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Original Research Article

A Cross-Sectional Study for Assessment of Insulin Resistance on Body Mass Index, and Metabolic Risk Factors in Central Indian Diabetics

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Abstract:

Introduction: A major contributing factor to the onset of type 2 diabetes, especially in people with high body mass index (BMI), is insulin resistance.

Aims and Objectives: This study shows a relationship among BMI with insulin resistance in patients with diabetes type-2, which might aid in the selection of practical methods for diabetes early intervention.

Materials and Methods: In order to better understand the association among BMI with insulin resistance, along with the effects of this condition on metabolic and cardiovascular health, a cross-sectional research including 100 pre-diabetic individuals was conducted. The study gathered information on the patients' cholesterol levels, blood pressure, BMI, insulin resistance (as determined by the Homeostatic Model Assessment for Insulin Resistance, or HOMA-IR), and demographic profile. The patients were divided into groups based on their weight: normal, overweight, and obese.

Results: The mean age of the participants was 45.79 years with a standard deviation of 12.31. The majority of the participants were female, accounting for 52% of the total. The average body mass index (BMI) of the participants was 28.41 kg/m² with a standard deviation of 4.49. An evident and strong connection ($r=0.64$, $P<0.001$) was seen among BMI with the HOMA-IR score, indicating a clear relationship between higher BMI and insulin resistance. Obese people had a significantly elevated HOMA-IR index (3.51±1.29) in comparison to overweight persons (2.49±1.01) and individuals of normal weight (1.91±0.79). Furthermore, the study revealed deterioration in lipid profiles and an elevation in blood pressure among those in higher BMI categories. Gender had no significant impact on insulin resistance, but a little rise in HOMA-IR was seen with increasing age ($P=0.021$).

Conclusion: The findings highlighted the considerable correlation between increased body mass index and intensified insulin resistance in people with pre-diabetes. They emphasize how important it is to maintain a healthy weight in order to lower the risk of diabetes and cardiovascular disease.

Keywords: Body mass index; Diabetes control; Insulin resistance; Pre-diabetes.

Introduction

Diabetes is a metabolic disorder characterized by insufficient production of insulin or ineffective insulin function, resulting in the inability to manage blood glucose levels. [1] Insulin resistance is a condition where insulin becomes less efficient in reducing blood glucose levels. This condition generally occurs before the development of type 2 diabetes. [2] Individuals diagnosed with diabetes have a higher susceptibility to many long-term health disorders such as cardiovascular disease, vision impairment, limb loss, renal disease, and depression compared to those who do not have diabetes. Diabetes is associated with a twofold increase in the risk of cardiovascular disease. Additionally, diabetic retinopathy is the primary cause of avoidable vision loss in those of working

age. Diabetes is a significant contributor to early death, resulting in about 23,300 fatalities in India over the year of 2010-11. [3] Globally, the prevalence of diabetes of the type 2 variety is rising, and insulin resistance is a key component of the underlying processes behind this serious public health concern. [4]

A vital window of opportunities for measures to prevent the onset of full-fledged diabetes is provided by pre-diabetes, a condition marked by impaired glucose tolerance that is yet to cross the diabetes threshold. [5] It has been established that the body mass index (BMI), a widely used measure of body fat that considers a person's height and weight, is a reliable indication of insulin resistance. [6]

Many studies have demonstrated the link between a higher body mass index (BMI) and an increased risk of insulin resistance, which emphasizes the need of maintaining a healthy weight in the fight against diabetes. [7] The relationship between BMI and insulin resistance in diabetic persons has not been well investigated in studies.

However, there are studies that can give useful information. The most recent statistics and evidence show the current trends in the incidence of obesity and diabetes at both the national and local levels, as well as the possible ramifications in terms of health outcomes, disparities, and financial burden. The analysis also provides references to the most recent and pertinent policy and guideline papers.

Aims and objectives:

The goal of this research is to investigate the relationship amongst BMI & insulin resistance in people with diabetes in order to pinpoint the precise function that being overweight plays in the onset of type 2 diabetes.

The main objectives of the study are to determine who is at risk of developing diabetes using body mass index (BMI) and to look into the relationship between different BMI categories—such as normal weight, overweight, and obese—and insulin resistance as determined by the HOMA-IR index.

lipid metrics (total cholesterol, HDL, LDL), fasting insulin values, SBP, DBP, CRP, fasting blood sugar values, and HbA1c levels in order to evaluate the effect of BMI on metabolic and cardiovascular risk factors and to gain insight into how body weight affects these parameters during the pre-diabetic stage.

The second goal is to assess gender-specific characteristics and the impact of age upon insulin resistance using HOMA-IR values. The purpose of this research is to find any noteworthy trends or variances that might offer information for creating individualized intervention plans.

Materials and methods:

The study design and setting involved a cross-sectional observational study. Prior to conducting the study, approval from the institutional ethics committee was obtained, and written informed consent was obtained from the selected patients.

The study sample consisted of 100 participants who met the American Diabetes Association's recommended criteria for pre-diabetes, either by fasting glucose levels or by HbA1c values.

Inclusion criteria:

- Individuals who are 18 years of age or older.
- The American Diabetes Association's recommendations about fasting glucose levels as well as HbA1c criteria have been followed in verifying the diagnosis of pre-diabetes.

Criteria for exclusion:

- People who have already been diagnosed with diabetes
- Women who are pregnant;
- People with known endocrine or metabolic issues, with the exception of pre-diabetes.

Data extraction: The subjects finished an all-inclusive first assessment that involved capturing physical measurements like height and weight as well as personal data like age and gender.

Additionally, the participants' Body Mass Index (BMI) was calculated. The World Health Organization's categories were used to categories BMI. Normal weight is defined as having a body mass index (BMI) below 25 kg/m2. Overweight is defined as having a BMI between 25 and 29 kg/m2. Obesity is defined as having a BMI more than 30 kg/m2.

Measurements conducted in a laboratory:

The HOMA-IR technique was used to measure insulin resistance, and fasting blood samples were used to measure HbA1c levels, fasting blood sugar levels, and complete lipid profiles, which include total cholesterol, LDL, HDL, as well as triglycerides.

Furthermore, supplementary measurements such as CRP and fasting insulin levels were taken to enhance the overall evaluation of metabolic well-being.

Statistical Analysis:

The individuals' clinical characteristics and demographic information were summarized using descriptive statistics. Pearson's correlation coefficient was used to analyze the association between BMI and HOMA-IR.

An analysis of variance (ANOVA) was used to compare the average HOMA-IR values among various body mass index (BMI) categories. After analysis, the value of <0.5 was statistically significant.

Results:

In order to investigate the connection amongst BMI with insulin resistance in diabetic patients, we analyzed the demographic data of 120 participants in our study. With 52% of the cohort being female, the gender distribution was almost equal. The average age of the cohort was 45.79 years, with a standard deviation of 12.31 years.

The average BMI of the cohort was 28.41 kg/m², with a standard deviation of 4.49 kg/m². [Table 1]

Table 1: Demographic characteristics

Variables	Value
Total number of participants	100
Mean age (in years)	45.79±12.31
Females (%)	52%
Mean BMI (kg/m²)	28.41±4.49

The HOMA-IR index gradually increased when the different BMI categories were analyzed, [Table 2] and this rise was linked to distinct BMI statuses. More specifically, the mean HOMA-IR index of the participants who were classified as having a normal weight (n = 25) was 1.91 (SD = 0.79). The average HOMA-IR for the 45 overweight subjects was 2.49 (SD=1.01), but the average HOMA-IR for the 30 obese persons was 3.51 (SD=1.329).

This research unequivocally demonstrates that insulin resistance rises significantly with BMI.

Table 2: BMI categories and HOMA-IR index

BMI categories	Total number	Percentage	Mean HOMA-IR index
Normal weight	25	25	1.91±0.79
Overweight	45	45	2.49±1.01
Obese	30	30	3.51±1.29

We conducted a thorough assessment of metabolic and cardiovascular risk factors for individuals in different BMI categories. [Table 3]

The primary observations included: As BMI categories grew, there was a substantial increase in total cholesterol, LDL ("bad") cholesterol, and triglycerides; however, HDL ("good") cholesterol exhibited a negative trend. Obese individuals had significantly higher levels of triglycerides (180.01±59.99 mg/dL), LDL (150.01±34.99 mg/dL), as well as the total cholesterol level (220.1±40.01 mg/dL), while their HDL levels seemed lower (44.99±7.01 mg/dL).

Obese participants had HbA1c measurements of 6.01±0.51% and fasting glucose readings of 109.98±15.01 mg/dL.

Table 3: Detailed risk profile for cardiovascular disease and metabolism

Parameter	Normal	Overweight	Obese
Total cholesterol (mg/dL)	185.1±30.01	200.1±35.01	220.1±40.01
LDL (mg/dL)	110.01±25.01	129.99±30.01	150.01±34.99
HDL (mg/dL)	55.99±10.01	50.01±8.01	44.99±7.01
Triglycerides (mg/dL)	130.01±44.99	150.01±50.01	180.01±59.99
Fasting glucose (mg/dL)	89.98±10.01	100.01±11.98	109.98±15.01
HbA1c (%)	5.51±0.51	5.69±0.49	6.01±0.51
SBP (mmHg)	120.01±7.01	125.01±8.01	130.01±10.01
DBP (mmHg)	85.01±5.01	88.01±6.01	92.01±7.01
Insulin resistance by HOMA-IR	1.49±0.51	2.01±0.69	2.51±1.01
CRP (mg/L)	2.01±1.01	3.01±1.49	4.01±1.99
Fasting insulin (µU/mL)	8.01±2.01	10.01±2.99	12.01±4.01

Table 4 shows that the mean HOMA-IR among males was 2.79±1.31, somewhat higher compared to the mean for females (2.61±1.09). Moreover, HOMA-IR and age showed a statistically significant connection (P=0.021), indicating that insulin resistance in people without diabetes may rise with age.

Table 4: Age and Gender correlation with HOMA-IR

Variables		Values
Correlation of Age with HOMA-IR		P=0.021
Gender	Males	2.79±1.31
	Females	2.61±1.09

Discussion:

The findings from our study, which involved 100 individuals at risk of developing diabetes, highlight a strong and meaningful connection between body mass index (BMI) and the HOMA-IR index. This lends credence to the theory that greater degrees of insulin resistance are directly caused by higher BMIs. [7]

The BMI and HOMA-IR indices ($P<0.001$) highlights the significance of managing obesity to stop the advancement of insulin resistance in addition to demonstrating a strong link. This connection is especially significant in the context of pre-diabetes, a period that offers a tactical opportunity for intervention to stop the development of type-2 diabetes. [8] A further proof of the linear relationship between insulin resistance and obesity is the gradient in mean HOMA-IR measurements between the BMI categories for normal weight and obese people. [8]

The results of our investigation are in line with those of earlier studies [9-14], which demonstrate that visceral fat particularly contributes to the worsening of insulin resistance by promoting the production of adipokines and systemic inflammation. The substantial variations in HOMA-IR values across BMI groups are supported by an ANOVA and post hoc analysis, highlighting the importance of weight control in lowering insulin resistance. Furthermore, the results concerning lipid profiles and blood pressure provide extensive information on the complex effects of obesity. They show how higher BMI is associated with higher blood pressure and worse lipid profiles, increasing the possibility of cardiovascular illnesses in pre-diabetic individuals. [15]

Interestingly, there was no statistically significant difference in HOMA-IR values across genders according to our research. This shows that among individuals that have a higher risk of developing diabetes, the relationship between insulin resistance and BMI is consistent for both genders. On the other hand, the slight association shown among HOMA-IR with age implies that an individual's level of insulin resistance may grow with age. This suggests that while age has a role in developing insulin resistance, it does not have the same significant influence as BMI. [16]

Study limitations: It is important to acknowledge the constraints of our research, specifically the cross-sectional methodology that hinders the establishment of a causal correlation between insulin resistance and body mass index. Additionally, while though the relatively small number of 100 pre-diabetic subjects was instructive, it could not accurately represent the larger pre-diabetic community, which could limit how broadly the results can be applied. Furthermore, even though HOMA-IR is frequently employed as a surrogate indication for insulin resistance, the complex character of the insulin resistance syndrome may not be adequately captured by it.

Conclusion

Our study's findings demonstrate the critical need for focused therapies that emphasise lifestyle changes and weight loss in people at risk for diabetes. Type-2 diabetes can be delayed or prevented by significantly reducing insulin resistance, which can be achieved by seeing fat as a modifiable risk factor.

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