76.5)	174(87)	132(66)	3.44(2.07-5.71)	.000
Hypertension					
No	214(53.5)	83(41.5)	131(65.5)	1	
Yes	186(46.5)	117(58.5)	69(34.5)	2.67(1.78-4.01)	.000

Table 2: Family history and clinical information among the diabetic and non diabetic (Continue)

Variable	Total	Case	Control	OR (CI 95%)	P-value
Systolic blood pressure					
<120	69(17.2)	34(17)	35(17.5)	1	
120-139	205(51.2)	87(43.5)	118(59)	.75(.44-1.31)	.32
≥140	126(31.5)	79(39.5)	47(23.5)	1.73(.95-3.13)	.69
Diastolic blood pressure					
<80	114(28.5)	46(23)	68(34)	1	
80-89	167(41.8)	72(36)	95(47.5)	1.12(.69-1.81)	.64
≥90	119(29.8)	82(41)	37(18.5)	3.27(1.91-5.61)	.000
LDL					
Normal	159(40.2)	84(42)	75(38.3)	1	
Abnormal	237(59.8)	116(58)	121(61.7)	.85(.57-1.28)	.44
HDL					
Normal	268(67.7)	117(58.5)	151(77)	1	
Abnormal	128(32.3)	83(41.5)	45(23)	2.38(1.54-3.68)	.000
TG					
Normal	148(37)	54(27)	94(47)	1	
Abnormal	252(63)	146(73)	106(53)	2.40(1.58-3.63)	.000
CHOL					
Normal	201(50.4)	97(48.7)	104(52)	1	
Abnormal	198(49.6)	102(51.3)	96(48)	1.13(.77-1.68)	.51

Abbreviation: BMI= body mass index, WHR= waist-hip ratio, LDL= low-density lipoprotein, HDL= high-density lipoprotein, TG= triglycerides, CHOL= cholesterol

The history of hypertension was significantly more frequent among the diabetes group (OR=2.01, 95 % (CI) =1.33-3.03 and P=0.001). Also among the diabetes group dyslipidemia was more prevalence (OR=4.03, 95 % (CI) = 2.65-6.11and P<0.001).

Obesity was more common among diabetic patients 47.5% vs. 31% (OR=3.06, 95% CI=1.79-5.24, P<0.001). Furthermore, among the diabetes group the central obesity (WHR) was higher (OR=3.44, 95% CI=2.07-5.71, P<0.001).

Consumption of fast food, physical activity, duration of sleep, smoking and passive smoking was similar in the two groups, whereas consumption of fruit, vegetable, red meat and fish was significantly lower in diabetic subjects (P<0.001). Also the Consumption of solid oil were significantly more frequent among the diabetes group (41.5% vs. 24%, OR= 2.24, CI 95 %= (1.46-3.45), P<.0001).

Table3: The basic lifestyle habits among the diabetic and non diabetic

Variable	Total	Case	Control		P-value
Smoking					
No	343(85.8)	169(84.5)	174(87)	1	
Yes	57(14.2)	31(15.5)	26(13)	1.22(.69-2.15)	.47
Passive smoking					
No	354(88.5)	178(89)	176(88)	1	
Yes	46(11.5)	22(11)	24(12)	.90(.49-1.67)	.75
Physical activity					
Yes	265(66.2)	125(62.5)	140(70)	1	
No	135(33.8)	75(37.5)	60(30)	1.40(.92-2.12)	.11
Duration of sleep					
≤7 hours	176(44)	85(42.5)	91(45.5)	1	
>7 hours	224(56)	115(57.5)	109(54.5)	1.13(.76-1.67)	.54
Type of oil consumption					
Liquid	269(67.2)	117(58.5)	152(76)	1	
Solid	131(32.8)	83(41.5)	48(24)	2.24(1.46-3.45)	.000
Fast food					
No	257(64.2)	123(61.5)	134(67)	1	
Yes	143(35.8)	77(38.5)	66(33)	1.27(.84-1.91)	.25
Type of cooking					
Boiled	249(62.2)	108(54)	141(70.5)	1	
Roasted	7(1.8)	6(3)	1(.5)	7.83(.92-66.03)	.047
Fried	144(36)	86(43)	58(29)	1.93(1.27-2.93)	.002
Red meat consumption per month					
≥4	344(86)	162(81)	182(91)	1	
2-3	49(12.2)	33(16.5)	16(8)	2.31(1.23-4.36)	.008
<2	7(1.8)	5(2.5)	2(1)	2.80(.53-14.6)	.26
Fish consumption per month					
≥4	88(22)	37(18.5)	51(25.5)	1	
2-3	128(32)	50(25)	78(39)	.88(.51-1.53)	.66
<2	184(46)	113(56.5)	71(35.5)	2.19(1.30-3.67)	.003
Weekly consumption of vegetables					
≥4	128(32)	43(21.5)	85(42.5)	1	
2-3	143(35.8)	63(31.5)	80(40)	1.55(.95-2.55)	.07
<2	129(32.2)	97(47)	35(17.5)	5.31(3.11-9.05)	.000
Weekly consumption of fruit					
>10	229(57.2)	95(47.5)	134(67)	1	
6-10	127(31.8)	70(35)	57(28.5)	1.73(1.11-2.68)	.013
≤5	44(11)	35(17.5)	9(4.5)	5.48(2.51-11.94)	.000

Table 4 shows the baseline physical and metabolic characteristics of case and control subjects. The mean Weight, BMI, Waist circumference, Waist-hip ratio, Diastolic blood pressure, HDL cholesterol, and triglyceride were significantly higher in diabetes patients than in control subjects.

Table 4: Baseline of physical and metabolic characteristics (mean± standard deviation) in cases and controls (Student t-test)

Variable	Cases(n=200)	Control(n=200)	P-value
Height	1.64± 9.8	1.64± 9.13	.78
Weight	79.11± 10.87	75.76± 11.76	.003
Body mass index(BMI)	29.47± 3.95	28.19±	.003
Waist circumference	99.59± 9.68	93.83± 10.47	.000
Hip circumference	104.52± 9.34	103.66± 9.92	.15
Waist-hip ratio(WHR)	.95± .07	.90± .06	.000
Systolic blood pressure	131.32± 17.67	128.45± 15.47	.078
Diastolic blood pressure	81.76± 10.29	79.35±9.76	.001
LDL	113.10± 40.51	112.92± 37.37	.963
HDL	48.91± 15.97	55.12± 15.93	.000
TG	217.16± 115.39	173.74± 91.93	.000
CHOL	200.63± 50.47	195.89± 42.86	.312

Table 5: Effect of multiple risk factors, modeled with logistic regression

Independent variables	B coefficient	OR (95% CI)	P-value
Family history of diabetes			
Yes	2.38	9.37 (4.7 – 18.69)	0.000
No	—	—	—
History of dyslipidemia			
Yes	1.58	4.89 (2.51-9.51)	0.000
No	—	—	—
Type of oil consumption			
Solid	.77	2.26 (1.12 – 4.16)	0.02
Liquid	—	—	—
Weekly consumption of vegetable			
≤	—	—	—
2-3	-0.56	0.56 (0.07 – 4.16)	0.57
≥4	-2.46	0.11 (0.016 – 0.84)	0.034
Weekly consumption of fruit			
≤ 5	—	—	—
6-9	-1.57	0.20 (0.06 – 0.72)	0.014
≥10	-2.46	0.08 (0.02 – 0.29)	0.0001
Waist-hip ratio (WHR)			
Obese	.98	2.67 (1.27 – 5.60)	0.009
Normal	—	—	—
Diastolic blood pressure			
<80	—	—	—
80-90	1.09	2.99 (1.38 -6.46)	0.005
>90	.34	.71 (.34 – 1.47)	0.35
HDL			
Normal	—	—	—
Abnormal	.67	1.95 (1.01 -3.82)	0.04
LDL			
Normal	—	—	—
Abnormal	.72	.48 (1.09 – 3.89)	0.026
History of child birth > 4 kg			
Yes	4.15	63.89 (5.67 – 719.29)	0.001
No	—	—	—

Table 5 shows the results of the logistic regression analysis. We performed logistic regression analysis to predict risk factors for diabetes. To find predictive and effective factors on diabetes, the variables that have significant p-value in the initial analysis, and also have clinical significance were entered into the regression model. The logistic regression model was adjusted for age and gender. family history of diabetes in first-degree relatives (P<0.001), family history of dyslipidemia (P=0.009), history of dyslipidemia (P<0.001), Waist-hip ratio (P=0.009), consumption of fruit (P<0.001), Consumption of vegetables(P<0.001), Type of oil consumption (P=0.02), History of child birth >4 kg (P=0.001), LDL (P=0.026) and low HDL (P=0.047) were associated risk factors for diabetes.

Discussion

Diabetes mellitus is the most common metabolic disorder and has a high prevalence in Yazd province, Iran [16,20]. According to our knowledge and research, there are no population-based studies that have examined the diabetes and associated risk factors in Yazd. Type 2 diabetes is one of the major public health challenges in the twenty first century, and results from an interaction between genetic and environmental factors. Many risk factors such as obesity, family history of diabetes mellitus, race and ethnic background, hypertension, dyslipidemia, age and sex have been identified which influence the prevalence or incidence of diabetes [21].

In this case control study performed in 400 subjects aged >30 years (200 case and 200 control), family history of diabetes in first-degree relatives, family history of dyslipidemia, history of dyslipidemia, Waist-hip ratio, consumption of fruit, Consumption of vegetables, Type of oil consumption, History of child birth >4 kg and low HDL were positively associated with diabetes. Whereas consumption of fast food, physical activity, sleeps duration, smoking and passive smoking were similar in the two groups.

The results of our study showed that there was no significant association between smoking and diabetes. While the results of the study by Carole Willi and et al showed the Active smoking is associated with an increased risk of type 2 diabetes [22].

The results of our study showed an inverse association between fruit and vegetable consumption and diabetes. This is consistent with previous studies [23-27]. The role of fruits and vegetables in prevention of type 2 diabetes tends to be associated the fiber found in fruits and vegetables. Dietary fiber helps slow the release of sugar into the bloodstream, helping keep blood sugar levels normal. However, some studies have shown fruit and vegetable intake was not associated with a clearly reduced risk of incident type 2 diabetes [28, 29].

Our result showed family history of diabetes

was an independent predictor of Type 2 diabetes in the regression logistic model. This finding may point to the strong association of Type 2 diabetes with genetic predisposition in the Yazd population. Similar to the findings in this study, in the other studies, family history of diabetes was associated with incident diabetes [16,30-32]. In The studies that was performed in Tehran and Tabriz results showed that People who have first degree relative suffering from diabetes have a 50% and 30% risk of having this disease respectively [33, 34] .

In this study it was found that the consumption of fish was lower in the diabetic cases than healthy controls. Consistent with our findings, previous studies also showed the protective effect of fish consumption [35-37]. Whereas In contrast with our findings, in some studies found no evidence that higher consumption of fish reduces the risk of type 2 diabetes [38, 39].

In adults obesity is considered the most important risk factors for type 2 diabetes. In previous studies mentioned obesity is a risk factor for diabetes [16,40-44]. In the present study, we showed that the waist-to-hip ratio and BMI were both associated with type 2 diabetes. Central obesity, expressed by an increased waist-to-hip ratio, was an important factor associated with diabetes. The results regression logistic models suggest that waist-to-hip ratio is a better predictor of diabetes than the body mass index.

Our result showed no significant relationship between physical activity in the case and control groups. Whereas the inverse relationship can be seen in cross-sectional studies between physical activity and type 2 diabetes [45-48]. In this context, prospective studies have shown that physical activity can prevent type 2 diabetes [49-55]. Overall, the evidence is suggests an important role of physical activity in the prevention of type 2 diabetes.

The results from this study show that diabetes and associated risk factors are a health problem in Yazd city. Thus, controls of both modified and non-modified risk factors are effective for the prevention of diabetes and its complications in future. In general, more analytic studies in future are needed to clarify the relationship between the diabetes and associated risk factors.

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