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Original Research Article

Comparative Study of Insulin Resistance Using HOMA-IR Index and Its Relationship with Serum Triglycerides and HDL Levels in Obese and Non-Obese Individuals

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Abstract:

Background: Obesity is a major risk factor for developing insulin resistance, leading to metabolic complications like type 2 diabetes and cardiovascular diseases. The Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) is a validated index used to assess insulin sensitivity. Dyslipidemia, particularly high triglycerides (TG) and low high-density lipoprotein cholesterol (HDL-C), is commonly associated with insulin resistance in obese individuals. This study aims to evaluate the HOMA-IR index and its correlation with serum TG and HDL-C levels in obese and non-obese individuals.

Objective: To assess the relationship between serum insulin levels, triglycerides, HDL, and the HOMA-IR index in obese patients and compare the findings with non-obese control subjects.

Material and Methods: This cross-sectional study involved 100 participants, divided into two groups: 50 obese patients (BMI ≥30 kg/m²) and 50 age-matched non-obese controls (BMI 18.5–24.9 kg/m²). The study was conducted in the Department of Biochemistry at a tertiary care hospital. Fasting plasma glucose and insulin levels were measured, and the HOMA-IR index was calculated for all subjects. Lipid profiles, including serum triglycerides and HDL, were also measured. The correlation between HOMA-IR, serum insulin, TG, and HDL was analyzed.

Results: Obese individuals showed significantly higher HOMA-IR values (mean ± SD: 4.5 ± 1.3) compared to the control group (mean ± SD: 1.8 ± 0.5). Serum triglycerides were elevated ($p<0.01$), and HDL levels were lower ($p<0.05$) in the obese group. A significant positive correlation was observed between HOMA-IR and serum triglycerides ($r=0.62$, $p<0.01$) and a negative correlation with HDL ($r=-0.48$, $p<0.05$) in obese individuals, while no significant correlations were found in the control group.

Conclusion: The study demonstrates a strong association between insulin resistance and dyslipidemia in obese patients. Obese individuals exhibited significantly higher insulin resistance as measured by HOMA-IR, along with elevated triglycerides and reduced HDL levels. These findings underline the importance of addressing lipid abnormalities in obese individuals to prevent long-term metabolic complications.

Keywords: Insulin resistance, HOMA-IR, obesity, triglycerides, HDL, lipid profile.

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Introduction

Obesity is increasingly recognized as a significant public health concern globally, leading to a variety of metabolic disorders, including insulin resistance, type 2 diabetes, dyslipidemia, and cardiovascular diseases [1]. The prevalence of obesity has escalated dramatically in recent decades, making it a priority for research and public health initiatives.

Insulin resistance is defined as a reduced sensitivity of peripheral tissues to the action of insulin, which results in impaired glucose uptake and elevated plasma glucose levels. It is a critical factor in the development of metabolic syndrome and type 2 diabetes [2]. Insulin resistance often leads to compensatory hyperinsulinemia, where the pancreas produces more insulin in an attempt to maintain normal glucose levels. However, this mechanism can eventually become insufficient, leading to sustained hyperglycemia and the associated complications of diabetes [3].

The Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) is a widely utilized method for estimating insulin sensitivity based on fasting plasma insulin and glucose levels. It is a simple, reliable tool for clinical and epidemiological studies to assess insulin resistance [4]. Elevated HOMA-IR values are indicative of insulin resistance, while lower values suggest better insulin sensitivity.

Dyslipidemia, characterized by elevated serum triglycerides (TG) and decreased high-density lipoprotein cholesterol (HDL-C) levels, is commonly associated with insulin resistance, particularly in obese individuals. These lipid abnormalities are critical components of the metabolic syndrome and are known to increase the risk of cardiovascular diseases [5,6]. The interplay between insulin resistance and dyslipidemia is complex, with each condition exacerbating the other [7].

While much research has focused on the relationship between obesity and insulin resistance, comparative studies involving non-obese control groups are limited. Understanding these differences is crucial for developing effective interventions to prevent and manage metabolic disorders in obese individuals [8].

This study aims to evaluate the HOMA-IR index and its relationship with serum triglycerides and HDL levels in obese patients compared to a control group of non-obese individuals. By analyzing these relationships, we hope to gain deeper insights into the metabolic disturbances associated with obesity and the implications for clinical practice [9].

Aim and Objectives

Aim: To assess the relationship between serum insulin, triglycerides, HDL, and the HOMA-IR index in obese patients and compare these findings with non-obese control subjects.

Objectives:

1. To measure fasting plasma insulin and glucose levels in obese and non-obese individuals.
2. To evaluate and compare the HOMA-IR index, triglycerides, and HDL levels between the two groups.

Material and Methods

This cross-sectional study was conducted in the Department of Biochemistry at a tertiary care hospital. A total of 100 participants were enrolled, comprising 50 obese patients (BMI ≥30 kg/m²) and 50 non-obese, age-matched control subjects (BMI 18.5–24.9 kg/m²). The inclusion criteria for obese patients included those diagnosed with obesity and no history of diabetes or cardiovascular diseases. Non-obese controls were selected based on a normal BMI with no history of chronic metabolic diseases.

Sample Size: 100 (50 obese, 50 non-obese).

Study Duration: The study was conducted over a 6-month period.

Inclusion Criteria:

- Obese patients (BMI ≥30 kg/m²) for the test group.
- Non-obese (BMI 18.5–24.9 kg/m²) age-matched controls.

Exclusion Criteria:

- Patients with known diabetes, cardiovascular diseases, or other chronic metabolic conditions.
- Patients on lipid-lowering drugs.

Procedures:

Blood samples were collected after an overnight fast of 8–12 hours. Fasting plasma insulin and glucose were measured using standard enzymatic assays. HOMA-IR was calculated using the formula: HOMA-IR= (Fasting Insulin (μU/mL)× Fasting Glucose (mg/dL) 405

Lipid profiles, including serum triglycerides and HDL-C, were measured using enzymatic methods. All assays were performed using automated analyzers.

Statistical Analysis: Data were analyzed using SPSS software. The results are expressed as mean ± standard deviation (SD). The significance of differences between the two groups was determined using independent sample t-tests. Correlations between HOMA-IR and lipid parameters were assessed using Pearson's correlation coefficient. A p-value of <0.05 was considered statistically significant.

Results

Table 1: Demographic Characteristics

Parameter	Obese (n=50)	Non-Obese (n=50)
Age (Years)	35.5 ± 8.1	34.8 ± 7.5
Gender (M)	25:25	26:24

Table 2: Comparison of HOMA-IR, Serum Insulin, Triglycerides, and HDL between Obese and Non-Obese Groups

Parameter	Obese (n=50)	Non-Obese (n=50)	p-value
HOMA-IR	4.5 ± 1.3	1.8 ± 0.5	<0.01
Fasting Insulin (μU/mL)	19.2 ± 4.5	9.1 ± 2.8	<0.01
Serum Triglycerides (mg/dL)	210 ± 45	145 ± 30	<0.01
HDL (mg/dL)	36 ± 6	52 ± 8	<0.05

The obese group exhibited significantly higher HOMA-IR values (mean ± SD: 4.5 ± 1.3) compared to the control group (mean ± SD: 1.8 ± 0.5), indicating a higher level of insulin resistance in the obese population. Additionally, fasting insulin levels were markedly higher in the obese group (19.2 ± 4.5 µU/mL vs. 9.1 ± 2.8 µU/mL, $p<0.01$). Serum triglycerides were significantly elevated in the obese group (210 ± 45 mg/dL) compared to controls (145 ± 30 mg/dL, $p<0.01$), while HDL levels were lower in the obese group (36 ± 6 mg/dL) compared to controls (52 ± 8 mg/dL, $p<0.05$).

Correlation Analysis

A significant positive correlation was observed between HOMA-IR and serum triglycerides in the obese group ($r=0.62$, $p<0.01$), indicating that as insulin resistance increased, triglyceride levels also tended to rise. Conversely, a negative correlation was found between HOMA-IR and HDL levels ($r=-0.48$, $p<0.05$), suggesting that higher insulin resistance was associated with lower HDL levels. In contrast, no significant correlations were found in the non-obese group, highlighting the distinctive metabolic profile observed in obese individuals.

Discussion

The findings of this study are consistent with the existing literature on the relationship between obesity, insulin resistance, and dyslipidemia. The significantly elevated HOMA-IR values in the obese group underscore the prevalence of insulin resistance in individuals with obesity.

These results align with previous studies that have reported a direct association between obesity and impaired insulin sensitivity [10]. The positive correlation between HOMA-IR and serum triglycerides further supports the notion that insulin resistance is linked with dyslipidemic profiles, particularly elevated triglyceride levels. Insulin plays a critical role in lipid metabolism, and its resistance may lead to increased hepatic lipogenesis, resulting in elevated triglycerides in the bloodstream [11].

Furthermore, the negative correlation between HOMA-IR and HDL levels in obese patients is consistent with the findings of other studies, which have demonstrated that insulin resistance is associated with reduced HDL-C levels [12]. Low HDL is a well-established risk factor for cardiovascular diseases, emphasizing the importance of monitoring lipid profiles in obese individuals.

This study's results also emphasize the necessity for early interventions targeting insulin resistance and dyslipidemia in obese patients. Lifestyle modifications, including dietary changes and increased physical activity, play a crucial role in managing obesity and improving insulin sensitivity [13]. Pharmacological approaches may also be warranted for some patients, particularly those at high risk of developing type 2 diabetes and cardiovascular diseases [14].

Limitations

This study has certain limitations. The cross-sectional design does not allow for causality to be established. Additionally, the sample size, although adequate for preliminary analysis, could be expanded for more robust conclusions. Longitudinal studies are warranted to assess the progression of insulin resistance and its long-term implications in both obese and non-obese populations.

Conclusion

In conclusion, this study highlights the significant association between insulin resistance, as measured by the HOMA-IR index, and lipid abnormalities in obese individuals.

The findings demonstrate that obese patients have higher triglyceride levels and lower HDL levels compared to non-obese controls. The strong correlation between insulin resistance and dyslipidemia underlines the necessity for early detection and intervention in this high-risk population to mitigate the potential long-term complications of obesity.

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