Effect of Dietary Micronutrients on Body Insulin Status of Nonobese Type 2 Diabetic Subjects

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Abstract

Context: Food habits have an impact on the preponderance of diabetes mellitus (DM). Dietary nutrients have shown overriding influence on insulin sensitivity and secretory status of diabetic subjects due to rapid lifestyle changes and urbanization.

Objective: to explore the association of important dietary micronutrients and body insulin status of nonobese type 2 diabetic subjects.

Place and period of study : BIRDEM during the period of July 2007 to January 2008.

Study design: Case control study.

Materials: Ninety eight (98) nonobese type 2 diabetic subjects and ninety seven (97) healthy controls.

Methods: Nutrient profile was obtained by dietary recall method. Homeostatis Model Assessment was applied for measuring insulin status. Laboratory analysis and anthropometric measurements were done by standard methods.

Results: Univariate and multivariate statistical analysis were performed. Significant insulin secretory defect was found in diabetic group (Median (range),%; control 153 (65-285); DM, 50 (4-264). In diabetic group total calcium [Median (range), mg/dl; control, 331 (142-1368); DM 419(173-1742)] and total vit C [(Median (range) mg/dl; control, 54.2 (20.6-165); DM 86.04 (25.2 – 176)] consumption were found to be significantly higher (P<.001) than control group. But no significant association was established between insulin secretion (HOMA % B) with micronutrients intake among the case (subject) group.

Conclusion: Micronutrients consumption does not influence β-cell secretory dysfunction (insulin secretion) in non obese type 2 diabetis mellitus patients.

Key words: dietary micronutrients, insulin secretion, nonobese type 2 diabetics

Introduction:

Diabetes mellitus (DM) is a fast expanding global health problem. Despite possible influences of genetic and perinatal factors, diet is likely to have greater and overriding influence in generation of type 2 diabetes due to rapid lifestyle changes and urbanization[1]. The prevalence of type 2 diabetes has been shown to vary in different population probably as a consequence of food habits and obesity.

It has recently been demonstrated that a marked reduction in insulin sensitivity and a preserved insulin release characterized obese diabetic patients, while nonobese patients have a reduction in insulin release and normal insulin sensitivity[2].

Chronic low grade inflammation, which is considered to be a key mechanism in the pathogenesis of type 2 DM, is associated with the dietary pattern low in cruciferous vegetables, yellow vegetables and fruits[3]. In a recent trial over a 2 year period among men and women with type 2 DM, increased consumption of fruits and vegetables significantly reduced concentration of

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inflammatory markers[4]. In a cross sectional study in a British population[5] a dietary pattern characterized by high intake of fruits and vegetables were inversely associated with features of metabolic syndrome.

In one prospective Cohort study vitamin C intake was significantly lower among incident cases of type 2 DM[6]. In some case-control and cross-sectional studies vitamin A and vitamin C have been observed at lower level in individuals with diabetes[7-8]. Thiamine and riboflavin levels are found to be depressed in various tissues in diabetic subjects[9].

Some observational studies have shown an inverse relationship between dietary calcium intake and body weight[10-11] and thus insulin resistance. CARDIA study revealed a negative relationship between calcium intake and obesity and insulin resistance syndrome[12].

Loma Linda University's Adventist Health Study was the first to report the positive association between meat intake and risk of type 2 DM[13]. Numerous studies have confirmed that this association is related to high heme content of meat[14-15]. Similarly high body iron stores have been linked to insulin resistance[16] and metabolic syndrome[17]. It is also evidenced that reduction in body iron stores with blood-letting in Type 2 DM results in improvement in glycemic control and insulin resistance[18], suggesting a pathogenic role of iron in type 2 DM.

The strategy adopted in this study is to explore the role of micronutrients in expressing the magnitude of insulin resistance and secretory defect in nonobese type 2 DM and to setup a causal relationship between a pathological state and the potential factor.

Study subjects & Methods:
This is a case-control study conducted in BIRDEM from July 2007 to January 2008 with 195 subjects out of which 98 were diagnosed patients of type 2 DM (case) taken from outpatient department and the remaining 97 were normal healthy subjects (control) with a BMI less than 30 and within the age limit of 30 to 50 years. The subjects were explained about the nature and purpose of the study. Their written consent, medical history were taken. Clinical examination were done methodically.

Height (m), weight (kg) of the subjects were measured by standard scales and Basal met abolic index (BMI) were measured by dividing the weight with square of height. Fasting plasma glucose and insulin level were measured by enzymatic method and ELISA respectively. â-cell secretion (HOMA B) and insulin sensitivity (HOMA S) were derived from these two parameters by Homeostasis Model Assessment (HOMA) using a particular software (HOMA-CIGMA software). Nutrients information were calculated using recall method where a questionnaire, prepared by nutritionist was introduced which dealt with dietary habits, frequency of eating and the type of cooking medium. The consumption were recorded on a weekly, monthly and more than a month basis. Standard sets of common utensils, utilized in our households, were used to assess the portion of food articles. Data analysis of dietary parameters were carried out by a special software. Statistical analysis were performed using SPSS-12 software.

Results
The study subjects, both case and control group are found to have BMI (Table-I) below obesity range (<30). Considering the insulinaemic status of the study group significant insulin secretory defect (Table-II) have been identified among the cases as HOMA %B is lower in them [Median (range), %; 50(4-269)]. Regarding microminerals intake (Table-III), diabetic patients are found to consume significantly higher level of calcium [Median (range), mg/d; 419 (173-1742)] and vit-C [Median (range), mg/d; 86.04 (25.2-176)]. Consumption of others showed no significant difference. Any correlation or association can not be proved between secretory status or HOMA% B of study group with their micronutrients intake in Spearman's rho correlation study and multiple regression analysis (Table-IV).

Table-I

BMI of the study subjects

Variables	Control (n=97)	T2 DM (n=98)	t/p value Control vs. T2DM
BMI (kg/m^2)	22.96 ± 2.78	23.42 ± 2.5	1.063/0.289

Results are expressed as Mean ± SD. Independent 't' test is performed as the test of significance at 5% level of significance .n=number of subjects. BMI=Body mass index.

Table-II

Insulinaemic status, β cell secretion & insulin sensitivity status of the study subjects

Variables	Control (n=97)	T2 DM (n=98)	z/p value Control vs. T2 DM
F. insulin (pmol/L)	75 (21 - 212)	76 (20 - 634)	0.456/0.648
HOMA % B	153 (65 - 285)	50 (4 - 269)	8.67/<0.001
HOMA % S	69 (1 - 247)	67 (9 - 256)	0.182/0.856

Results are expressed as Median (range). Mann-Whitney 'u' test was performed as the test of significance at 5% significance level .n= number of subjects. F. insulin= Fasting insulin. HOMA % B= b cell function assessed by homeostasis model assessment. HOMA % S = insulin sensitivity by homeostasis model assessment.

Table-III

Vitamins and Minerals intake of study subjects

Variables	Control(n=97)	T2 DM (n=98)	z/p value Control vs. T2 DM
Calcium (mg/d)	331 (142 - 1368)	419 (173 - 1742)	3.29/0.001
Iron (mg/d)	22.8 (11.8 - 38.4)	22.18 (11.37-41)	0.421/0.674
Thiamine (mg/d)	1.11 (0.62 - 2.24)	1.16 (0.38 - 2.9)	1.267/0.205
Riboflavin (mg/d)	1.84 (0.54 -5.13)	1.9 (0.96 - 5)	0.122/0.903
Vit-C (mg/d)	54.2 (20.6 - 165)	86.04 (25.2 - 176)	3.601/<.001
Vit-A (IU/d)	1885 (1019 - 5300)	2126 (1087 - 7087)	1.765/0.078

Results are expressed as Median (range). Mann-Whitney 'u' test was performed as the test of significance at 5% significance level. n= number of subjects. Vit-C= Vitamin C. Vit-A= Vitamin A.

Table-IV

Spearman's rho correlation coefficient (r) analysis of HOMA % B with micronutrients intake of study subjects

Variables	Control (n= 97)		T2 DM (n= 98)	
	r	p	r	P
Calcium(mg/d)	0.045	0.741	0.064	0.532
Iron(mg/d)	0.227	0.089	-0.163	0.108
Thiamine(mg/d)	0.171	0.203	-0.109	0.287
Riboflavin(mg/d)	-0.099	0.465	0.015	0.884
Vit-C(mg/d)	0.133	0.325	-0.063	0.535
Vit-A(IU/d)	0.131	0.332	-0.084	0.413

Spearman's rho correlation coefficient (r) was performed for analysis. n= number of subjects. r= correlation coefficient.

Table-V

Multiple Regression analysis of HOMA% B with micronutrients intake of the study subjects

Variables	Standardized coefficient (β)	p value
Calcium (mg/d)	.002	.988
Iron (mg/d)	.174	.080
Thiamine (mg/d)	-.061	.641
Riboflavin (mg/d)	-.007	.928
Vit C- (mg/d)	-.160	.153
Vit- A (IU/d)	-.064	.513

Multiple Regression analysis is performed with HOMA% B as dependent variable. Vit-C= Vitamin C, Vit-A= Vitamin A

Discussion

The usual pathophysiological events in type 2 DM is the presence of insulin resistance followed by compensatory hyperinsulinemia but eventually â cell failure occur due to exhaustion. In contrast to this scenario the nonobese diabetic population in the present study did not show any hyperinsulinemia or insulin resistance. Rather they showed a highly significant reduction in insulin secretory capacity. This conforms to the previous studies in Bangladeshi population [19-21] where a predominant secretory defect had been found in Type 2 DM.

Hyperglycemia of diabetes worsens insulin resistance and oxidative stress is known to impair insulin action[22]. People with diabetes are reported to have lower circulating vitamin C level than non-diabetic subjects[23]. In some case-control and cross-sectional studies significantly lower serum levels of vitamin C and vitamin A have been observed in type 2 DM patients[7-8]. In one American study Vit-A concentration was even higher in diabetic patients[24]. A cross-sectional study on Potsdam Cohort failed to show a relation between vitamin A and insulin resistance[25]. In this study vitamin C intake in Type 2 DM patients was significantly higher than control (p=<.001). Vitamin A intake was also marginally raised in patients than control. Analysis performed by Spearman's correlation coefficient and Multiple Regression evidenced no relation or association between these vitamins and insulin secretion.

The altered metabolism of thiamine and riboflavin results in depression of glucose levels in diabetic subjects[9]. Intakes of thiamine and riboflavin were almost similar in two groups in the current study. No association was established between these vitamins intake and insulin secretion. It has been suggested that the combined action of some vitamins cocktail is a possible reason for the controversial results between different trials and studies[26].

Recently Liu et al [27] reported that the intake of calcium may be associated with lower prevalence of insulin resistance and metabolic syndrome in middle aged and older women. Several observational studies have shown an inverse relationship between dietary calcium intake and insulin sensitivity[10-11]. In this study though calcium intake was found significantly higher (p=0.001) in type 2 DM subjects than control but no association or relation was established between calcium and insulin secretion in further analysis.

A relationship between high iron intake and high body iron stores and type 2 DM is well recognized on US adult[28]. Sheu with co-workers[16] found that increased iron intake influence insulin resistance. Estimation of iron intake in this study showed no significant difference between the Type 2 DM group and control group. There was also no association between iron intake and HOMA% B in either univariate or multivariate analysis.

This study reveals that nonobese type 2 DM patients in our country have insulin secretory defect rather than insulin resistance. Analyzing the micronutrients consumption, Vit-C and calcium were found to be higher in cases but it does not seem to have a direct influence on body insulin status. The dietary recall method has certain limitation to reflect the accurate amount and pattern of diet. Subjects sometimes tend to report greater consumption which is thought to be socially desirable and proof of their economic status. So, selective micronutrients have been brought under preference.

Conclusion:

The study is concluded with the finding that nonobese Type-2 DM patients possess â- cell secretory defect and micronutrients intake by them have no stimulatory role on this depressed insulin secretion.

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