A COMPARATIVE STUDY OF NUTRITIONAL STATUS, GLYCEMIC STATUS AND LIPID PROFILE IN HEALTHY AND DIABETIC PATIENTS

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ABSTARCT: Background and Objectives: Obesity is a positive risk factor in the development of type 2 diabetes mellitus, dyslipidemia, insulin resistance and hypertension. Lack of systematic study on these aspects provoked to compare the nutritional, glycemic status and lipid profile in healthy and diabetic patients. **Methods:** In the present study, 57 age and sex matched non-diabetic subjects, 58 diabetic only and 43 diabetic with hypertension individuals were recruited. BMI, Waist-Hip ratio, Fasting blood sugar, postprandial blood sugar, glycosylated haemoglobin (HbA_{1c}) and lipid profile were estimated using standard procedure. The data was compared using Analysis of Variance. P value was taken as significant at 5 percent confidence level (P<0.05). **Results:** Analysis showed a significant increase in FBS, PPBS and HbA1c levels (p=0.001 respectively), W/H ratio (p=0.005), BMI (p=0.05) serum cholesterol and serum triglyceride levels (p=0.001) in Group-1 and Group-2 compared to controls. The HbA_{1c} levels were higher in males of diabetic group with W/H ratio > 0.95 (p=0.001) and females of diabetic group with W/H ratio >0.80 (p= 0.001) respectively. **Interpretation and Conclusion:** While FBS and PPBS measurements are established guide for modifying treatment, measurement of HbA1c must be considered as a standard method for assessing long-term glycaemic control.

Key Words: Central obesity, Generalized obesity, Glycosylated haemoglobin, Lipoproteins

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Introduction:

Diabetes mellitus once regarded as a single disease entity, is now seen as a heterogeneous group of diseases, characterized by a state of chronic hyperglycemia, resulting from a diversity of etiologies, environmental and genetic, acting jointly. Type 2 diabetes mellitus (NIDDM) is much more common than type1 diabetes mellitus (IDDM). NIDDM is typically gradual in onset and occurs mainly in the middle- aged and elderly, frequently mild, slow to progress, and is compatible with long survival if given adequate treatment. Diabetic patients, if undiagnosed or inadequately treated develop multiple chronic complications. Currently, the number of cases of diabetes worldwide is estimated to be around 150 million. It was estimated that 20% of the current global diabetic population resides in the South-East Asian region. The result of prevalence studies of diabetes mellitus in India in adults was found to be 2.4 percent in rural and 4.0-11.6 percent in urban dwellers[1].

It was reported that obesity is the major culprit for diabetes. Obesity is an abnormal growth of the adipose tissue due to an enlargement of fat cell (hypertrophic obesity) or an increase in fat cell number (hyperplastic obesity) or a combination of both. It is often expressed in terms of body mass index (BMI) [2]. The distribution of adipose tissue in different anatomic depots also has substantial implications for morbidity. Specifically, intra-abdominal and abdominal subcutaneous fat has more significance than subcutaneous fat present in the buttocks and lower extremities. Determining the waist-to-hip ratio (W/H ratio) most easily makes this distinction[3].

The estimation of urine and blood sugar levels are done commonly for diagnosis and monitoring of glycaemic control and they are subjected to various physiological and pathological fluctuations. They represent the current glycaemic status of the patient and they are poor indicators of long-term control. For the last few years, estimation of glycosylated haemoglobin and fructosamine has been increasingly used to achieve better monitoring of long-term glycaemic control in diabetes. When plasma glucose is consistently elevated, there is an increase in nonenzymatic glycation of haemoglobin: this alteration reflects the glycaemic history over the previous 2 to 3 months, since erythrocytes have an average life span of 120 days[4].

Individuals with diabetes mellitus may have several forms of dyslipidemia. Circulating lipoproteins are just as dependent on insulin as the plasma glucose. In obese patients with type II diabetes, a distinct "diabetic dyslipidemia" is characteristic of the insulin resistance syndrome. Its features are a high serum triglyceride level (300-400 mg/dl), a low HDL cholesterol (less than 30 mg/dl), and a qualitative change in LDL particles. Measures designed to correct the obesity and hyperglycemia, such as exercise, diet and hypoglycemic therapy, are the treatment of choice for diabetic dyslipidemia. The patients in whom normal weight was achieved, all features of the lipoprotein abnormalities are cleared[5]. Considering this, the present study was taken up to correlate glycosylated haemoglobin (glycaemic status), waist hip ratio, body mass index and lipoprotein level (nutritional status) in type 2 diabetes mellitus patients.

Material & Method:

In the present study, type 2 diabetes mellitus patients coming for regular check-up to a tertiary care centre after institutional ethical clearance and written consent from all the participants. One hundred and one consecutive cases were taken and 57 age-matched non-diabetic subjects were included as controls in this study. The subjects were selected irrespective of their sex and duration of illness. Out of the 101 diabetic patients, 58 were diabetic only and 43 were diabetic with hypertension. The study group was divided into Group-1 (Diabetic only patients), Group-2 (Diabetic with hypertension patients) and Group-3 (Non-diabetic subjects as controls). BMI, Waist-Hip ratio, Fasting blood sugar, postprandial blood sugar, glycosylated haemoglobin (HbA_{1c}) and lipid profile were estimated using standard procedure.

Patients were classified as having diabetes on the basis of history, regardless of duration of disease or need for anti diabetic agents. Major selection criteria for diabetes included are, a random plasma glucose level of 200mg/dL or greater when the symptoms of diabetes were present and a fasting plasma glucose level of 126 mg/dL or greater[4]. Subjects with Type-1-Diabetes mellitus patients were excluded.

Waist-Hip ratio was calculated by measuring the circumference of the abdomen (waist) and the circumference of the hips and taking the ratio as the Waist-Hip ratio (W/H ratio).[19] The abdominal or waist circumference was measured with a flexible tape placed in a horizontal plane at the level of the natural waist line or in the narrowest part of the torso as seen from the anterior view[6]. The hip circumference was measured in the horizontal plane at the level of maximal circumference, including the maximum extension of buttocks posteriorly[6].

In males, the normal W/H ratio is < 0.95 and the abnormal W/H ratio is > 0.95. In females, the normal W/H ratio is < 0.80 and the abnormal W/H ratio is > 0.80[7]. The Body mass index (BMI, Quetelet's Index) is a simple index of weight-for-height. Weight is measured in kilograms and height is measured in meters. BMI is calculated by dividing weight in kilograms by the square of the height in meters (kg/m^2). The BMI between 20-24.9 was considered normal, between 25-29.9 was considered overweight and >30 was considered as obesity.

The glycosylated haemoglobin was measured by auto analyzer method. Any value >7 % were considered as increased HbA_{1c}. HbA_{1c} was measured after one month of the recording of FBS and PPBS.

Statistical Analysis: The values were represented as Mean ± SEM. The different groups were compared using Analysis of variance. P value was taken as significant at 5 percent confidence level (P<0.05).

Results:

In the present study, glycosylated haemoglobin (glycaemic status), waist hip ratio, body mass index and lipoprotein level (nutritional status) in type 2 diabetes mellitus patients was compared between the type 2 diabetes mellitus patients with and without general and central obesity.

The analysis showed that the Fasting Blood Sugar, Postprandial Blood Sugar and Glycosylated haemoglobin levels were significantly higher (p=0.001 respectively) in Group-1 and Group- 2 compared to controls (Table-1). The differences between the ages of different groups were not significant (p=0.331, NS). This indicated that the subjects were age-matched. The SBP and DBP were significantly higher (p=0.001 respectively) in Group-2 compared to the Group-1 and controls.

The W/H ratio and BMI were significantly higher (p=0.005 and 0.05 respectively) in Group-1 and Group- 2 compared to controls (Table -2).

The serum cholesterol and serum triglyceride levels were significantly higher in Group-1 and Group-2 (p=0.001 respectively) compared to controls. The serum HDL cholesterol levels were significantly lower in Group-1 and Group-2 (p=0.001 respectively) compared to controls (Table -3). The serum cholesterol and triglyceride levels were higher in individuals in diabetic group with BMI > 25 and it was statistically significant (p=0.048 and 0.01 respectively). Even though the serum HDL- cholesterol levels were lower in the individuals in diabetic group with BMI > 25, it was not statistically significant (p=0.35, Table -4).

The serum cholesterol and triglyceride levels of males were higher in diabetic group with W/H ratio > 0.95 and it was statistically significant (p=0.044 and 0.048 respectively). It was also found to be higher in females of diabetic group with W/H ratio > 0.80 and it was statistically significant (p=0.009 and 0.048 respectively). But, there is a nonsignificant decline (p=0.299) in HDL-cholesterol levels in males of diabetic group with W/H ratio >0.95 and females (p=0.391) of diabetic group with W/H ratio >0.80 (Table -5 and 6).

TABLE-1: - Comparison of demographic characteristics and Basal parameters like Fasting Blood Sugar (FBS), Post Prandial Blood Sugar (PPBS) and Glycosylated haemoglobin (HbA1c) levels in the subjects of different group.

	Group - 1(N=58)	Group - 2 (N=43)	Controls (N=57)	P value
Age (in years)	57.51 ± 1.08	59.34 ± 1.33	57.29 ± 0.60	0.331 #
FBS (mg/dL)	125.18 ± 4.82	127.25 ± 4.30	87.82 ± 1.21	0.001 ***
PPBS (mg/dL)	186.03 ± 7.36	186.76 ± 6.55	126.10 ± 5.46	0.001 ***
HbA_{1C} (%)	8.01 ± 0.16	8.34 ± 0.15	7.08 ± 0.22	0.001 ***

Note: Values are Mean ± SEM, # Not Significant, *** Very Highly Significant

TABLE-2: Comparison of anthropometric measurements and Basal parameters like Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Waist-Hip Ratio (W/H Ratio) and Body Mass Index (BMI) in the subjects of different group.

	Group-1 (N=58)	Group-2 (N=43)	Controls (N=57)	P value
SBP (mmHg)	134.48 ± 2.16	148.74 ± 3.31	137.19 ± 1.88	0.001 ***
DBP (mmHg)	83.55 ± 0.86	91.16 ± 1.45	87.12 ± 1.05	0.001 ***
W/H Ratio	0.94 ± 0.00	0.95 ± 0.01	0.90 ± 0.00	0.005 **
BMI	25.63 ± 0.50	26.03 ± 0.71	24.26 ± 0.41	0.05 *

Note: Values are Mean ± SEM, * Significant, ** Highly Significant, *** Very Highly Significant

TABLE-3: - Comparison of lipid profile in the subjects of different group.

	Group-1(N=58)	Group-2(N=43)	Controls (N=57)	P value
Cholesterol (mg/dL)	202.31 ± 4.31	209.90 ± 4.89	168.01 ± 2.78	0.001 ***
Triglycerides(mg/dL)	242.53 ± 10.50	255 ± 9.53	180.54 ± 4.39	0.001 ***
HDL (mg/dL)	37.94 ± 1.18	35.63 ± 1.14	48.32 ± 0.63	0.001 ***

Note: Values are Mean ± SEM, *** Very Highly Significant

TABLE-4:- Comparison of diabetic patients with or without general obesity with the lipid profile.

	BMI < 25 (N=47)	BMI > 25 (N=54)	P value
Cholesterol (mg/dL)	199.12 ± 4.92	211.12 ± 4.18	0.048 *
Triglyceride(mg/dL)	227.87 ± 12.38	265.22 ± 7.63	0.01 **
HDL(mg/dL)	37.80 ± 1.39	36.22 ± 1.00	0.35 #

Note: Values are Mean ± SEM, # Not Significant, * Significant, **Highly Significant

TABLE-5: - Comparison of central obesity of male diabetic patients with the lipid profile.

	W/H ratio < 0.95 (N = 38)	W/H ratio > 0.95 (N = 31)	P value
Cholesterol (mg/dL)	198.18 ± 4.49	226.68 ± 5.27	0.044 *
Triglyceride (mg/dL)	237.78 ± 8.65	255.22 ± 9.48	0.048 *
HDL (mg/dL)	36.97 ± 1.33	33.79 ± 1.77	0.299 #

Note: Values are Mean ± SEM, * Significant, # Not Significant

TABLE-6: - Comparison of central obesity of female diabetic patients with the lipid profile.

	W/H ratio < 0.80 (N = 13)	W/H ratio > 0.80 (N = 19)	P value
Cholesterol (mg/dL)	218.69 ± 8.057	229.63 ± 6.15	0.009 *
Triglyceride (mg/dL)	239.00 ± 17.56	258.26 ± 15.34	0.048 **
HDL (mg/dL)	38.68 ± 2.37	36.03 ± 1.47	0.391 #

Note: Values are Mean ± SEM. * Significant, ** Highly Significant, # Not Significant

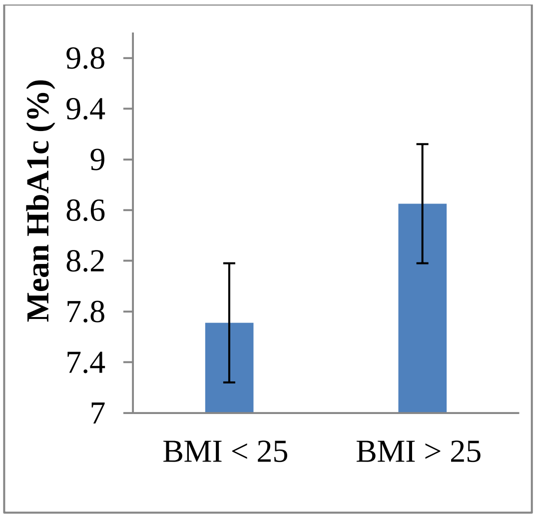

FIG-1: - Comparison of glycosylated haemoglobin of diabetic patients with or without general obesity. Values are Mean ± SEM, *** Very Highly Significant.

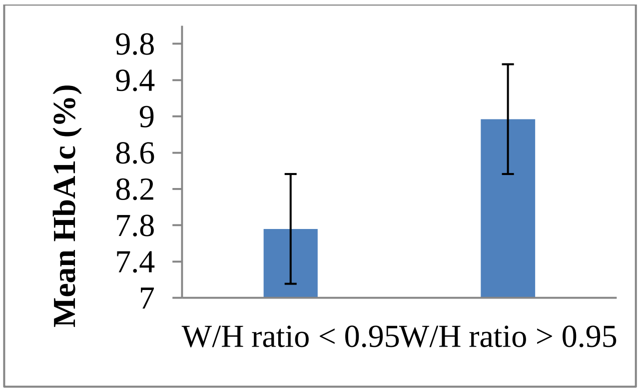

FIG-2: Comparison of glycosylated haemoglobin of male diabetic patients with or without central obesity. Values are Mean ± SEM, *** Very Highly Significant.

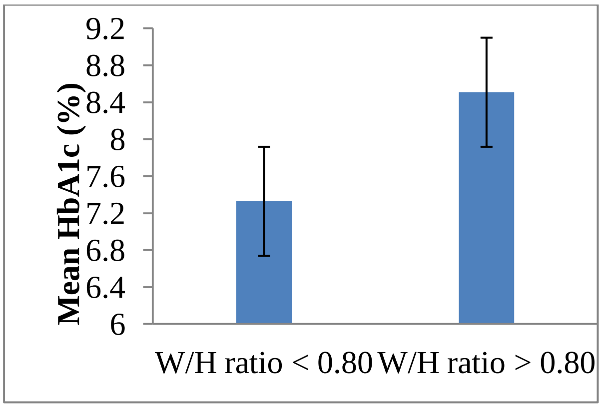

FIG-3: - Comparison of glycosylated haemoglobin of female diabetic patients with or without central obesity. Values are Mean ± SEM, *** Very Highly Significant.

The HbA1c levels were higher in individuals in diabetic group with BMI > 25 and it was statistically significant (p=0.001) as compared to subjects without general obesity (Fig-1). The HbA_{1c} levels were higher in males of diabetic group with W/H ratio > 0.95 (p=0.001) and females of diabetic group with W/H ratio > 0.80 (p= 0.001) respectively (Fig-2 and 3).

Discussion:

Obesity is an important and well-established risk factor for type 2 diabetes mellitus. Anthropometric measures of general and central obesity as predictors of type 2 diabetes mellitus risks have been well studied. The risk of diabetes increases progressively with increasing body mass index and waist-hip ratio. Weight gain is associated with an increase in insulin resistance and deterioration in glucose tolerance. Mainly the centrally located adipocytes have specific metabolic roles in the pathogenesis of insulin resistance and type 2 diabetes mellitus[8]. Our study has revealed that, on comparison with non-diabetic group, diabetic group showed increased body mass index. Chan J M et al., [9] also demonstrated a strong positive association between overall obesity as measured by BMI and risk of diabetes.

Body mass index and waist hip ratio (W/H ratio) indicates the measure of general obesity and central obesity. W/H ratio is also used as an indicator for assessing the risk of development of type 2 diabetes mellitus. Present study showed a significantly higher W/H ratio in diabetic group compared to non-diabetic group as reported by Dalton M et al[10].

Individuals with diabetes mellitus may have several forms of dyslipidemia due to the additive cardiovascular risk of hyperglycaemia and hyperlipidemia. The most common pattern of dyslipidemia is hypertriglyceridemia and reduced HDL-cholesterol levels[4]. In the present study, it was observed that the serum cholesterol and serum triglyceride levels were significantly higher in diabetic patients compared to non-diabetic subjects. The serum HDL-cholesterol level was also significantly lower in diabetic patients, compared to non-diabetic subjects.

There was a positive correlation between serum cholesterol, triglyceride and BMI and no correlation between HDL-cholesterol and BMI in diabetic group. It is in line with the observations of Vamamoto A et al[11]. It was also reported that, individuals with high indices (BMI, W/H ratio and waist circumference) had significantly increased levels of glucose, LDL-cholesterol, mean blood pressure, triglyceride, insulin and lower values of HDL and total cholesterol ratio in normal individuals[12].

Generalized obesity can be considered as a major risk factor for cardiovascular disease, diabetes, hypertension and premature death, but abdominal or central obesity is even more closely related to these. Diabetes causes accelerated atherosclerosis and this could result in peripheral vascular and ischemic heart disease and stroke, which are the major causes of death in diabetics. Present study showed a positive correlation between serum cholesterol, triglyceride and W/H ratio in female diabetic group indicating W/H ratio had the strongest relationship with type 2 diabetes mellitus, dyslipidemia. Therefore, W/H ratio could be considered as the most useful measure of obesity to identify individuals with CVD risk factors. Komiya S, et al[13] reported that in the group of obese women with high W/H ratio (greater than 0.87), the ratio of cholesterol to HDL-cholesterol and triglyceride were higher and HDL-cholesterol lower than in the normal group with low W/H ratio (less than 0.80) in female subjects, ranging from 31 to 40 years in age.

In normoglycemic subjects, a small proportion of HbA is attached to carbohydrate moiety, and forms glycosylated haemoglobin. In conditions of sustained hyperglycaemia, such as diabetes mellitus, the proportion of haemoglobin that is glycosylated is increased substantially. This glycosylation is the result of post-translational modification of HbA molecules. The binding of glucose is a non-enzymatic process that occurs continuously during the life of the red blood cell. Thus the amount of glycosylated haemoglobin reflects the glycaemic control of a patient during the 6-8 week period before the blood sample was obtained[8]. The present study showed a positive correlation between HbA1c and BMI in the diabetic group as reported by Bell R A et al[14].The present study also revealed a positive correlation between HbA1c and W/H ratio in males in the diabetic group as reported by Chang C J et al[15].

Recent prospective, epidemiological research has demonstrated the power of an increased W/H ratio to predict both cardiovascular disease (CVD) and type 2 diabetes mellitus in men and women. An increased total body fat mass in obesity interacts synergistically in the development of type 2 diabetes mellitus. Increased W/H ratio with abdominal obesity was associated with a cluster of metabolic risk factors, as well as hypertension. This metabolic syndrome is closely linked to visceral fat mass. Increased W/H ratio without obesity may instead be associated with life-style factors such as smoking, alcohol intake, physical inactivity, coagulation abnormalities, and psychosocial, psychological and psychiatric factors[16].

Present study showed positive correlation between HbA1c and W/H ratio in diabetic females as reported by Nakazaki M. et al[17]. They reported the correlations of HbA1c with each plasma glucose level obtained on day-0(same day), 1 and 3 months prior to HbA1c determination, and found that pre-and post breakfast plasma glucose levels were the most reliable predictors of 1 month later HbA1c in type 2 diabetes mellitus.

From this study, it was concluded that most of the type 2 diabetes mellitus patients are obese, weight loss and exercise of moderate degree, are associated with insulin sensitivity and often improve glucose control i.e.; significant improvement in glycosylated haemoglobin levels in diabetics. Improvement of glycaemic control can lower serum triglycerides and have a modest beneficial effect on rising HDL-cholesterol.

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