# THE PREVALENCE OF CARDIOVASCULAR RISK FACTORS AND CORRELATION WITH NUTRITIONAL STATUS IN PATIENTS WITH TYPE 2 DIABETES

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## Abstract

**BACKGROUND:** Type 2 diabetes is a major predictor of cardiovascular disease (CVD). There is a large body of evidence that nutrients have a important role in preventing and controlling of CVD risk factors. This study aimed to investigate the prevalence of CVD risk factors and their relations with nutrients and energy intake in patients with type 2 diabetes.

**METHODS:** In this cross-sectional study, 107 patients with type 2 diabetes were recruited from individuals who underwent routine medical check-up in the out patient clinic of Shariati Hospital, Tehran, Iran. Patients were evaluated for age, anthropometric measures, blood pressure, fasting blood glucose, lipid profile and HbA1C. Nutrient intakes were obtained via 24- hour recall from each patient in three consecutive days. Nutrients and data analysis were done using FPII and SPSS version 13 soft wares.

**RESULTS:** Overall, 10.9% and 87.9% of patients had respectively two and more than two CVD risk factors. The intakes of energy, protein, dietary fiber and vitamins including vitamin C, E, B12, B6, B3, B2, B1, B5 and mineral such as copper and zinc were less than the standard values ($P < 0.001$). The status of some nutrients intake was significantly correlated with some CVD risks factors.

**CONCLUSION:** This study indicates a high prevalence of CVD risk factors among diabetic patients and emphasizes on the important role of nutrients intake in prevention and control of these risks. These findings suggest the necessity for improvement of nutrition status for reducing the prevalence of diabetes and CVD.

**Keywords:** cardiovascular risk factors, nutrition, diabetes.

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## Introduction

Diabetes mellitus (DM) is a metabolic disorder that principally characterized by elevated blood glucose levels and micro vascular and macro vascular complications. Worldwide, approximately 200 million people have type II diabetes mellitus (DM) that has been predicted to increase to 366 million by 2030. Type 2 diabetes is the serious risk of large-vessel atherosclerosis. Rates of cardiovascular disease (CVD) mortality and morbidity are particularly high in patients with type 2 diabetes that represent a significant cost for health care systems. Type 2 DM patients generally carry a number of risk factors of CVD, including hyperglycemia, abnormal lipid profiles, alterations in inflammatory mediators and other risk factors which may be closely associated with insulin resistance.[1-5] Atherosclerotic coronary artery disease (CAD) and other forms of CVD are the major causes of mortality and morbidity in type 2 DM that decrease the quality of life in these patients.[6] This condition is generally

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associated with hypertension, hyperlipidemia and obesity.[7,8] Myocardial infarction (MI) accounts for 60% of deaths, thus it is also common in these patients. Overall mortality of type 2 DM has increased two- to three fold and life expectancy is reduced by five to 10 years.[6] The risk of MI in Patients with type 2 DM (but without previous MI) is as high as nondiabetic patients with previous MI.[1] The National Cholesterol Education Program (NCEP) guidelines classify DM as a CAD "risk equivalent" – a disorder that carries the 10-year risk for developing new major coronary events equal to that of nondiabetic persons with established CAD (i.e., less then 20%).[9] However, the major metabolic defect in DM (i.e., hyperglycemia) does not by itself raise the risk to the level of a CAD risk equivalent and a group of metabolic risk factors combine with hyperglycemia to impart a high risk.[9]

CVD have heterogeneous etiologies, environmental factors, including diet, plays a major role in their development. Many studies have been shown the importance of nutrition in prevention and control of diabetes. Nutrition therapy is one of critical components of diabetes care and management.[10] The relations of some macronutrients and micronutrients including carbohydrate, protein, fat, dietary fiber, MUFA, PUFA, vitamins E, C and carotenoids, selenium, magnesium, zinc, copper and chromium with glucose and lipid control in patients with type II diabetes and prevention of acute and chronic side effects of diabetes have been shown in previous studies [10-15], but the exact role of nutrients in relation with CVD risks is unknown.

Thus present study designed to determine the status of energy and nutrients intake in compare with RDA ( Recommended daily allowance) standards, also describes the prevalence of CVD risk factors presenting in relations with nutrients intake in patients with type 2 DM and indicates how current and potential future nutritional strategies aim to reduce this CVD risk.

## Materials and Methods

In this cross-sectional study, 107 (22men and 85 women) patients with at least 40 years of old, 2 years diagnosis of type 2 diabetes with oral treatment were recruited from an unselected population that underwent routine medical check-up in the out patient Clinic of Shariati Hospital. The diagnosis of T2DM was based on the World Health Organization criteria.[16] Patients with history of metabolic disease and CVD were excluded. Informed written consent was obtained from all subjects before their participation in the study, which was approved by the ethical committee in Tehran medical university. Anthropometric questionnaires for each of patients were completed by trained dietitians. Anthropometric parameters included Weight (to the nearest 0.1 kg), height (to the nearest 0.5 cm), were measured, while the subjects were fasting and measured in light indoor clothing without shoes. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Waist-to-hip ratio (WHR) was calculated as waist circumferences divided by hip circumference. To avoid subjective error, all measurements were taken by the same person.

Usual dietary intake was assessed using a 24- hour recall questionnaires from each patients in three successive days. All questionnaires were completed by trained dietitians. Portion sizes of consumed foods were converted to grams using household measures.[17] Each food and beverage was then coded and analyzed for content of energy and other nutrients using Food Processor II (FP II) software.

The blood samples were collected between 08:00 and 09:00 a.m. after a 10-12 h fasting. The tubes were promptly centrifuged, and the serum was separated and stored at -80ºC. All samples were run in the same assay. All measurements were performed in the Endocrinology and metabolism research center (EMRC) laboratory of Shariati hospital.

$HbA_1C$ measured using HPLC exchange Ion method (DS5 England). Fasting Plasma glucose (FPG) was performed by GOD/PAP method, Triglycerides (TG) by GPO-PAP method, Total cholesterol (TC) by Enzymatic Endpoint method, direct high-density lipoprotein-cholesterol (HDL-C) and low density lipoprotein-cholesterol (LDL-C) by enzymatic clearance assay. All of these performed by using Randox laboratories kit (Hitachi 902). Blood pressure was measured twice after the participants had been sitting for 15 min.

Glucose tolerance test (OGTT) test was performed according to the World Health Organization standard procedure. After overnight fasting, the subjects given a standardized glucose solution of 75 g glucose in 250 ml of water. Blood samples were taken after 120 min to measure plasma glucose concentrations by utilizing the GOD/PAP and Randox method laboratory kits.

Obesity was defined as BMI $\geq$ 30 kg/m$^2$, over weight as 24.9 $\leq$ BMI $\leq$ 29.9 and normal weight as BMI $\leq$ 24.9.[18] According to the Adult Treatment Panel III guidelines of the National Cholesterol Education Program,[19] hypercholesterolaemia was considered as TC $\geq$ 200 mg/dl. We use of American Dietetic Association definitions (ADA)[20] to classifying levels of patients lipid profiles, hypertriglyceridaemia as TG $\geq$ 150 mg/dl, low HDL-C as, less than 40 mg/dl and 50 mg/dl respectively in men and women and high LDL-C as $\geq$ 100 mg/dl. According to ADA definitions plasma levels of HbA1C greater than 7%

was a criteria for poor control of diabetes. In each case, current use of medications also was in these definitions. According to seventh record of American Heart Association/National Heart, Long, Blood Institute (AHA/NHLBI)[21] patients with systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 85 mmHg or current use of antihypertensive medications was defined as hypertension.

Results are reported as the mean ± S.D. All of the statistical analyses were performed using the SPSS version 13 software. Comparisons were carried out using Paired t-test. P values less than 0.05 were considered to be statistically significant.

## Results

Table 1 shows the baseline characteristics for men and Women participate in this study. The most common cardiovascular risk factor was overweight and obesity (BMI ≥ 25), which was found in almost all patients.

The means of BMI, FPG, total cholesterol (TC), TG and HDL-C levels in women were more than men and levels of LDL-C in men was more than women. This difference about FPG was significant (P = 0.028) (Table 1).

The prevalence of CVD risk factors was shown in table 2. Totally 57.1% of men and 44 % of women were overweight and respectively 23.8 % and 40.5% of men and women were obese. Totally about 87.9% and 10.3 of patients respectively had two and more than two risk factors; only 1.8% of them didn't have any risk except for diabetes (hyperglycemia).

In this study, intakes of protein, total fat including saturated fatty acids (SFAs), mono unsaturated fatty acids (MUFAs), poly unsaturated fatty acids (PUFAs) and dietary fiber were less than RDA standards (P < 0.001). Energy and macronutrients intakes are shown in table 3.

In table 4 intakes of micronutrients was shown in two sexes. Totally intakes of some of vitamins including E, C, $B_1$, $B_2$, $B_3$, $B_6$, $B_{12}$, $B_5$ and minerals such as copper and zinc were significant less than RDA standards (P < 0.001). The daily intakes of other nutrients except selenium were significantly higher than RDA standards.

The intakes of selenium, vitamins $B_1$ and $B_2$ in women were significant higher than men (P < 0.05). The daily intakes of Carbotydrate, Total fat, SFAs, MUFAs and vitamin E, were decreased significantly with age (P < 0.01, r > 0.2).

We could not show significant correlation between intake of energy with BMI and WHR. There were negative correlations between BMI with the intakes of Protein, Carbohydrate, Dietary fiber (P < 0.05, r > 0.2), Carotenoids (P= 0.036, r = 0.208), Folate and vitamin $B_1$ (P = 0.01, r > 0.2), Calcium, Iron and magnesium (P < 0.01, r > 2), Phosphorus, selenium and zinc (P < 0.05, r > 0.2).

Then we analyzed the correlation between daily intakes if energy and nutrients and risk factors of CVD. There was a significant and positive correlation between plasma levels of $HbA_1C$ and dietary intakes of MUFAs and PUFAs (P = 0.01, r > 0.2), Total fat, SFAs and protein (P < 0.01, r > 0.260). The positive correlations between daily intakes of vitamins $B_1$, $B_2$, $B_3$ and plasma levels of $HbA_1C$ were significant (P < 0.05, r > 0.2). We also could show the positive and significant correlation between levels of $HbA_1C$ and intakes of Calcium, Iron, magnesium, Phosphorus, selenium and sodium (P > 0.05, r > 0.2).

There were positive and significant correlations between daily energy intake from fat and levels of FPG, OGTTP (P < 0.05, r > 0.2) and significant negative correlation between daily intake of carotenoids and FPG (P = 0.03 , r > 0.2).

We found significant and negative correlations between intakes of B3 with serum levels of TG and PUFAs with serum levels of LDL-C (P < 0.05, r > 0.2) in diabetic patients. In this study we couldn't show any significant correlations between dietary intakes and other CVD risk factors.

**Table 1.** The clinical characteristics and laboratory results of diabetic patients

| Characteristics | Men ( n=22) | Women (n=85) | P value |
|---|---|---|---|
| Age (year) | 10.79 ± 59.8 | 10 ± 53.8 | 0.018 |
| BMI ($Kg/m^2$) | 4 ± 28.4 | 4.36 ± 29.14 | NS[1] |
| FPG (mg/dl) | 54 ± 132.6 | 53.2 ± 161.7 | 0.028 |
| OGTT (mg/dl2) | 83.7 ± 211.6 | 66.6 ± 193.07 | NS |
| HbA1C (%) | 1.17 ± 7.2 | 0.91 ± 7.55 | NS |
| TCHO (mg/dl) | 29.12 ± 184.9 | 39.6 ± 192 | NS |
| LDL-C (mg/dl) | 19.6 ± 108.7 | 27.7 ± 111.4 | NS |
| HDL-C (mg/dl) | 9 ± 40.9 | 11.4 ± 45.48 | NS |
| TG (mg/dl) | 48.8 ± 137.4 | 128.6 ± 181.9 | NS |

1. Non significant

Results are expressed as mean ± S.D for T2DM patients. BMI, body mass index; FPG, Fasting plasma glocuse; OGTT, oral glucose tolerance test; HDL-C, high density lipoprotein; LDL-C, low density lipoprotein; TCHO, total cholesterol; TG, Tree glyceride

[a] p-Values are for Independent t-test.

**Table 2.** The prevalence of cardiovascular diseaserisk factors in diabetic patients.

| Characteristics | Men (%) | Women(%) | Total (%) |
|---|---|---|---|
| TCHO (≥ 200 mg/dl) | 28.6 | 39.4 | 37.5 |
| LDL-C (≥ 100 mg/dl or use of medicine) | 61.9 | 61.4 | 61.5 |
| HDL-C (mg/dl)<br>Men ≥ 40 mg/dl<br>Women ≥ 50 mg/dl<br>Or use of medidine | 42.9 | 75.9 | 66.3 |
| TG (≥ 150 mg/dl or use of medicine) | 44.6 | 47.6 | 45.2 |
| Hypertension (135/85 ≥ or use of medicin) | 23.8 | 39.3 | 36.2 |
| Over weight and obesity (BMI ≥ 24.9) | 72.7 | 83.5 | 81.3 |
| Obesity (BMI ≥ 29.9) | 23.8 | 40.5 | 32.2 |

BMI, body mass index; FPG, Fasting plasma glocuse; OGTT, oral glucose tolerance test; HDL-C, high density lipoprotein; LDL-C, low density lipoprotein;TCHO, total cholesterol; TG, Tree glyceride

**Table 3.** Energy and nutrients intake in comparison with recommended allowance in diabetic men and women*

| | Daily intakes | | Percent of RDA | | P Value£ |
|---|---|---|---|---|---|
| | Men | Women | Men | Women | |
| Energy (calories) | 1778.43 ± 446.89 | 1794.36 ± 1158.13 | 96.7 ± 24.42 | 95.83 ± 26.96 | < 0.001 |
| Protein (gr) | 73.7 ± 22.6 | 65.09 ± 21.36 | 128.67 ± 41.64 | 124.94 ± 42.82 | < 0.001 |
| Carbohydrate (gr) | 279.19 ± 73.33 | 245.34 ± 72.22 | 101.3 ± 26.52 | 96.81 ± 29.25 | < 0.001 |
| Dietary fiber (gr) | 21.84 ± 7.99 | 21.57 ± 9.61 | 114.33 ± 37.18 | 123.96 ± 53.8 | < 0.001 |
| Otal fat (gr) | 53.9 ± 19.17 | 52.41 ± 16.57 | 87.62 ± 21.85 | 89.93 ± 28.96 | < 0.001 |
| Cholesterol (mg) | 173.69 ± 155.74 | 161.21 ± 172.61 | 57.95 ± 51.83 | 53.96 ± 57.41 | < 0.001 |
| SFAs[1] | 17.5 ± 4.4 | 16.16 ± 5.83 | 82.76 ± 18.89 | 83.27 ± 30.49 | < 0.001 |
| MUFAs [2] | 18.58 ± 5.98 | 16.76 ± 5.49 | 24.87 ± 26.06 | 86.17 ± 28.83 | < 0.001 |
| PUFAs [3] | 15.35 ± 4.96 | 15.14 ± 5.88 | 72.38 ± 22.69 | 77.98 ± 30.3 | < 0.001 |

**Table 4.** Micronutrients intakes in compare of RDA in diabetic men and women*

| Nutrients | Daily intake | | Persent of RDA | | P value£ |
|---|---|---|---|---|---|
| | Man | Woman | Man | woman | |
| Vitamin A | 946.85 ± 1533.25 | 829 ± 832.22 | 111.9 ± 192.9 | 103.71 ± 102.9 | < 0.001 |
| VitaminE | 8.04 ± 2.19 | 7.64 ± 2.18 | 91.48 ± 24.04 | 95.63 ± 27.35 | < 0.001 |
| Vitamin B1 | 1.79 ± 0.46 | 1.54 ± 0.64 | 176.52 ± 45.33 | 153.86 ± 0.49 | < 0.001 |
| Vitamin B2 | 2.17 ± 0.6 | 1.805 ± 0.78 | 179.14 ± 51.30 | 150.6 ± 65.08 | < 0.001 |
| Vitamin B3 | 18.98 ± 7.48 | 16.19 ± 5.47 | 143.67 ± 56.08 | 140 ± 148.3 | < 0.001 |
| Vitamin B6 | 1.17 ± 0.34 | 1.13 ± 0.41 | 56.05 ± 15.46 | 57.25 ± 21.08 | < 0.001 |
| Vitamin B12 | 4.92 ± 8.57 | 3.26 ± 4.57 | 164.38 ± 28.62 | 108.92 ± 152.4 | < 0.001 |
| Folate | 256.66 ± 70 | 240.6 ± 109.9 | 64.24 ± 17.45 | 61.58 ± 26.95 | < 0.001 |
| Vitamin B5 | 5.41 ± 1.2 | 4.78 ± 1.91 | 77.43 ± 17.34 | 68.34 ± 27.35 | < 0.001 |
| Vitamin C | 66.52 ± 52.25 | 80.12 ± 81.03 | 114.3 ± 84.3 | 143.3 ± 136.2 | < 0.001 |
| Calcium | 897.8 ± 254.9 | 812.67 ± 444.5 | 112.38 ± 32.27 | 102 ± 55.4 | < 0.001 |
| Copper | 1.87 ± 1.14 | 1.51 ± 0.68 | 74.95 ± 45.54 | 60.61 ± 27.46 | < 0.001 |
| Iron | 15.61 ± 4.68 | 13.72 ± 4.43 | 121.33 ± 58.9 | 84.22 ± 34.58 | < 0.001 |
| Magnesium | 296.38 ± 87.58 | 289.32 ± 119.4 | 92.05 ± 24.11 | 91.07 ± 38.68 | < 0.001 |
| Phosphorus | 1204.47 ± 297.63 | 1076.27 ± 470.2 | 150.76 ± 37.07 | 283.7 ± 135.8 | < 0.001 |
| potasium | 2123.38 ± 475.27 | 1945.24 ± 836.7 | 56.62 ± 12.56 | 57.03 ± 23.95 | < 0.001 |
| selenium | 2150.01 ± 77.94 | 177.46 ± 76.2 | 171.95 ± 62.4 | 441.5 ± 272.1 | < 0.001 |
| sodium | 2353.47 ± 872.27 | 2028.27 ± 763.9 | 106.86 ± 39.61 | 92.2 ± 34.6 | < 0.001 |
| zinc | 11.02 ± 2.70 | 9.73 ± 3.39 | 73.48 ± 17.99 | 64.82 ± 22.2 | < 0.001 |

## Discussion

The results of present study indicate high prevalence of CVD risk factors in diabetic patients. We found that more than one third to two third of patients with type 2 diabetes respectively had dyslipidemia and hypertension. Having BMI 25 or greater, was the most common risk in this population. In present study more than 80% of diabetic patients had at least two risks factors of CVD and were high risk for macro vascular disease.

The prevalence of CVD risk factors is high in diabetic patients in compare of general population. In one study that performed by Azizi and et al[22] on the adults population of Tehran, showed that respectively about 31% and 27% of general population of adults have moderately high levels of TC an LDL-C (the levels of TC between 200 to 229 mg/dl and LDL-C between 100 to 129 mg/dl) and about 27% and 23% have high levels (TC ≥ 230 mg/dl and LDL-C ≥ 130 mg/dl). The prevalence of hypertension in general population[23,24] found 18% to 22% which is about one third of our study.

To date many studies showed the important role of nutrition especially energy consumption and weight reduction[25-27] in prevention and controls of chronic diseases include diabetes. In this study the intakes of protein, total fat and dietary fiber were less than RDA but the intakes of other nutrients including carbohydrates, cholesterol and energy were significantly higher than standards. These results were in favor of one recent study [28] and focuses on reduction of energy intake in diabetic patients and are in contrast with the other.[29] Like one study that performed on diabetic patients[29] in present study we could show the deficiencies in daily intakes of copper and zinc. This two minerals have an essential role in enhancing insulin sensitivity and prevention of chronic outcomes of diabetes. In favor of present study, the study of Tazakkori and et al[30] found that the intakes of macronutrients in patients with type 1 diabetes are less than recommended standards. Our findings about intakes of vitamins A, C and selenium were like one resent study,[31] but the intakes of vitamin E in our findings was higher than the results of this study.

Our findings showed significant negative correlation between intake of carbohydrates and BMI that was in contrast with previous studies[28,29] that found no correlation between carbohydrate and BMI in general populations.[32,33] In contrast with some studies[34,35] we could find significant negative correlation between intake of protein and BMI, and in favor of another[36] we showed negative and significant correlation between BMI and daily intake of zinc. We found no correlation between intake of calcium and vitamin C and prevalence of CVD risk factors that were in contrast with results of one previous study.[37] In contrast with one resent study,[38] we found positive and significant correlation between intake of vitamin $B_1$ and plasma levels of $HbA_1C$. We showed the negative correlations between intakes of $B_3$ and serum levels of TG that was consistent with founding of one recent study,[39,40] which can show the effects of vitamin $B_3$ intake on reducing production of VLDL-C from liver in diabetic patients. In contrast with some previous studies,[39-41] we couldn't show any correlation between intake of dietary vitamin $B_3$ and another risks of CVD.

Like our findings, some studies showed negative correlation between dietary intake of carotenoids and serum levels of FPG but in contrast with these studies we couldn't show any correlation between dietary intake of carotenoids and plasma $HbA_1C$ levels in diabetic patients.[42,43]

In present study we showed vital role of nutritional status in control of high prevalence of CVD risk factors in type two diabetes, especially in control of BMI, FPG, fasting serum levels of TG and LDL-C and plasma levels of $HbA_1C$.

There are several limitations that should be considered when examining the results of this study. First, we used cross-sectional data to identify the association of nutrients intake with CVD risks, which does not allow us to make causal inferences. Second, subject with type 2 diabetes usually use medicines for control of circulating glucose and lipids and dietary supplements that can effects nutritional habits and laboratory measurements and thus the results of this study.

## Conclusion

In summery, our findings indicate the high prevalence of CVD risk factors in type 2 diabetes and essential role of energy and nutrients intakes in control and prevention of these risk factors in diabetic patients. These findings suggest the need for improvement of nutrition status to reduction of diabetes and CVD prevalence. To identify many unknown reasons of high prevalence and differences of these risk factors among diabetic patients, the need of further study can be suggested.

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