Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(3), 845-849 | ISSN:2251-6727

A Study on Relationship between Type-II Diabetes Mellitus and BMI among Patients with Non-alcoholic Fatty Liver Disease

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(Received: 07 March 2024 Revised: 12 April 2024 Accepted: 12 May 2024)

KEYWORDS
Diabetes, Fatty Liver, Body Mass Index

Abstract

Introduction: Diabetes and its complications are a major public health concern among all age groups. Indians are highly susceptible to diabetes with modest over weight, central obesity, and decrease in physical activity. Obesity is the leading factor in the pathogenesis of health disorders such as hypertension and type-2 diabetes mellitus. However, there is little data available on diabetes and its correlation with BMI among Indian population. ***Objective:*** This study was aimed to determine the effects of elevated body mass index (BMI) on type 2 diabetes mellitus (DM) onset and its complications among subjects. ***Methodology:*** Total 200 subjects of all age groups with or without T2DM were included who had non-alcoholic fatty liver disease. Data on demographic profile and treatment history of diabetes were collected using pre-designed questionnaire. FBS and HbA1c were tested. Weight and height were measured to calculate BMI. SPSS was used to assess the relationship between T2DM and BMI. ***Results:*** The overall prevalence of diabetes was 93% (male: 49%, female: 51%).Prevalence of diabetes increased as the BMI of participants increased. Prevalence of diabetes among obese individuals (BMI ≥25 kg/m^2) was 57% compared to 0% among normal weight individuals. Obesity was associated with higher risk of diabetes compared with the individuals of control group as well as with normal weight in this study. ***Conclusion:*** Having even moderately elevated BMI is associated with increased risk of developing DM complications. BMI and FBG are positively correlated and subjects are therefore at risk of obesity and its related conditions.

Introduction

From basic steatosis to its inflammatory expression of non-alcoholic steatohepatitis (NASH), non-alcoholic fatty liver disease (NAFLD) presents with a wide range of symptoms. It is difficult to determine whether to use a single or combination of clinical or laboratory tests because the only way to distinguish between NAFLD and NASH is by liver biopsy.10 Hepatocellular carcinoma, liver failure, and cirrhosis are rare outcomes for NAFLD patients.[1-3]NAFLD and type 2 diabetes (T2DM) are prevalent conditions that frequently coexist and have the potential to work in conjunction to have unfavourable consequences. The co-existence of type 2 diabetes (T2DM) and non-alcoholic fatty liver disease (NAFLD) elevates the risk of developing diabetes-related complications, such as macro- and microvascular problems, and increases the chance of developing more severe NAFLD, which can lead to cirrhosis, hepatocellular carcinoma, and even death.[4]

By 2030, type 2 diabetes mellitus (DM) is predicted to become twice as common.[5]A serious public health concern for people of all ages is diabetes and its repercussions. Indians are particularly vulnerable to diabetes due to their mild overweight, central obesity, and decreased physical activity levels.The primary cause of the pathophysiology of conditions like type 2 diabetes mellitus and hypertension is obesity. Unfortunately, there is a paucity of information on diabetes and associated risk factors in both case and control individuals.

Aside from issues connected to the eyes, the incidence of DM complications has been increasing in adults over 65years.[6] Today, for instance, people with type 2 diabetes have a same risk of experiencing an acute

Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(3), 845-849 | ISSN:2251-6727

myocardial infarction (AMI) as people without diabetes who have never experienced an AMI before.[7]Apart from these adverse effects, people with diabetes mellitus are also 17 times more likely to experience an amputation as a result of peripheral vascular disease. They also have a higher chance of acquiring nephropathy, retinopathy, and coronary heart disease.[8]

Research conducted throughout several regions of India has demonstrated the increasing incidence of overweight and obesity in the nation, with overweight and obesity being identified as the primary factor contributing to the increasing incidence of diabetes across the country.[9-11] Several studies have reported a strong association between excess weight and increased risk of death, placing the overweight group at a 40% higher and the obese group at up to 300% higher risk of death than individuals whose BMI is normal ($18.5 \leq BMI < 25$).[12-14]

Excess weight and physical inactivity are also associated with an increased risk of developing various diseases, particularly type 2 diabetes.[15]Since excess weight is an important predictor of type 2 DM, the term "diabesity" was proposed by Astrup and Finer in 2000.[8]Specifically, in comparison to women with normal BMI, overweight, obese class I and II ($30 \leq BMI < 39.99$), and class III ($BMI \geq 40$) individuals face increased risks of developing type 2 DM with 7.6%, 20.1% and 38.8% greater risk respectively.[16]

This study determines the effects of elevated body mass index (BMI) on type 2 diabetes mellitus (DM) onset and its complications among cases with non-alcoholic fatty liver disease and control groups.

Material and Methods

A case control prospective study was conducted during the period 2013-2016 among subjects of all age in and around the Ujjain district of central India. A random sampling design was adopted to recruit the participants into the study. Total 100 subjects with T2DM and 100 subjects as control group were recruited in this study.The study protocol was reviewed and approved by the Institutional Ethical Committee of Ruxmaniben Deepchand Gardi Medical College (RDGMC), Ujjain, Madhya Pradesh. Informed consent was taken from all the respondents before data collection.

After obtaining informed consent, all the participants were interviewed by trained interviewers using a predesigned and pre-tested questionnaire through face-to-face interview to collect data on socio-demographic variables and treatment seeking behaviours.

Inclusion Criteria: Subjects of either gender between 20-70 years and not taking any antidiabetic drugs. **Exclusion Criteria**: Patients suffering from diseases like liver disease, renal disease, cardiac disease, respiratory disease or any other acute or chronic diseases as well as patients suffering from AIDS, thyroid disorder, psychiatric illness or on insulin therapy were also excluded. Pregnant women were also not included in the study.

For the collection of blood sample, tourniquet was applied in the arm and blood was taken from antecubital vein of the patient. The collected blood was allowed to clot for 30 minutes. Serum was separated from cells and collected in a separate labelled aliquot vial. FBG measurement was done using laboratory kits in morning after 12-hours fasting and/or two-hour post-prandial. A fasting blood sugar level above 126 mg/dl and post prandial glucose value of ≥200 mg/dL was confirmed as diabetic.[11]

Measurements of height and weight were done as per the guidelines of the World Health Organization (WHO).[17, 18]Weight was recorded to nearest 0.5 kg and height was recorded to nearest 0.5 cm. Height was measured in standard standing position without shoes by using a tape meter, while keeping shoulders in erect position. BMI of participants was calculated using the formula: weight (kg)/height (m^2). Subjects with a BMI of 18-22.9 kg/m^2 were classified as normal weight, 23.0-24.9 Kg/m^2 were classified as overweight and those with a BMI greater than or equal to 25 Kg/m^2 were defined as obese. Participants were divided into four groups for both males and females according to the WHO Asia Pacific guidelines: Underweight: BMI <18.5 kg/m^2; normal weight: BMI 18.5-22.99 kg/m^2; overweight: BMI 23-24.99 kg/m^2; and obese: BMI >25 kg/m^2. Normal weight individuals were used as the reference group.

Data were entered and analysed using SPSS version 22. Descriptive statistics such as frequency and mean with standard deviation (SD) were used to present the results. Chi-square test was used for comparison of proportions across groups, and t-test was used to compare continuous variables**.** ANNOVA and cross tabulation was used to perform statistical calculation. P value less than 0.05 was considered significant.

Result

Table 1 shows the socio-demographic characteristics of the study participants. A total of 200 (male: 98, female: 102) individuals participated in the study. The mean age of the participants was 61.37 (SD: 7.42) years.

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JCHR (2024) 14(3), 845-849 | ISSN:2251-6727

Most of the participants were in the age group of above 40 years (166/200; 83%) years, and 60/200; 30% had no formal education.

Table 1: Socio-demographic and other parameters of study participants; n=200

Variables		**Frequency; n (%)**	**Total**
Age (Years)	Below 40	34 (17)	200
	Above 40	166 (83)	
Gender	Male	98 (49)	200
	Female	102 (51)	
Education	Up to high school	60 (30)	200
	Beyond high school	140 (70)	
BMI (kg/m^2)	Normal weight (18-22.99 kg/m^2)	10 (05)	200
	Over weight (23.0-24.99 Kg/m^2)	82 (41)	
	Obese (>25 kg/m^2)	108 (54)	
Diabetes status	Diabetic	186 (93)	200
	Non diabetic	14 (07)	

The overall prevalence of diabetes was 93% (male: 49%, female: 51%). 5% (10/200) patients were found to have normal BMI (18-22.9 kg/m^2) and non-diabetic, 82/200; 41% patients were overweight (23-24.9 kg/m^2) however, 43% (80/186) of subjects were overweight and diabeticand 108/200; 54% (108/200) patients were obese having BMI >25 kg/m^2, however, 57% (106/186) of the diabetic patients were obese (Table 2).

Prevalence of diabetes increased as the BMI of participants increased. Prevalence of diabetes among obese individuals (BMI ≥25 kg/m^2) was 57% compared to 0% among normal weight individuals (Table 2). Obesity was associated with higher risk of diabetes compared with the individuals of control group as well as with normal weight in this study.

Table 2: Status of diabetes mellitus and BMI among study participants; n=200

Variables	**Normal weight**	**Overweight**	**Obese**	**Prevalence; n (%)**	***p* -value**
Diabetic	00	80	106	186 (93)	<0.0001
Non diabetic	10	02	02	14 (07)	<0.0001

Discussion

The study showed that overall, 93% of subjects had diabetes, which is significantly higher than the prevalence documented in previous studies. According to this study, obesity is a significant risk factor for diabetes in this group, which is consistent with previous research from other regions of the world.[5]We found that the prevalence of diabetes increased with increasing BMI level as prevalence of diabetes among obese individuals (BMI ≥25 kg/m^2) was 57% compared to 0% among normal weight individuals.

This study indicated that those who were obese had a higher chance of developing diabetes when compared to people who were normal weight. These findings are consistent with previous research that found that obesity and overweight are consistently linked to cardiovascular risk in the majority of population.[19-22]Despite using a lower BMI cut-off value (BMI ≥25 kg/m2) to diagnose obesity, which is recommended for Asian populations, rather than the conventional cutoff value (BMI ≥30 kg/m2), obesity was found to be a major risk factor in this study. These findings indicate a stronger connection between BMI and the onset of diabetes than was previously shown in research of similar kind.[16]

The finding that Indians have an average BMI that is overweight suggests the possibility of a hereditary component related to a sedentary lifestyle and inadequate physical activity.[22]According to a study by Bakari and his colleagues, there is a strong positive association between BMI and RBS in females but not in males.[23]A BMI of greater than 23 kg/m2 is linked to cardiovascular risk and central obesity in the majority of Indians. Weight loss is linked to a lower BMI, and it indicates that weight plays a crucial role in preventing diabetes.[22]A large number of current weight-loss initiatives, such as dietary, exercise, and behavioural therapies, are effective in helping people lose weight

Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(3), 845-849 | ISSN:2251-6727

over the long term and significantly lower the incidence of diabetes.[24-26]

There are a few limitations to this study: (1) it is a cross-sectional study, making it difficult to draw causal inferences; (2) the multivariate analysis did not account for various important confounding variables (such as family history of diabetes, dietary, and lifestyle factors), which may limit our ability to understand the true relationship between explanatory variables (like BMI) and outcome variables (like diabetes); (3) due to logistical challenges, measurement of CBG was done by a glucometer device rather than venous blood glucose estimation; (4) the study was conducted in a single district, making the results not generalizable to the entire region or nation.

Conclusion

This study highlights that obesity is a key parameter associated with diabetes mellitus among general population of India. To conclude, there exists a complex and bidirectional link between T2DM, BMI, and NAFLD. The etiology of both NAFLD and T2DM is heavily influenced by obesity, as evidenced by a higher BMI. And vice versa, there is a higher chance of T2DM in those with NAFLD. Having even moderately elevated BMI is associated with increased risk of developing DM complications. The impact of these interrelated metabolic diseases on liver health and general well-being must be reduced by acknowledging and treating them. To further understand the underlying mechanisms and provide targeted treatment plans for this group of high-risk patients, further detailed studies should be conducted.

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