IS THERE ANY RELATIONSHIP BETWEEN THE TYPE OF DIETARY FAT AND BLOOD GLUCOSE? RESULTS OF ISFAHAN HEALTHY HEART PROGRAM

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Abstract

INTRODUCTION: Existing evidence suggests that the type of dietary fat may affect glucose metabolism in the body. The objective of this study was to evaluate the relationship between the type of dietary fat and blood glucose.

METHODS: This is a cross-sectional descriptive study of 12600 adults aged over 19 years who came from the provincial towns of Isfahan, Najaf Abad in Isfahan Province and Arak, Iran. The subjects were selected using the randomized-cluster sampling method. A food frequency questionnaire was used to obtain data on the subjects' dietary patterns.

RESULTS: A significant positive relationship was observed in Arak between fasting blood sugar and the consumption of foods containing poly unsaturated fatty acids (PUFA) (P=0.04). There was a significant positive relationship in all three provincial towns between age and fasting blood sugar, 2-hour post-load plasma glucose (2HPP), body mass index (BMI), wais-to-hip ratio and waist circumference (P<0.001). There was a significant negative relationship between the male sex and all variables, except fasting blood sugar (P<0.001). Consumption of foods containing PUFA was found to have a significant positive relationship with body mass index (P=0.002) and waist circumference (P<0.001) in Isfahan; also in Najaf Abad there was a significant positive relationship between body mass index and consumption of PUFA sources (P=0.047). In Arak body mass index and waist circumference had positive relationship with consumption of PUFA sources (P<0.001). In all three provincial towns, diabetic patients had healthier dietary patterns compared to non-diabetics, in terms of the type of dietary fat.

CONCLUSION: It can be concluded that the people's nutritional knowledge about dietary fats is inadequate. Hence Isfahan Healthy Heart Program can increase public awareness of the importance of disease prevention via appropriate interventions.

Keywords: Dietary fat, Blood glucose, Fatty acids, Community Study.

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Introduction

Dietary fats are regarded as important, but modifiable risk factors for diabetes type II.[1] The amount and type of some dietary fats can remarkably affect many metabolic processes. Although studies in this area have often focused on the metabolism of fats, there is strong evidence suggesting that glucose metabolism may also be affected by the type of dietary fat.[2] Epidemiological and metabolic studies suggest that

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certain types of dietary fats may be related to the pathophysiology of diabetes. Certain dietary fatty acids may affect glucose metabolism and the development of diabetes through causing changes in the composition of cell membrane phospholipids and altering the function of insulin receptors.[1,3,4] However, available findings in this area are not integrated. One cross-sectional analysis has reported a positive relationship between the intake of saturated fatty acids and insulin concentration, as well as an inverse relationship between the intake of polyunsaturated fatty acids and its plasma concentration.[5] A prospective study[6] has demonstrated that trans fatty acids increase the risk of developing diabetes, while polyunsaturated fatty acids reduce this risk. Another study has reported a positive relationship between the intake of polyunsaturated fatty acids and elevated blood sugar levels.[7] Given the small number of studies investigating the independent relationship between blood sugar and the pattern of fat intake, we decided to assess the relationship between the types of dietary fats and blood sugar concentration in adult subjects participating in Isfahan Healthy Heart Program.[8]

Materials and Methods

Data for this descriptive cross-sectional study were obtained from subjects participating in the first phase of Isfahan Healthy Heart Program (2000-2001) in the provincial towns of Isfahan, Najafabad, and Arak. Complete explanation and details of materials and methods are described elsewhere.[8]

The society was divided into urban and rural segments for sampling. Sampling was conducted using the randomized-cluster method. Criteria of inclusion in the study consisted of: minimum 19 years of age, absence of hemorrhagic diseases or mental retardation, Iranian nationality, and having lived in one of the aforesaid provincial towns for at least six months. Pregnant women were excluded from the study.

The number of samples was calculated at 6300 based on the formula.[8] A total of 12600 adult individuals from the provincial towns of Isfahan, Najaf Abad and Arak were selected. Given the relatively equal distribution of sexes in the Iranian population, equal numbers of men and women were assigned to each cluster.

A questionnaire of confirmed credibility and reliability was used to collect data.[8] Demographic data, including age and sex, nutritional knowledge, attitude, and practice, and medical history were obtained. Clinical and laboratory examinations were conducted. A standardized 48-item food frequency questionnaire was used to assess the subjects' nutritional practices. Demographic data and information about the individuals' nutritional knowledge, attitude, and practice were collected by trained interviewers. Clinical and laboratory evaluations were conducted by trained physicians.[8]

A trained person measured the weight and height of subjects, while they were not wearing shoes and were lightly dressed. Waist and hip circumference were measured in the standing position while the subjects were lightly dressed. Waist circumference (WC) was measured midway between the lowest rib and the highest end of pelvis. Hip circumference was measured at the level of the bony prominence of femur.[9] Body mass index (BMI) was calculated using the formula: weight/height^2, and waist–to-hip ratio was calculated using the formula: waist circumference/hip circumference.[9] Blood samples were taken from all subjects after a 14-hour fasting period. After obtaining blood samples in the fasting state, and providing the person had no history of diabetes he or she was given a syrup containing 75 g glucose and a second blood sample was taken after two hours to measure his or her 2HPP (2-hour post-load plasma glucose).[8] Blood sugar was measured using the glucose oxidase enzymatic method. Only a single fasting blood sample was taken from the patients who gave history of diabetes.

The collected data were analyzed using SPSS. Hydrogenated oil, animal ghee, butter, cream, animal fat, chicken skin, and pizza were regarded as sources of saturated fatty acids (SFA), olive oil was regarded as a source of monounsaturated fatty acids (MUFA), vegetable oil and nuts were counted as sources of polyunsaturated fatty acids, and hydrogenated oil was considered as the source of trans fatty acids (TFA). Individuals who used each of the above-mentioned items at least once a day were regarded as regular consumers of that item and were included in the analysis. The relation between each of the variables (i.e. FBS, 2hpp, BMI, WHR) and the consumption of each of the sources of SFA, MUFA, PUFA, TFA, as well as sex and age was evaluated using the Linear Regression method. Chi-square test was used to compare the frequency distribution of the consumption of different types of fat between diabetics and non-diabetics, as well as between individuals with glucose intolerance and normal individuals.

Results

The numbers of individuals from the provincial towns of Isfahan, Najaf Abad and Arak who participated in the study were 4187, 1988, and 6339, respectively (totaling 12514 individuals). The mean age of

subjects versus sex, mean levels of FBS, 2HPP, BMI, WHR and WC in each of the three provincial towns has been presented in Table 1. The percentages corresponding to the consumption of each of the sources of fatty acids in the three provincial towns have been presented separately in Table 2.

The relationship between WC, WHR, BMI, FBS and the type of dietary fat, age and sex has been shown in Table 3. BMI and WC showed a significant positive relationship with the consumption of sources of PUFA in Isfahan (P=0.002 and P<0.001, respectively). The female sex showed a significant positive relationship with all variables, except FBS (P<0.001). There was no meaningful relationship between FBS and sex in Isfahan.

In Najaf Abad, only BMI showed a significant positive relationship with consumption of the sources of PUFA (P=0.047). Age showed a significant positive relationship with all of the variables (P<0.001). The male sex was inversely related to 2HPP, BMI, WHR and WC in Najaf Abad (P<0.001). There was no significant relationship between sex and FBS; however, a significant inverse relationship was found between FBS and the male sex after excluding diabetic individuals who were under medication (P=0.034).

In Arak, WC, BMI and FBS showed a significant positive relationship with consumption of the sources of PUFA (P=0.040 and P<0.001 and P<0.001, respectively). Age showed a significant positive relationship with all of the variables (P<0.001). The male sex showed a significant inverse relationship with all of the variables, except FBS (P<0.001). No significant relationship was observed between sex and FBS in Arak. Table 4 presents the frequency distribution of different types of fat sources and the comparison of the dietary patterns of fat consumption between diabetic and non-diabetic subjects, as well as between normal subjects and those with glucose intolerance in the three provincial towns of Isfahan, Najaf Abad and Arak as well as in the entire population. There was a significant difference between the intake of sources of SFA, PUFA, and TFA in Isfahan and Arak, as well as in the entire population between diabetics and non-diabetics. In Najaf Abad there was a significant difference between diabetics and non-diabetics in respect of consuming SFA and TFA sources (Table 4).

The relative chance of consuming SFA and TFA sources in diabetics was significantly less than non-diabetics in all three provincial towns, as well as in the entire population: O.R (95%CI)=1.482(1.232-1.781), O.R(95% CI)=1.576 (1.178-2.108), O.R(C.I) =1.340 (1.015-1.769) (in the mentioned order). Comparison between subjects with glucose intolerance and normal individuals in Isfahan as well as the entire population revealed a significant difference between the consumption of the sources of SFA (P=0.001 and P<0.001, respectively), PUFA (P=0.002 and P<0.001, respectively) and TFA (P<0.001). In Najaf Abad, there was no significant difference between subjects with glucose intolerance and normal individuals in respect of consuming sources of different fatty acids. In Arak, only the consumption of TFA sources in subjects with glucose intolerance was significantly less than normal individuals (P=0.041).

TABLE 1. Means of age, fasting blood sugar, 2-hour post-load plasma glucose, body mass index, waist–to-hip ratio and waist circumference in Isfahan, Najaf Abad and Arak.

Variable	Isfahan		Najaf Abad		Arak	
	N	Mean ± SD	N	Mean ± SD	N	Mean ± SD
Mean age (total)	4187	38.9 ±0.23	1988	38.1 ±0.31	6339	39.2 ±0.19
Women	2171	38.7 ±0.31	998	38.0 ±0.43	3222	39.1 ±0.26
Men	2016	39.0 ±0.35	990	38.1 ±0.45	3117	39.2 ±0.28
Fasting blood sugar	4167	85.4 ±0.57	1969	80.30 ±0.63	6196	83.8 ±0.37
2-hour post load plasma glucose	4095	104.9 ±0.91	1892	97.4 ±0.98	6100	100.1 ±0.61
Body mass index	4167	26.2 ±0.09	1974	26.1 ±0.12	6326	25.3 ±0.06
Waist-to-hip ratio	4163	0.92 ±0.001	1983	0.91 ±0.001	6325	0.89 ±0.001
Waist circumference	4166	94.1 ±0.2	1983	92.3 ±0.31	6325	87.7 ±0.16

SD: Standard deviation

TABLE 2. Distribution of subjects consuming various types of dietary fat in Isfahan, Najaf Abad and Arak.

Variable	Isfahan		Najaf-Abad		Arak	
	N	Percent	N	Percent	N	Percent
SFA* sources	3196	76.3%	1450	72.9%	5968	94.1%
MUFA** sources	68	1.6%	20	1.0%	107	1.7%
PUFA*** sources	1291	30.8%	309	15.5%	1064	16.8%
TFA**** sources	3010	71.9%	1395	70.2%	3773	91.1%

*Saturated fatty acids
**Monounsaturated fatty acids
*** Ployunsaturated fatty acids
****Trans fatty acids

TABLE 3. Relation between fasting blood sugar, 2-hour post-load plasma glucose, body mass index, waist-to-hip ratio, waist circumference and dietary fat, age and gender.

			SFA +		MUFA ++		PUFA +++		TFA ++++	Age		Gender	
Isfahan	R2*	Beta**	P***	Beta	P	Beta	P	Beta	P	Beta	P	Beta	P
FBSa	0.047	-0.047	0.155	-0.010	0.500	0.011	0.486	0.029	0.394	0.209	<0.001	-0.022	0.151
FBS -	0.023	-0.021	0.538	-0.004	0.794	0.006	0.703	0.007	0.831	0.148	<0.001	-0.020	0.207
2HPPb	0.106	-0.052	0.112	-0.008	0.575	0.019	0.238	0.028	0.403	0.310	<0.001	-0.072	<0.001
2HPP -	0.077	0.030	0.358	-0.004	0.818	0.020	0.230	0.002	0.948	0.260	<0.001	-0.079	<0.001
BMI c	0.080	0.016	0.625	0.029	0.05	0.049	0.002	-0.051	0.128	0.205	<0.001	-0.173	<0.001
WHRd	0.260	-0.058	0.056	0.013	0.341	0.007	0.635	0.033	0.288	0.436	<0.001	-0.121	<0.001
WCe	0.176	-0.047	0.130	0.001	0.958	0.053	<0.001	0.005	0.883	0.355	<0.001	-0.198	<0.001
Najaf-Abad													
FBS	0.070	-0.087	0.160	0.009	0.694	0.005	0.827	0.074	0.236	0.258	<0.001	0.000	0.983
FBS -	0.049	-0.055	0.375	0.007	0.747	-0.009	0.708	0.024	0.703	0.207	<0.001	-0.048	0.034
2HPP	0.112	-0.083	0.167	-0.007	0.748	0.028	0.204	0.031	0.605	0.289	<0.001	-0.141	<0.001
2HPP -	0.107	0.070	0.241	-0.003	0.904	0.018	0.429	0.015	0.799	0.273	<0.001	-0.157	<0.001
BMI	0.116	0.072	0.226	0.007	0.743	0.043	0.047	-0.109	0.068	0.233	<0.001	-0.237	<0.001
WHR	0.196	0.040	0.481	-0.001	0.957	-0.014	0.483	-0.057	0.315	0.405	<0.001	-0.176	<0.001
WC	0.167	0.011	0.846	0.010	0.619	0.017	0.420	-0.059	0.307	0.294	<0.001	-0.271	<0.001
Arak													
FBS	0.036	-0.031	0.131	-0.015	0.244	0.027	0.040	0.020	0.335	0.186	<0.001	-0.002	0.902
FBS -	0.022	-0.011	0.604	-0.008	0.522	0.017	0.215	0.022	0.315	0.146	<0.001	0.014	0.284
2HPP	0.054	0.004	0.828	-0.008	0.526	0.018	0.175	-0.024	0.263	0.213	<0.001	-0.087	<0.001
2HPP -	0.041	0.009	0.657	-0.006	0.652	-0.024	0.075	-0.018	0.401	0.183	<0.001	-0.083	<0.001
BMI	0.086	-0.024	0.239	0.013	0.294	0.060	<0.001	-0.003	0.881	0.189	<0.001	-0.211	<0.001
WHR	0.104	0.032	0.104	0.000	0.971	-0.001	0.946	-0.033	0.109	0.318	<0.001	0.052	<0.001
WC	0.122	-0.013	0.459	0.010	0.406	0.073	<0.001	-0.011	0.585	0.319	<0.001	-0.105	<0.001

*:R. Square
**:Regression coefficient
***: P. Value
+: Saturated fatty acids
++: Monounsaturated fatty acids
+++: Polyunsaturated fatty acids
++++: Trans fatty acids

A: Fasting blood sugar
B: 2-hour post-load plasma glucose
c: body mass index
d. waist-to-hip ratio
e. waist circumference
-. With omitting diabetics received drug

TABLE 4. Comparison of consumption of various dietary fats in diabetics versus non-diabetics and subjects with glucose intolerance versus healthy subjects in Isfahan, Najaf Abad and Arak.

Fat sources	Diabetic %(n)	Non-diabetic %(n)	P*	O.R** (C.I)***	IGTa	Normal	P	O.R(C.I)
Isfahan								
SFA[I]	60.8(138)	77.3(3044)	<0.001	0.456(0.346-0.602)	61.1(55)	76.7(3127)	0.001	0.477(0.311-0.734)
MUFA[II]	2.2(5)	1.6(63)	0.418	1.386(0.552-3.480)	2.2(2)	1.6(66)	0.658	1.381(0.333-5.729)
PUFA[III]	37.0(84)	30.5(1201)	0.039	1.340(1.015-1.769)	45.6(41)	30.5(1244)	0.002	1.906(1.252-2.901)
TFA[IV]	59.0(134)	72.6(2862)	<0.001	0.543(0.413-0.714)	53.3(48)	72.3(2948)	<0.001	0.438(0.288-0.666)
Najaf Abad								
SFA	60.8(62)	(73.4 1371)	0.005	0.561(0.372-0.845)	61.9(13)	72.9(1420)	0.260	0.604(0.249-1.466)
MUFA	2.0(2)	1.0(18)	0.278	2.054(0.470-8.977)	4.8(1)	1.0(19)	0.194	5.076(0.648-39.772)
PUFA	20.6(21)	15.3(286)	0.153	1.433(0.873-2.354)	19.0(4)	15.6(303)	0.556	1.277(0.427-3.822)
TFA	60.8(62)	70.5(1317)	0.036	0.647(0.430-0.975)	61.9(13)	70.1(1366)	0.414	0.692(0.285-1.679)
Arak								
SFA	87.2(231)	94.5(5603)	<0.001	0.398(0.273-0.580)	91.9(102)	94.2(5732)	0.304	0.698(0.350-1.391)
MUFA	1.1(3)	1.7(101)	0.629	0.661(0.208-2.098)	2.7(3)	1.7(101)	0.436	1.646(0.514-5.271)
PUFA	23.8(63)	16.5(980)	0.002	1.576(1.178-2.108)	23.4(26)	16.7(1017)	0.061	1.524(0.977-2.377)
TFA	84.2(233)	91.4(5419)	<0.001	0.502(0.356-0.706)	85.6(95)	91.2(5547)	0.041	0.576(0.377-0.985)
Total								
SFA	72.6(431)	85.3(10018)	<0.001	0.453(0.376-0.547)	76.6(170)	84.9(10279)	<0.001	0.582-(0.425-0.797)
MUFA sources	1.7(10)	1.6(182)	0.798	1.087(0.572-2.066)	2.7(6)	1.5(186)	0.16	1.780(0.781-4.059)
PUFA	28.3(168)	21.0(2467)	<0.001	1.482(1.232-1.781)	32.0(71)	21.2(2564)	<0.001	1.750(1.315-2.328)
TFA	70.5(419)	81.8(9598)	<0.001	0.533(0.444-0.640)	70.3(156)	81.4(9861)	<0.001	0.539(0.402-0.721)

*P. Value
**Odds Ratio
***Confidence Interval
I: saturated fatty acids
II: Monounsaturated fatty acids
III: ploy unsaturated fatty acids
IV: Trans fatty acids
a: Intolerance glucose test

Discussion

The relationship between FBS, 2HPP, BMI, WHR, WC and the consumption of sources of different fatty acids (i.e. SFA, MUFA, PUFA, TFA), age and sex was investigated in this study.

In Arak, a significant positive relationship was observed between FBS and consumption of PUFA sources (Table 2). This is consistent with findings of the Hoorn study.[7] There was no relationship between markers of diabetes and the consumption of sources of different dietary fats in other provincial towns. The positive relationship observed between FBS and consumption of sources of PUFA in Arak was different from the results of most studies,[3,5,6] but one,[7] however; this can be explained in view of the significant positive relationship between BMI and WC, and consumption of PUFA sources in the same town. The positive relationship between elevated blood sugar levels and obesity,[10,11] especially of the central type[12-14] has been established by different studies.

Nevertheless, this relationship was no longer significant after exclusion of diabetic patients under medication. Lack of significant relationship between markers of diabetes and dietary fat, especially in the provincial towns of Isfahan and Najaf Abad can be attributed to the fact that the total percentage of energy supplied from fats in these societies is too low to allow the characterization of their relation with markers of diabetes in this study.[15] In Isfahan and Arak there was a significant positive relationship between BMI and WC, and consumption of PUFA sources (Table 2). In Najaf Abad, this significant positive relationship was only observed between BMI and consumption of PUFA sources. These findings lead to the conclusion that people's nutritional knowledge about fats is inadequate. The common perception is that including sources of PUFA alone suffices for health, and there is little appreciation of the importance of replacing sources of PUFA with those of SFA and TFA.

A significant positive relationship was observed between all studied variables and age in all three provincial towns. This is consistent with findings of similar studies.[10,11,14]

Except in a single instance, the relationship between 2HPP, BMI, WHR, WC, and sex followed an identical pattern in all provincial towns, i.e. there was a significant inverse relationship between all of the variables (except WHR) and the male sex. WHR showed a significant positive relationship with the male sex in Arak.

There was no significant relationship between FBS and sex in any of the provincial towns. However, a significant inverse relationship between FBS and the male sex was found in Najaf Abad after excluding

diabetic patients who were under medication. Based on results of different studies,[10,14] diabetes, elevated blood sugar concentration, and obesity are more prevalent in women, compared to men.

Table 3 demonstrates the following:

1. In all of the three provincial towns, the dietary pattern of fat consumption in diabetics is significantly healthier than non-diabetics
2. Only in Isfahan did subjects with glucose intolerance follow a healthier dietary pattern of fat consumption compared to normal individuals

The former can be explained by the findings of studies[16-18] which demonstrate that knowledge of having a disease or its risk factors provides enough incentive for improving one's life-style. The healthier dietary pattern of fat consumption in subjects with glucose intolerance compared to normal individuals in Isfahan can be thereby explained. Lack of any significant difference between the dietary pattern of fat consumption in subjects with glucose intolerance, compared to normal individuals in Najaf Abad and Arak can be attributed to their inadequate nutritional knowledge and the presence of fewer educational facilities in these provincial towns compared to Isfahan.

A fundamental limitation in the interpretation of the results was that they were derived from cross-sectional descriptive data. This kind of study design does not allow considering the chronological relation between exposure and outcome. Such chronological relations can only be analyzed in prospective studies. Finally, it can be concluded that:

a) People's nutritional knowledge, especially about dietary fats is inadequate and the importance of replacing PUFA dietary sources with foods containing SFA and TFA cannot be adequately stressed.

b) Disease serves as an effective incentive for improving life-style; hence sustained efforts must be made to increase public awareness of the benefits of healthy nutrition and primary prevention.

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