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A Study On Influence Of Obesity And Oxidative Stress On Type II Diabetes Mellitus

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Abstract
Obesity and oxidative stress have garnered attention in the majority of biomedical fields and clinical research in recent years. Type II diabetes can be brought on by an excessive amount of body fat accumulation, and the risk of Type II diabetes rises linearly with body mass index and oxidative stress. Present study focusses on the levels of random blood sugar (RBS), malondialdehyde (MDA), HbA1c, hypertension in individuals with obesity. Out of 100 obese patient reports studied 90% have shown diabetes and 87.5% are with hypertension. Patients showed statistically significant increase in the levels of MDA, RBS and HbA1c when compared to normal ranges. Results show that obesity and oxidative stress are the major determinants for the poor metabolic control in patients with Type II diabetes.
Key words*: Obesity, Oxidative Stress, Type II diabetes, MDA*

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I. Introduction

A collection of metabolic diseases known as diabetes mellitus are typified by high blood glucose levels (hyperglycaemia) and insufficient insulin production or action by the pancreas[1]. Type 2 diabetes is a long-term, potentially crippling, and often fatal medical condition. This disease requires regular monitoring of an individual's blood sugar level and treatment[2]. In type 2 diabetes, the body either does not properly produce or use insulin. The pancreatic beta cells produce the protein hormone insulin in response to a number of stimuli, including glucose and arginine, but glucose is the primary determinant [3]. The body becomes resistant to insulin if it is not properly producing or using it. This resistance causes high blood sugar levels.

It has been reported that oxidative stress is a known mechanism in the development of diabetic complications[4]. It is thought that oxidative stress brought on by hyperglycaemia raises pro-inflammatory protein levels and causes infiltrated macrophages to release inflammatory cytokines, which causes both local and systemic inflammation[5]. Oxidative stress can affect red blood cells and other cells due to the elevated levels of polyunsaturated fatty acids, ferrous ions, and molecular oxygen [6].

Research has indicated that oxidative stress is among the variables contributing to this process, although the precise roles of the molecules under investigation in the β cell death process remain to be established. On another note, it's noteworthy to note that if oxidative stress originates from chronic hyperglycaemia, then pancreatic beta cell apoptosis may be the cause of diabetes[7]. The early stages of the illness would involve oxidative stress. Certain studies suggest that oxidative stress may be the cause of insulin secretion disorders and β cell death[8.]

When an individual predisposed to diabetes has excess weight, the cells in the body become less sensitive to the insulin that is released from the pancreas. There is some evidence that fat cells are more resistant to insulin than muscle cells. The worldwide increase in the prevalence of obesity is likely responsible for the recent increase in the prevalence of type 2 diabetes because obesity influences both insulin action and β cell function. A gradually rising risk of type 2 diabetes is linked to a progressive increase in body mass index (BMI), which measures adiposity[9]. Compared to people with a lower body (gluteofemoral) fat phenotype, obese individuals with a predominant increase in upper body fat (abdominal subcutaneous and intra-abdominal fat), intrahepatic triglyceride content, intramyocellular lipid content, and pancreatic fat are more likely to develop type 2 diabetes[10]

According to reports, metabolic dysregulation, obesity, hypertension, and abnormal lipid metabolism all contribute to insulin resistance and the development of type 2 diabetes mellitus in susceptible individuals. The current study focusses on the influence of obesity and oxidative stress in the development of diabetes by looking at patient records that are kept on file at the hospital.

II. Materials and Methods

This cross-sectional study, conducted at MediCiti Institute of Medical Sciences, Ghanpur Village, Medchal Mandal during the year 2021, included the reports of one hundred obese individuals. The OPDs and indoor wards provided reports of the participants. Various procedures were performed in the laboratory to obtain the laboratory reports needed for the present study. The Thiobarbituric acid reactive substances method was used to measure serum MDA. By using the ion exchange resin method, the HbA1c was determined. Estimation of RBS (Random blood sugar) was done by glucose oxidase and peroxidase method. The criteria for obesity were established by the WHO expert consultation on body mass index (BMI) in Asian populations, which was used to choose reports[11].

Inclusion criteria

. Age greater than eighteen.
. BMI over 23kg/m2
. Waist> 90 cm in men and > 80 cm in women.

Obesity criteria

. Weight greater than 30 percent of ideal weight
. BMI greater than 25 is obese
. Women's> 80 cm, men > 90 cm in waist circumference.

Exclusion criteria

The study's exclusion criteria encompassed the, Individuals with chronic infections, renal disease, cancer, under steroidsor hormone replacement therapy; smokers; alcoholics; Type I diabetic patients, pregnant women and users of regular antioxidant supplements (Vitamin C and Folic acid) for at least 15 days prior to the study's commencement.

Diabetes mellitus diagnosis

Patients were diagnosed with diabetes if their plasma glucose levels were either (a) 126 mg/dL (7.0 mmol/L) during fasting or(b) 200 mg/dL (11.1 mmol/L) during a 2-hour glucose tolerance test using an oral glucose load equal to 75 g of anhydrous glucose in water or (c) 126 mg/dL (7.0 mmol/L) plus random plasma glucose levels of 200 mg/dL (11.1 mmol/L) or (d) HbA1c levels of greater than 6.5% or 48mmol/mol. The tests were repeated to confirm the Diabetes mellitus diagnosis[12].

Hypertension diagnosis

Hypertension was diagnosed for the individuals with a blood pressure of ≥ 140 /90 mm of Hg[13].

Statistical Analysis

The data was analysed using the statistical software statistical product and service solutions (SPSS 15.0). Each assay was replicated 3 times. Values were expressed as mean ± SE and Student's t-test was applied to locate significant ($P \leq 0.05$) differences between groups. Pearson's correlation coefficient (r value) was determined within groups.

III. Results

The study consisted of 100 individuals reports of which 80 were male and 20 were female. Table no 1 explains the individuals with obesity showing diabetes and hypertension. Out of the 80 males with obesity 90% are diabetic and 87.5% are with hypertension. Whereas 20 females with obesity have shown 70% diabetes and 75% hypertension.

Table no 2 show 72 male and 14 female individuals with T2DM and oxidative stress.These diabetic patients showed statistically significant ($p<0.001$) increase in MDA, RBS and HbA1c when compared to normal ranges.

Table no 3 represents non diabetic obese individuals with oxidative stress and results show that HbA1c and RBS levels of these individuals are with in the normal range where as the MDA levels have shown an increase from the normal range.

Figure1 show correlation between MDA and RBS in 72 male individuals with obesity and Type II Diabetes. Additionally, it was also noted that MDA and RBS had a positive correlation showing Statisticalsignificance at $p<0.001$ with a correlation coefficient of $r=0.981$.

In Figure 2, 72 male patients with Type II Diabetes and obesity have the correlation between MDA and HbA1c. Furthermore, a positive correlation was observed between MDA and HbA1c, with a correlation coefficient of $r=0.932$ and statistical significance at $p<0.001$.

Figure 3 shows the correlation between MDA and RBS in 14 female patients with Type II Diabetes and obesity. Moreover, a correlation coefficient of r=0.973 and statistical significance at p<0.001 indicated a positive relationship between MDA and RBS.

In Figure 4, 14 female patients with Type II Diabetes and obesity are correlated with MDA and HbA1c. Moreover, a positive correlation between MDA and HbA1c was shown by a correlation coefficient of r=0.926 and statistical significance at p<0.001.

IV. Discussion

A cross-sectional study of a chosen population who visitedMediCiti Institute of Medical Sciences Hospital was conducted in this study. The study's subject population consisted reports of 100 individuals, of whom 14 were female and 80 were male. Out of the 80 males with obesity 90% are diabetic and 87.5% are with hypertension. Whereas 20 females with obesity have shown 70% diabetes and 75% hypertension. Studies have shown that the prevalence of diabetes is associated with obesity and oxidative stress and varies amongst populations.

Type II diabetes is a common disease with a rapidly increasing global prevalence that has been largely attributed to the obesity. In the present study it is observed that obesity is associated with increased risk of incident Type II diabetes in both males and females.Present study also shows an elevated levels of HbA1c and RBS (Random blood sugar) in both males and females with obesity, which is an indicator of Type II diabetes. Analysis of glycated haemoglobin (HbA1c) in blood provides evidence about an individual's average blood glucose levels during the previous two to three months, which is a biomarker for monitoring the levels of glucose among diabetic patients and it is important to note that the HbA1c levels are directly proportional to the blood glucose levels[14].

Malondialdehyde (MDA) level is commonly known as a marker of oxidative stress (polyunsaturated fatty acid peroxidation and hence considered a meaningful sign of lipid peroxide[15]. It is believed that oxidative stress is the main cause of Diabetes mellitus and insulin resistance[16].Kidney disease, vascular dysfunction, and impaired glucose metabolism are linked to this oxidative damage. Due to the low amount of glucose that enters the cells in Diabetes mellitus, the cells prefer to use most of the glucose to produce energy rather than antioxidants, leading to oxidative stress conditions acts as a biomarker for diabetic complication[17]. Present study confirms the presence of oxidative stress in diabetic patients with an increase in MDA levels. Increase in MDA level causes protein glycation which leads to malfunctioning of enzymes, damage to cellular machinery, and increased insulin resistance. The hepatic tissue's accumulative load of reactive oxygen and nitrogen species may be the cause of the elevated MDA content[18]. Present study also shown that individuals with obesity has higher MDA levels confirming the oxidative stress. Susceptibility to oxidative damage is greater in obese subjects because of depleted antioxidant sources[19].

V. Conclusion

In conclusion there is an influence of obesity and oxidative stress in the development of Type II Diabetes mellitus.

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Table no 1: Individuals with obesity showing diabetes and hypertension (In numbers)

Sex	Obesity (Number ofindividuals)	Diabetes (Number of individuals)	Hypertension (Number of individuals)
Male	80	72	70
Female	20	14	15

Table no 2: Individuals with Diabetes mellitus and oxidative stress

Individuals	Diabetes (Number of individuals)	RBS (mmol/L)		HbA1c (%)		MDA (nmol/dL)	
		Range	Diabetes (Mean±SD)	Range	Diabetes (Mean±SD)	Range	Diabetes (Mean±SD)
Male	72	145-545	282.36±115.25	5.5-14.8	8.92±2.15	452-755	645.25±68.24
Female	14		275.48±125.26		8.75±2.16		652.23±62.45

Values are expressed as Mean±SD ,Statistically significant at p<0.001.

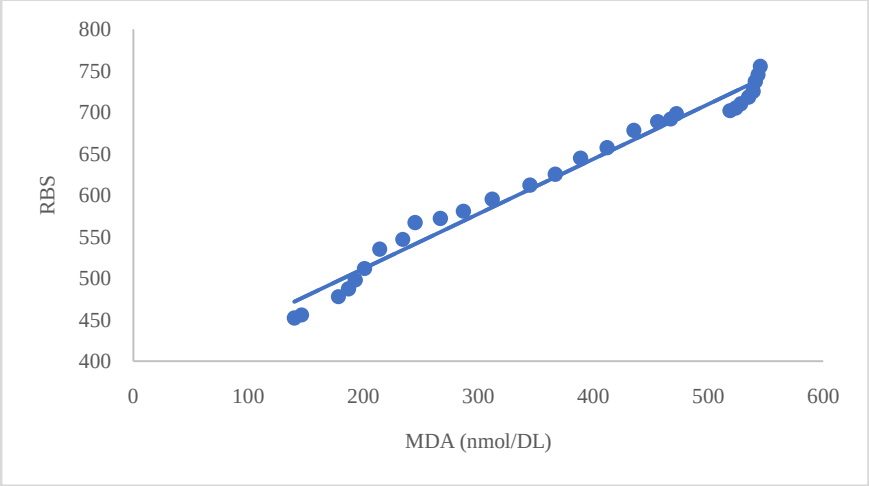
Table no 3: Non diabetic Individuals with oxidative stress

Individuals	Non-Diabetes	RBS (mmol/L)	HbA1c (%)	MDA (nmol/dL)

	(Number of individuals)	Range	Non -Diabetes (Mean±SD)	Range	Non-Diabetes (Mean±SD)	Range	Non-Diabetes (Mean±SD)
Male	08	72-145	98.56±25.15	4.5-6.8	5.22±0.25	254-415	315.28±48.25
Female	06		97.38±21.36		5.15±0.16		312.15±45.36

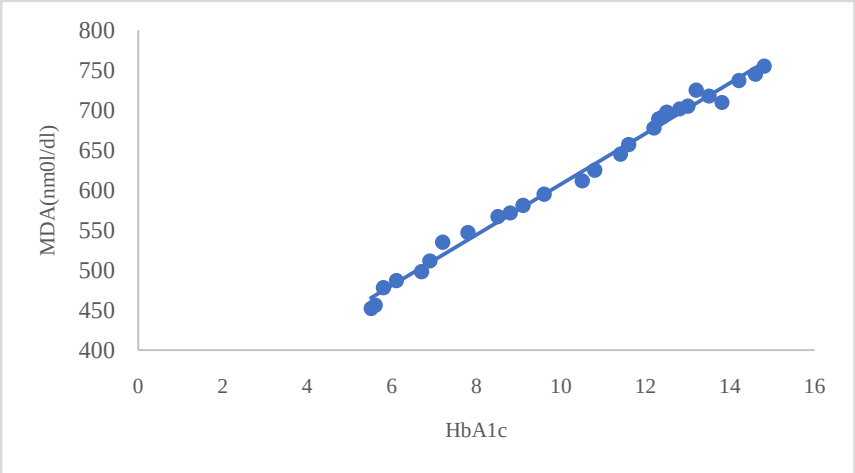
Values are expressed as Mean±SD ,Statistically significant at p<0.001

Figure 1: Correlation between MDA and RBS in Type II Diabetes individuals (males)



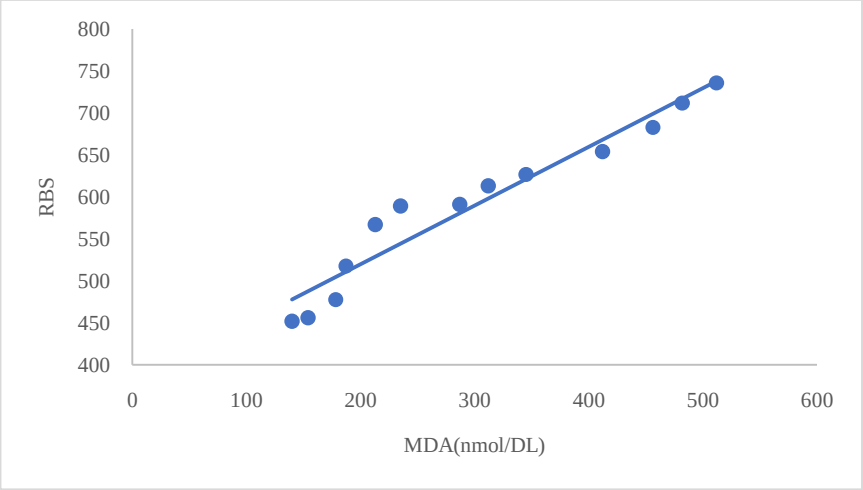
Statistically significant at p<0.001, Pearson's correlation coefficient r=0.981

Figure 2: Correlation between MDA and HbA1c in Type II Diabetes individuals (males)



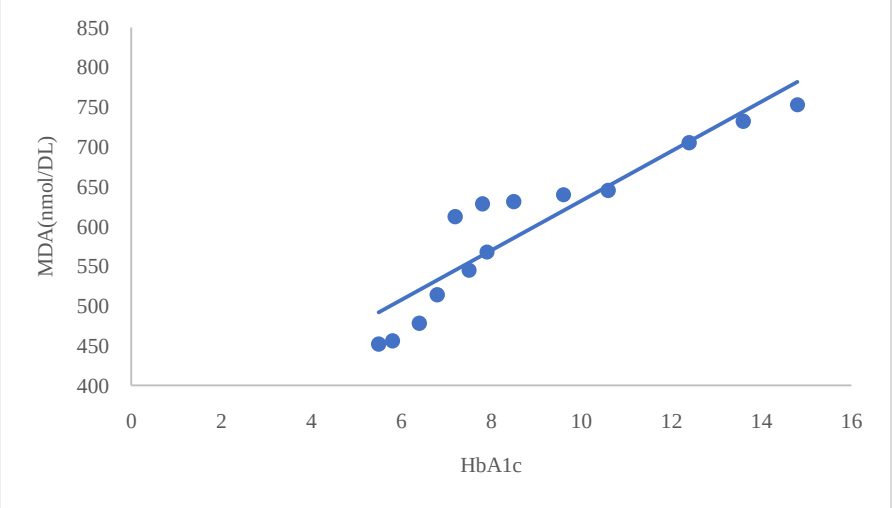
Statistically significant at p<0.001 Pearson's correlation coefficient r=0.932

Figure 3: Correlation between MDA and RBS in Type II Diabetes individuals (Females)



Statistically significant at p<0.001, Pearson's correlation coefficient r=0.973

Figure 4: Correlation between MDA and HbA1c in Type II Diabetes individuals (Females)



Statistically significant at p<0.001, Pearson's correlation coefficient (r value) r=0.926

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