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Impact of Serum Adiponectin Level on Insulin and hs-CRP in Patients with Type 2 Diabetes: A Case-Control Study

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ABSTRACT

Introduction: Type 2 diabetes mellitus (T2DM) is marked by insulin resistance, hyperglycemia, and systemic inflammation. Adiponectin—a hormone produced mainly by adipose tissue—enhances insulin sensitivity and exhibits anti-inflammatory properties. This study evaluated serum adiponectin and related metabolic markers in Iraqi patients with T2DM versus healthy controls.
Methods: In a case-control design, 84 Iraqi subjects were recruited (45 patients with T2DM and 39 controls). Fasting blood samples were obtained to measure adiponectin, insulin, high-sensitivity C-reactive protein (hs-CRP), fasting serum glucose (FSG), and Homeostatic Model Assessment-Insulin Resistance (HOMA-IR) using standardized ELISA and biochemical assays. Correlations between adiponectin and anthropometric parameters were also analyzed.
Results: Controls showed significantly higher serum adiponectin and insulin levels ($p < 0.05$) compared to patients with T2DM. In contrast, hs-CRP, FSG, and HOMA-IR were significantly elevated in the diabetic group ($p < 0.05$). Moreover, adiponectin demonstrated significant negative correlations with both height and weight among controls, with their lower body weight suggesting enhanced fatty acid oxidation.
Conclusions: These findings indicate that elevated adiponectin is associated with improved insulin sensitivity and reduced inflammatory markers. The data support the potential role of adiponectin in mitigating insulin resistance, hyperglycemia, and overweight risks in T2DM, warranting further investigation into its therapeutic utility.

1. Introduction

The prevalence of diabetes in 2021 had been reported to be about 537 million people and is expected to rise to 783 million in 2045 worldwide [1]. A conjugation of demographic and economic changes, with the association of large shifts in physical activity and dietary patterns, are properly considered a primary driver for the rise in diabetes in low- and middle-income countries [2]. Diabetes mellitus (DM) is a chronic disease causing insulin action resistance that leads to prolonged hyperglycemia besides metabolic disorders of lipids and protein [3]. Type 2 diabetes (T2DM), the most common type of DM, is characterized by an insulin resistance state that leads to a progressive decrease of adequate insulin secretion from β-cells [4]. Many results show increased levels of Homeostatic Model Assessment-Insulin Resistance HOMA-IR and fasting serum glucose FSG in patients with diabetes when compared to non-diabetics [5]. Although an individual's susceptibility to T2DM is determined by genetic predisposition, which is related to more than 88 genetic loci involved in susceptibility to T2DM [4], the increase in obesity, a sedentary lifestyle, industrialization, and energy-dense diets are responsible for making T2DM a widespread state [6]. Adiponectin was first described in 1995; it is a 30 kDa peptide generated in adipose tissues [7] exclusively produced by adipose tissue. Also, it is produced from skeletal muscles, cardiomyocytes, and endothelial cells [8]. The normal plasma level of 5–30 micrograms/ml [9]. There is a similarity between Adiponectin and Insulin in their effect on the liver and muscles concerning glucose metabolism, as shown in **(Figure 1)**. CRP is a 206-amino acid [10]. C-reactive protein (CRP) estimation is considered a marker for systemic inflammation [11]This study aims to estimate the serum levels of Adiponectin in relation to insulin, high-sensitivity C-reactive protein (hs-CRP), fasting serum glucose, and HOMA-IR in patients with T2DM compared with apparently healthy controls.

2. Methods

2.1. Study Design

A case-controlled study was conducted at The National Center for Diabetes, College of Medicine, Al-Mustansiriya University, Baghdad, Iraq. The patients with diabetes were selected from the outpatient clinic under the supervision of an endocrinologist from patients attending The National Center for Diabetes, Medicine College, Al Mutansryia University, Baghdad, Iraq. The selection criteria of patients listed in a questionnaire included having T2DM for at least 1 year, aged 18 years or older, and fasting over last night, while the exclusion criteria were malignant, endocrinopathy,

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Table 1: Analytical kits used in this study

Analyte	Supplier
Glucose	BIOLABO Diagnostic / France
hs C-Reactive Protein	Demeditec Diagnostics / Germany
Insulin	Demeditec Diagnostics / Germany
Adiponectin	Shanghai Yehua Biological Technology Co., Ltd / China

renal, and chronic liver diseases. Eighty- four subjects included in the present study were categorized into two groups: Group-1 diabetic patients, including forty-five patients with diabetes (17 males and 28 females) aged between (25 and 44) years; Group-2 control subjects, including thirty-nine subjects (19 males & 20 females) aged between (30-65) years were chosen from the general population to be apparently healthy. A venous blood specimen (7ml) was withdrawn from each subject after an overnight fasting. The blood samples were placed into a gel tube (no anticoagulant) to permit clotting before centrifugation for 10 minutes. The obtained serum was stored as aliquots and was kept frozen at -20 °C until their assay for insulin, hs- CRP, and adiponectin by specific ELISA kits, besides measuring fasting serum glucose (FSG) in an automated Kenza 240 TX Biochemical autoanalyzer device. Weight and height were measured for eighty-four subjects **(Table 1)**.

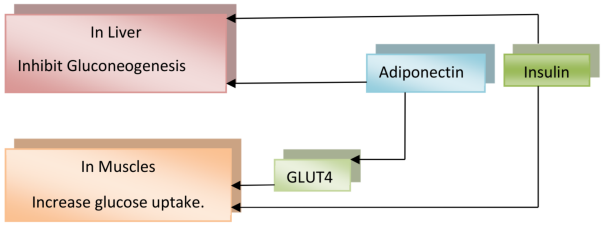


Figure 1: Effects of Adiponectin and Insulin on Glucose Metabolism in Liver and Muscle. This diagram illustrates the inhibitory effect on gluconeogenesis in the liver and the increase in glucose uptake in muscle tissues mediated by GLUT4, based on findings from Baldelli S et al., 2024 [12], and Guo et al., 2025 [13]. Diagram adapted by the author.

2.2. Statistical analysis

The results were expressed as (mean± standard deviation (SD) of mean). The Shapiro-Wilk test was conducted on all parameters to explore the normality of the data. The normally distributed variables were managed by t-test to compare the two studied groups. Pearson's correlation coefficient (r) was run to find out the statistically significant correlations between measured parameters. A P-value less than 0.05 was accepted as a significant difference. The analyses were conducted using the Statistical Package for Social Science (SPSS), version 25. HOMA-IR was calculated based on the following equation: HOMA-IR =fasting serum glucose(mg/ml) × fasting serum insulin (μU/ml)/405 [14].

3. Results

This study compared two groups: 45 patients with T2DM and 39 healthy controls. The T2DM patients were primarily middle-aged, with a mean age of 52.1 years (SD = 10.375), while the control group was younger, averaging 33.3 years (SD = 5.488), indicating a statistically significant age difference ($p < 0.0001$) **(Table 2)**. The analysis of body metrics showed that patients with

Table 2: Descriptive data of control and diabetic patients

Parameter	Control Mean ± SD (n=39)	DM Mean ± SD (n=45)	P-value
Age (year)	33.333 ± 5.488	52.111 ± 10.375	< 0.0001*
Gender (M/F)	19/20	17/28	NA
Weight (kg)	77.384 ± 14.401	83.088 ± 11.925	0.0502
Height (m)	1.675 ± 0.089	1.669 ± 0.095	0.7387
Disease duration (year)	NA	6.42 ± 4.801	NA
Adiponectin (µg/ml)	30.887 ± 9.780	14.848 ± 7.790	< 0.0001*
hs-CRP (µg/ml)	5.492 ± 2.905	17.937 ± 5.979	< 0.0001*
Insulin (µIU/ml)	13.502 ± 6.165	8.411 ± 1.161	< 0.0001*
FSG (mg/ml)	90.0 ± 19.351	176.555 ± 38.927	< 0.0001*
HOMA-IR	2.991 ± 1.532	3.671 ± 0.955	0.0154**

*= t-test (student test) significant at a level of p <0.05
**= t-test (student test) significant at a level of p <0.01
SD, Standard deviation; hs-CRP, high-sensitivity C-reactive protein; FSG, fasting serum glucose; HOMA-IR, Homeostatic Model Assessment-Insulin Resistance; M, Male; F, Female; NA, Not applicable.

Table 3: Significant correlations of body weight and height with adiponectin

Variable	Pearson Correlation	Significance (Sig. 2-tailed)
Weight	-0.683**	0.001
Height	-0.740**	0.001

**Correlation is significant at the 0.01 level (2-tailed).

T2DM had a higher mean weight of 83.088 kg (SD = 11.925) compared to 77.384 kg (SD = 14.401) in controls, with marginal statistical significance ($p = 0.0502$). However, the average height was comparable between groups—1.669 meters (SD = 0.095) for diabetics and 1.675 meters (SD = 0.089) for controls, which did not differ significantly ($p = 0.7387$) **(Table 2)**.

The biochemical profile revealed that FSG, hs-CRP, and HOMA-IR levels were significantly higher in the diabetic group ($p < 0.05$), while levels of fasting insulin and adiponectin were significantly lower compared to controls. Specifically, adiponectin levels were notably lower in T2DM patients at 14.848 µg/ml (SD = 7.790) versus 30.887 µg/ml (SD = 9.780) in controls ($p < 0.0001$) **(Table 2)**.

In addition, significant negative correlations were identified between adiponectin levels and both weight ($r = -0.683$, $p = 0.001$) and height ($r = -0.740$, $p = 0.001$) in the control group, underscoring the inverse relationship between adiponectin and body measurements in a healthy population **(Table 3)**.

4. Discussion

The significantly (P<0.05) higher FSG, hs-CRP, and HOMA-IR levels in patients with diabetes compared to the controls **(Table 2)**

may be explained by the hyperglycemia during type 2 diabetes participation in the inflammation process, which agrees with Wu et al. [15]This inflammation could lead to two effects: insulin resistance, as was found in Asimakidou et al. [16], and the significant ($P<0.05$) lowered adiponectin level, as agreed with El-Araby et al. [17]. The significantly ($P<0.05$) lowered level of insulin secretion in patients with diabetes could result from prolonged time exposure to the disease, which promotes hypo-insulinemia and hyperglycemia as β-cells will be exhausted with time, agreeing with (Faraj et al.;2020) [18]Besides, people with diabetes age more than controls, as aging can cause a gradual loss of β-cell mass, which agrees with Nasteska et al. [19].

The significant ($P<0.05$) higher adiponectin level with concurrent significant ($P<0.05$) higher insulin level in controls as compared to people with diabetes may come from the effect of adiponectin in increasing insulin sensitivity, which agrees with Wu et al. [20]. The significant ($P<0.05$) low levels of each of FSG, HOMA-IR, and hs-CRP in controls as compared to diabetics might be due to the anti-inflammatory effect of adiponectin, agreeing with Shimizu et al. [21]. It regulates glucose metabolism as adiponectin enhances glucose uptake in adipose and muscle tissues, as with Guo L et al [13]. The significant ($P<0.05$) negative correlation between adiponectin and weight with the concurrent significant (p0.05) lower weight value in controls compared to diabetics could be a result of adiponectin's influence in enhancing fatty acid oxidation [22], the same was found in Lara-Guzmán et al.[23]. The significant ($P<0.05$) negative correlation between adiponectin and height was also found by Norton et al., and they explained it on a genetic base [24] while disagreeing with Barnabé et al. [24]. The limited sample size of 84 individuals may restrict the findings' generalizability to the larger Iraqi population. The sample may not entirely reflect the variety of the entire country. As a result, the findings may not accurately reflect the country's overall image. Future studies should use bigger, nationally representative samples to improve the external validity of the findings.

5. Conclusions

Adiponectin can ameliorate diabetes mellitus, insulin resistance, and overweight risks as it can decrease the levels of glucose, hs-CRP, and HOMA-IR and enhance insulin sensitization and fatty acid oxidation, suggesting using adiponectin in the improvement of the risks of these cases. Therefore, a merit investigation is requested to pave the way for this finding.

Conflicts of Interest

The authors declare no competing interests that could have influenced the objectivity or outcome of this research.

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Institutional Review Board (IRB) approval

The IRB of the College of Pharmacy at the University of Baghdad, Baghdad, Iraq, approved this study protocol, designated as number 839, on October 25, 2020.

Large Language Model

No generative artificial intelligence or large language model tools were used in the preparation of this manuscript.

Authors Contribution

HFJ and SHA were responsible for the study design, data collection, analysis, and manuscript writing; MSJ contributed to the critical revision of the manuscript for important intellectual content. All authors read and approved of the final manuscript.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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