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RESEARCH

Insulin Resistance and their Affects on Biochemical Parameters of Cardiovascular Risk Factors

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■ Abstract

The objective of this study is to examine the impact of obesity and insulin resistance on various biochemical parameters associated with cardiovascular risk factors. Methods: This study employed a comparative cross-sectional design, involving a total of 234 participants. Among these, 178 individuals were identified as diabetes patients receiving treatment at the IBN_SENA TEACHING HOSPITAL, specifically in the diabetic and cardiovascular departments. Individuals diagnosed with type II diabetes were categorised into three distinct groups based on their body mass index (BMI): the group with a normal BMI, the group classified as overweight, and the group classified as obese. The control group consisted of a sample of 78 individuals who were in good health, picked from the IBN_SENA TEACHING HOSPITAL in Iraq. Results: The measurement of HbA1C indicated elevated levels of HbA1C in both the control group and the patients' group among females in all three categories. The analysis of Body Mass Index (BMI) indicated that males in the control group exhibited a comparatively lower BMI when compared to the other two groups. Similar patterns were observed in both male and female patients throughout the three groups. The findings of the study indicate a statistically significant association between body mass index (BMI) and insulin resistance, as well as a substantial relationship between insulin resistance measured by the homeostatic model assessment (HOMA) and cardiovascular risk factors. Our findings emphasise the importance of assessing insulin resistance in conjunction with body mass index (BMI) when evaluating the risk of cardiovascular disease (CVD). Furthermore, our research findings suggest that therapies targeting the reduction of insulin resistance and regional fat distribution may prove effective in mitigating cardiovascular disease (CVD) risk.

Keywords: BMI, Type 2 Diabetes Mellitus, Insulin Resistance, HOMA-IR

1. Introduction

Insulin resistance is a physiological state characterised by reduced responsiveness of cells to the actions of insulin, leading to the manifestation of hyperglycemia. (1) The aforementioned problem represents a significant risk factor in the pathogenesis of type 2 diabetes, obesity, and cardiovascular disease. (2) Cardiovascular disease is a leading cause of death worldwide and is commonly accompanied with an array of biochemical indicators that signal increased cardiovascular risk, such as raised blood pressure, an altered lipid profile, and inflammation. The crucial function of insulin resistance in the development of cardiovascular risk factors has been demonstrated. Gaining a comprehensive understanding of the biochemical alterations linked to insulin resistance and their impact on risk factors related to cardiovascular health has the potential to offer valuable insights into the underlying mechanisms involved in the pathophysiology of cardiovascular disease. Cardiovascular disease (CVD) is a prominent contributor to both morbidity and mortality on a global scale. The ailment in question is a multifactorial condition characterised by a complicated interplay of various risk factors, including hypertension, dyslipidemia, obesity, and diabetes mellitus. Insulin resistance, a condition described by compromised insulin function in specific organs, has been suggested as a potential connection between these risk factors and cardiovascular disease (CVD). Insulin resistance has been identified as having a correlation with various cardiovascular risk factors, including obesity, dyslipidemia, hypertension, and type 2 diabetes mellitus. The presence of insulin resistance results in elevated amounts of insulin in the bloodstream, which can contribute to endothelial dysfunction, oxidative stress, and inflammation. These physiological processes have been identified as potential factors in the pathogenesis and advancement of

cardiovascular disease. Multiple studies have provided evidence indicating a robust association between insulin resistance and cardiovascular disease (CVD), irrespective of the presence of other conventional risk factors. The Insulin Resistance Atherosclerosis Study (IRAS) demonstrated a positive correlation between insulin resistance and an elevated susceptibility to cardiovascular disease (CVD), even after accounting for conventional risk factors such as age, gender, blood pressure, and lipid profiles. The correlation between insulin resistance and cardiovascular disease (CVD) has been documented in several ethnic populations as well. A research investigation conducted on a sample of Chinese adults revealed a significant correlation between insulin resistance and an elevated susceptibility to cardiovascular disease (CVD), even after accounting for conventional risk factors through appropriate adjustments. In a comparable manner, a research investigation conducted on individuals of African American descent revealed a significant correlation between insulin resistance and an elevated susceptibility to cardiovascular disease (CVD). Body mass index (BMI) is a commonly employed metric for assessing obesity, derived by dividing an individual's weight in kilogrammes by the square of their height in metres. Obesity represents a significant risk factor for the development of cardiovascular disease (CVD), a prevalent cause of morbidity and mortality on a global scale. This article aims to investigate the correlation between body mass index (BMI) and cardiovascular disease (CVD). (10) Research has demonstrated that individuals with a high body mass index (BMI) are at a notable risk for cardiovascular disease (CVD) due to obesity. Numerous studies have documented a positive correlation between elevated body mass index (BMI) and the likelihood of acquiring cardiovascular disease (CVD), encompassing conditions such as coronary artery disease, stroke, and heart failure. According to a comprehensive study conducted on a substantial group of female nurses in the United States, it was observed that women with a body mass index (BMI) equal to or over 25 exhibited a notably elevated susceptibility to cardiovascular disease (CVD) in comparison to women with a BMI below 25. The relationship between body mass index (BMI) and the risk of cardiovascular disease (CVD) seems to exhibit a linear pattern, wherein a rise in BMI corresponds to an increase in the likelihood of developing CVD. According to a comprehensive meta-analysis comprising 97 prospective studies and a participant pool exceeding 1.8 million individuals, an elevation of 5 units in body mass index (BMI) was associated with a 29% rise in the likelihood of developing coronary artery disease, as well as a 13% increase in the risk of stroke. I apologise, but it seems that you have not provided any text for me to rewrite in Furthermore, the primary objective of this study is to investigate the influence of insulin resistance and body mass index on various cardiovascular diseases that are interconnected. The consequences of the findings from this study will have significant ramifications for the prevention and management of cardiovascular disease. Through the comprehensive examination of the biochemical pathways that contribute to insulin resistance and its impact on many risk factors associated with cardiovascular health, this research aims to enhance our understanding of the condition and facilitate the creation of innovative therapeutic interventions for the management of cardiovascular disease.

2. Materials and Methods

A comparative cross-sectional study was undertaken, involving a total of 234 samples obtained from June 2022 to March 2023. These samples were gathered from 178 individuals diagnosed with diabetes who were receiving treatment at IBN_SENA TEACHING HOSPITAL, specifically from the diabetic and cardiovascular departments. The participants diagnosed with type II diabetes were categorised into three distinct groups based on their body mass index (BMI): the group with a normal BMI, the group with an overweight BMI, and the group with an obese BMI. A total of 78 individuals who met the criteria for good health were chosen to comprise the control group, specifically from the IBN_SENA TEACHING HOSPITAL. In order to examine the relationship between cardiovascular chemistry indicators, including cholesterol, triglycerides, HDL, LDL, TC, CRP, troponin, and BNP, and insulin resistance (HOMA-IR), the researchers also assessed BMI as a measurable variable. The measurement of insulin resistance and metabolic parameters was conducted using the Cobas 111 analyzer and Enzyme-Linked Immunosorbent Assay (ELISA) technique.

2.1. Inclusion criteria

- The study participants were chosen to fall between the age range of 45 to 75 years.
- Individuals diagnosed with type 2 diabetes

2.2. Exclusion criteria

- Patients falling outside the designated age range
- Patients diagnosed with a different form of diabetes
- Patients with pre-existing cardiovascular conditions, as established prior to the commencement of the trial.

2.3. Ethical considerations

Informed consent was obtained from all participants, and the study was done in accordance with the ethical approval granted by the ethical council of the College of Medicine, Al-Nahrain University/Medical Research Unit.

2.4. Statistical analysis

The data was collected and afterwards processed using the statistical software SPSS (version 26). The statistical analyses employed in this work encompassed measures of central tendency such as mean and standard deviation, hypothesis testing through the use of P-values, and effect size estimation using Eta2.

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3. Results

The age range of the participants was within the demographic of those aged 45 to 70 years. The Body Mass Index (BMI) was assessed, and thereafter, individuals were categorised into three groups: normal BMI (18–24.9), overweight BMI (25–30), and obesity <30. The sample size for each group was 78 participants, with the sick group including 52 individuals and the control group consisting of 26 individuals. The allocation of participants among the groups is depicted in Figure 1.

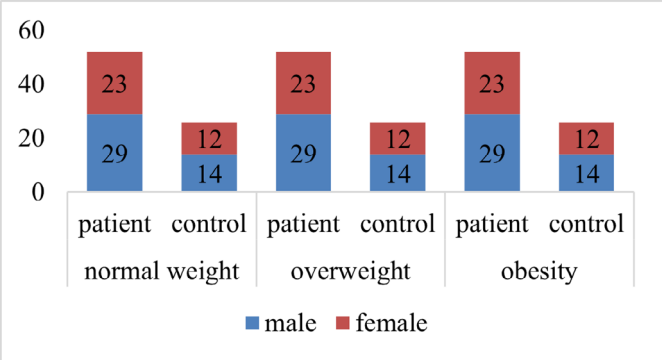

Figure 1: Distribution of patients among the groups.

The assessment of body mass index (BMI) indicated that males in the control group with a normal weight had a lower BMI of 26.63±(1.14). In contrast, the overweight group had a higher BMI of 32.72±(1.28), as did the obesity group with the same BMI of 32.72±(1.28). Similar patterns were observed in both male and female patients throughout the three groups.

3.1. Measuring

The analysis of glycosylated haemoglobin (HbA1C) indicated elevated levels of HbA1C in both the control and patients' groups among females within the three categories. Furthermore, a noteworthy correlation was observed between the rise in body mass index (BMI) and the elevation in glycated haemoglobin (HbA1C) levels. In a similar vein, the findings pertaining to fasting blood sugar (FBS) indicated a consistent correlation between males and females. Specifically, it was shown that FBS levels were considerably lower among males across all categories compared to females. Furthermore, there was a positive correlation observed between FBS levels and BMI, indicating that when BMI increased, FBS levels also increased. In a similar fashion, the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) exhibited a positive correlation with Body Mass Index (BMI) as it climbed. In a similar vein, it was shown that all cardiac measures had higher levels in females compared to males across the three groups. Table 1 presents the findings pertaining to chemical parameters observed in three distinct patient groups: normal weight, overweight, and obesity. Figure 2 illustrates the disparity across the groups based on HOMA-IR and BMI.

Table 1: Chemical parameters for the patients in the 3 groups

Groups	Patients in the normal weight group		Patients in the overweight group		Patients in the obesity group	
	female	male	female	male	female	male
BMI	22.49±(1.73)	20.93±(1.57)	27.69±(1.42)	26.43±(1.08)	33.68±(1.45)	32.11±(1.24)
HBA_1c(%)	6.1±(0.63)	5.24±(0.82)	7.17±(0.64)	6.38±(0.75)	10.61±(1.5)	9.24±(1.07)
FBS (mg/ml)	126.25±(12.71)	114.44±(10.98)	155.48±(11.95)	145.84±(12.37)	209.44±(13.89)	199.64±(8.29)
Insulin level (U\ml)	5.66±(0.92)	4.99±(1.02)	7.35±(0.65)	6.66±(0.36)	10.63±(0.99)	9.54±(0.71)
HOMA IR	1.78±(0.42)	1.43±(0.4)	2.83±(0.43)	2.4±(0.32)	5.52±(0.83)	4.7±(0.42)
T. Cholestrol (mg\dl)	151.14±(6.69)	143.68±(6.56)	171.4±(8.65)	164.2±(6.63)	216.88±(21.87)	203.6±(14.32)
TG (mg/dl)	147.29±(21.58)	134.76±(7.52)	153.81±(9.77)	142.64±(7.47)	182.81±(16.8)	166.64±(9.53)
HDL (mg/dl)	48.37±(6.87)	55.04±(7.57)	44±(6.97)	48.62±(7.47)	36.95±(4.06)	38.98±(5.35)
LDL (mg/dl)	111.69±(6.06)	106.54±(8.64)	125.47±(6.11)	121.5±(8.35)	143.28±(13.01)	133.37±(8.38)
TC (ratio)	3.11±(0.71)	2.49±(0.46)	3.58±(0.66)	3±(0.5)	5.04±(1.01)	4.37±(0.76)
CRP (mg/dl)	0.5±(0.07)	0.43±(0.06)	0.63±(0.11)	0.54±(0.09)	0.8±(0.15)	0.63±(0.13)
TROPONINE_T (ng/ml)	0.03±(0)	0.03±(0)	0.05±(0.01)	0.04±(0.01)	0.22±(0.19)	0.22±(0.21)
BNP(pg/mL)	92.66±(8.09)	85.24±(4.89)	104.96±(7.84)	96.24±(6.45)	146.25±(9.31)	136.16±(9.73)

The ANOVA test conducted on the chemical parameters demonstrated that, in comparison to the patient groups, the normal (control) group exhibited lower values for all indicators, with the exception of HDL (mg/dl) and BMI. These differences were found to be statistically significant, as indicated by a P-value of less than 0.05.

The Pearson correlation coefficient was employed by the researcher to investigate the potential association between body mass index (BMI) and insulin resistance. The findings of the study demonstrated a statistically significant association between body mass index (BMI) and insulin resistance in individuals classified as normal weight, overweight, and obese within the patient cohort. The findings were shown in Table 2.

Table 2: Relationship between BMI and insulin resistance

HOMA_IR	Statistic	BMI			
		(patient)		(control)	
		male	Female	male	Female
Normal weight	Pearson Correlation	0.667**	0.752**	0.797**	0.517
	Sig. (2-tailed)	0.000	0.000	0.001	0.085
	N	27	25	14	12
overweight	Pearson Correlation	0.772**	0.768**	0.583**	0.528
	Sig. (2-tailed)	0.000	0.000	0.000	0.078
	N	27	25	14	12
Obesity	Pearson Correlation	0.746**	0.464**	0.789**	0.502
	Sig. (2-tailed)	0.000	0.019	0.001	0.096
	N	27	25	14	12

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

In the control group of female participants, no significant connection was observed between body mass index (BMI) and homeostatic model assessment of insulin resistance (HOMA IR). However, in the sick group of females, a significant association was found between BMI and HOMA IR across all weight categories, except for the obesity group. The correlation between BMI and HOMA IR is moderate within the obese group, however in the male group, there exist stronger associations with other variables. In the overweight control group and the normal-weight patient group, there exists a moderate correlation between BMI and HOMA IR among males. The association between BMI and HOMA IR is comparatively weaker in male patients than in male controls throughout the normal weight and obesity categories. However, within the overweight category, the association is stronger in the patient group than in the control group.

Based on the provided table, a statistically significant and substantial correlation is seen between BMI and HOMA insulin resistance, as indicated by a p-value of 0.000 (below the threshold of 0.01). The observed relationship exhibits a positive association and is classified as a strong correlation, as indicated by a Pearson correlation coefficient over 0.6. Within the cohort of patients, the Pearson correlation coefficient exhibits a value over 0.7, hence signifying a substantial degree of association. In comparison, the control group exhibits a Pearson correlation coefficient ranging from 0.4 to 0.6, suggesting a moderate association that is comparatively less than the total correlation. Significant variations in five cardiovascular risk factor biochemical measures are observed within the normal weight group when there is a shift in HOMA Insulin Resistance levels. The criteria under consideration are body mass index (BMI), glycated haemoglobin (HbA1c) percentage, insulin concentration (U/mL), troponin T level (ng/mL), and brain natriuretic peptide (BNP) concentration (pg/mL). The observed differences in this study have a significance level below 0.05. In the overweight group, substantial variations in cardiovascular risk factors are observed only in two biochemical measures when there is a shift in the HOMA Insulin Resistance level. The criteria under consideration in this study are Body Mass Index (BMI) and Troponin T (TROPONIN_T) levels, measured in nanograms per millilitre (ng/mL). The observed differences in this study have a significance level below 0.05. Significant variations in cardiovascular risk variables are observed when there is a shift in the HOMA Insulin Resistance score, with just two specific biochemical markers being affected. The parameters under consideration are the concentration of insulin in units per millilitre (U/mL) and the level of total cholesterol in milligrammes per deciliter (mg/dL). The observed differences in this study have a significance value that is below the threshold of 0.05. Table 3 displays the findings of biochemical parameters.

Table 3: Difference between patients' biochemical parameters of cardiovascular risk factors upon deferent levels of HOMA Insulin Resistance

	Normal weight			Overweight			Obesity		
biochemical parameters of cardiovascular risk factors	Mean Square	F	Sig.	Mean Square	F	Sig.	Mean Square	F	Sig.
BMI	3.808	2.772	0.043	2.146	17.521	0.006	2.495	2.025	0.387
HBa1c(%)	0.860	7.611	0.001	0.674	2.533	0.189	2.190	1.176	0.567
FBS(mg/ml)	217.334			183.038			161.229	17.914	0.054
insulin level (U\ml)	1.304			0.442			1.086	48.283	0.020
Total Cholestrol(mg\dl)	62.573	1.741	0.175	73.911	1.428	0.404	400.745	35.622	0.028
TG(mg/dl)	362.119	5.443	0.003	109.773	1.538	0.370	259.947	2.849	0.294
HDL(mg/dl)	69.100	1.964	0.126	56.454	0.987	0.590	22.329	0.589	0.806
LDL(mg/dl)	62.202	1.147	0.434	58.749	2.582	0.183	149.336	5.914	0.155
TC (ratio)	0.525	2.548	0.057	0.451	3.164	0.134	0.942	2.298	0.350
CRP(mg/dl)	0.006	1.565	0.228	0.014	4.795	0.068	0.027	0.427	0.893
TROPONINE_T (ng/ml)	0.000	0.811	0.700	0.000	1.978	0.268	0.042	13.287	0.072
BNP(pg/mL)	64.496	1.842	0.151	69.558	0.875	0.652	112.613	0.669	0.765

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According to (Abeer, 2018), we can use the ETA2 test to determine the effect size of three biochemical parameters of cardiovascular risk factors for three patients. A large effect size is indicated by ES<0.8<1.1. Table (4)

Table 4: ETA2 test for the effect size of BMI on cardiovascular parameters

Measures of Association of normal weight group	Eta	Eta Squared	Effect size
BMI	0.431	0.186	Small
HBa1c(%)	0.516	0.266	Medium
TG(mg/dl)	0.363	0.132	Small
Measures of the Association of overweight group			
BMI	0.998	0.995	Very large
Measures of the Association of obesity group			
insulin level (U\ml)	1.000	0.999	HOMA IR has a large effect size on the two biochemical parameters of cardiovascular risk factors
Total Cholestrol(mg\dl)	0.999	0.999	

The results of the Eta2 test revealed that BMI has a large effect size on cardiovascular risk factors. The effect size of BMI on each parameter is shown in Table (5).

Table 5: Measures of Association of effect size of HOMA Insulin Resistance on biochemical parameters of cardiovascular risk factors

Measures of Association of normal weight group	Eta	Eta Squared	Effect size
HOMA IR	0.855	0.732	Large
HBa1c(%)	0.872	0.761	Large
FBS(mg/ml)	0.939	0.882	Very Large
insulin level (U\ml)	0.735	0.540	Large
Total Cholesterol (mg\dl)	0.766	0.587	Large
TG(mg/dl)	0.812	0.659	Large
HDL(mg/dl)	0.838	0.702	Large
LDL(mg/dl)	0.838	0.702	Large
TC (ratio)	0.882	0.778	Large
CRP(mg/dl)	0.711	0.505	Large
Measures of the Association of overweight group			
HOMA IR	0.907	0.823	BMI has a large effect size on the biochemical parameters of cardiovascular risk factors
HBa1c(%)	0.881	0.776	
FBS(mg/ml)	0.913	0.834	
insulin level (U\ml)	0.868	0.753	
Total Cholesterol(mg\dl)	0.841	0.708	
TG(mg/dl)	0.831	0.690	
HDL(mg/dl)	0.895	0.801	
LDL(mg/dl)	0.887	0.787	
TC (ratio)	0.923	0.851	
Measures of the Association of obesity group			
HOMA IR	0.936	0.876	Very large
HBa1c(%)	0.895	0.801	Very large
FBS(mg/ml)	0.948	0.898	Very large
insulin level (U\ml)	0.884	0.782	Large
Total Cholesterol(mg\dl)	0.905	0.820	Very large
TG(mg/dl)	0.918	0.844	Very large
LDL(mg/dl)	0.877	0.770	Large
TC (ratio)	0.892	0.795	Large
CRP(mg/dl)	0.725	0.526	Large

All variables have a very high statistical correlation with weak (less than 0.39) or medium (between 0.4 and 0.69) or strong (equal or greater than 0.7) positive (with no sign which means the sign is +) or negative (with – sign the only negative variable is HDL) relation (all with green background) except BMI with:

- TROPONINE_T has a weak relationship (0.312)
- TROPONINE_T and CRP are having medium relationships with HOMA_IR HBa1c
- TROPONINE_T is having a medium relationship with BMI, FBS, insulin, TG, HDL, LDL, and TC_HDL.

Table 6: Correlation between all parameters

	BMI	HOMA_IR	HBa1c	FBS	insulin	Total_Cholestrol	TG	HDL	LDL	TC_HDL	CRP	TROPONINE_T	BNP
BMI	1	0.947**	0.909**	0.970**	0.938**	0.916**	0.792**	-0.772-**	0.880**	0.831**	0.714**	0.581**	0.916**
HOMA_IR	0.947**	1	0.941**	0.979**	0.985**	0.936**	0.812**	-0.748-**	0.863**	0.852**	0.698**	0.658**	0.941**
HBa1c	0.909**	0.941**	1	0.938**	0.912**	0.883**	0.809**	-0.779-**	0.872**	0.863**	0.675**	0.639**	0.889**
FBS	0.970**	0.979**	0.938**	1	0.956**	0.922**	0.802**	-0.785-**	0.874**	0.852**	0.711**	0.630**	0.933**
Insulin	0.938**	0.985**	0.912**	0.956**	1	0.912**	0.789**	-0.744-**	0.854**	0.825**	0.688**	0.607**	0.912**
Total_Cholestrol	0.916**	0.936**	0.883**	0.922**	0.912**	1	0.818**	-0.738-**	0.853**	0.854**	0.683**	0.715**	0.932**
TG	0.792**	0.812**	0.809**	0.802**	0.789**	0.818**	1	-0.716-**	0.763**	0.919**	0.672**	0.577**	0.837**
HDL	-0.772-**	-0.748-**	-0.779-**	-0.785-**	-0.744-**	-0.738-**	-0.716-**	1	-0.805-**	-0.898-**	-0.656-**	-0.478-**	-0.723-**
LDL	0.880**	0.863**	0.872**	0.874**	0.854**	0.853**	0.763**	-0.805-**	1	0.839**	0.730**	0.559**	0.829**
TC_HDL	0.831**	0.852**	0.863**	0.852**	0.825**	0.854**	0.919**	-0.898-**	0.839**	1	0.704**	0.617**	0.845**
CRP	0.714**	0.698**	0.675**	0.711**	0.688**	0.683**	0.672**	-0.656-**	0.730**	0.704**	1	0.312**	0.737**
TROPONINE_T	0.581**	0.658**	0.639**	0.630**	0.607**	0.715**	0.577**	-0.478-**	0.559**	0.617**	0.312**	1	0.603**
BNP	0.916**	0.941**	0.889**	0.933**	0.912**	0.932**	0.837**	-0.723-**	0.829**	0.845**	0.737**	0.603**	1

4. Discussion

Cardiovascular diseases (CVD) continue to be a prominent issue in public health, contributing significantly to worldwide rates of illness and death.The identification of body mass index (BMI) and insulin resistance as significant risk factors for the onset of cardiovascular disease (CVD) has been established. Nevertheless, there remains a lack of comprehensive understanding regarding the fundamental pathways that connect body mass index (BMI), insulin resistance, and cardiovascular disease (CVD). The primary objective of this study was to examine the correlation between body mass index (BMI) and insulin resistance, as well as their potential connection with cardiovascular disease (CVD). Additionally, this paper aims to provide an overview of recent research findings pertaining to this subject matter.The user did not provide any text to rewrite. The results of this study offer more substantiation for the significance of BMI and insulin resistance as contributing variables in the pathogenesis of cardiovascular disease (CVD). The study conducted on persons diagnosed with type 2 diabetes revealed that visceral adipose tissue (VAT) exhibited a greater predictive capability for cardiovascular events compared to body mass index (BMI) or glycated haemoglobin (HbA1c) levels (5). Hence, therapies focused on visceral adipose tissue (VAT) may exhibit more efficacy in mitigating the risk of cardiovascular disease (CVD) compared to interventions targeting overall body weight. The research conducted by Neeland IJ (2017) aligns with our own findings since it examined the correlation between ectopic fat, specifically visceral adipose tissue (VAT), and the risk of cardiovascular complications in persons diagnosed with type 2 diabetes. The results showed that VAT was a greater predictor of cardiovascular events than body mass index (BMI) or HbA1c. The researchers reached the conclusion that therapies focusing on visceral adipose tissue (VAT) may yield greater efficacy in mitigating the risk of cardiovascular disease compared to interventions targeting overall body weight. Recent research has additionally indicated that hereditary factors may contribute to the relationship between body mass index (BMI), insulin resistance, and cardiovascular disease (CVD). Several genetic loci related with body mass index (BMI) and insulin resistance have been identified by genome-wide association studies. Notably, some of these loci are also found to be associated with cardiovascular disease (CVD). Moreover, recent studies have indicated that there may be a contribution of gene-environment interactions in the pathogenesis of cardiovascular disease (CVD). The user's text does not contain any information to rewrite in an academic manner. Further research should be conducted in order to explore these issues and enhance our overall comprehension of the association between body mass index (BMI), insulin resistance, and cardiovascular disease (CVD).Additional research is required in order to have a comprehensive understanding of the fundamental mechanisms that connect body mass index (BMI), insulin resistance, and cardiovascular disease (CVD). Recent research has indicated that there may be a potential association between persistent low-grade inflammation and this particular correlation.Adipose tissue is responsible for the secretion of various pro-inflammatory cytokines, including tumour necrosis factor-alpha (TNF-alpha), interleukin-6 (IL-6), and C-reactive protein (CRP). These cytokines have been linked to the development of insulin resistance and cardiovascular disease (CVD). Furthermore, it is worth noting that insulin resistance has the potential to initiate the activation of the renin-angiotensin-aldosterone system (RAAS), a physiological mechanism responsible for the control of blood pressure and fluid equilibrium. This activation of RAAS may potentially play a role in the pathogenesis of cardiovascular disease (CVD).Additional research is required to examine the involvement of these pathways in the correlation between body mass index (BMI), insulin resistance, and cardiovascular disease (CVD). In addition to lifestyle measures, recent studies have also examined the potential impact of pharmaceutical interventions in mitigating insulin resistance and reducing the risk of cardiovascular disease (CVD).One example is metformin, a frequently prescribed medicine for managing type 2 diabetes, which has demonstrated efficacy in enhancing insulin sensitivity and mitigating the likelihood of cardiovascular disease (CVD).Additionally, there have been studies demonstrating the efficacy of thiazolidinediones and glucagon-like peptide-1 (GLP-1) receptor agonists in

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enhancing insulin sensitivity and mitigating the risk of cardiovascular disease (CVD). (25) Nevertheless, it is imperative to acknowledge that these drugs include potential adverse effects and raise questions regarding their long-term safety. Consequently, further investigation is warranted to comprehensively comprehend their efficacy and safety.Lifestyle modifications, including alterations in food patterns and the adoption of a more active lifestyle, continue to be fundamental in the prevention and management of obesity and insulin resistance. Nevertheless, achieving sustained weight loss over an extended period of time continues to pose a significant difficulty for a considerable number of individuals, hence necessitating the implementation of supplementary interventions. Research studies have demonstrated the efficacy of bariatric surgery in reducing body mass index (BMI) and enhancing insulin sensitivity, as well as reducing the risk of cardiovascular disease (CVD). Nevertheless, the procedure of surgery presents inherent hazards and should be contemplated solely for persons who have been meticulously chosen.Additional study is required to explore possible targets for pharmaceutical treatments. Recent research has examined the potential impact of gut microbiota on the pathogenesis of insulin resistance and cardiovascular disease (CVD).(29) The utilisation of probiotics or prebiotics to manipulate the gut microbiota shows promise as an innovative treatment strategy for enhancing insulin sensitivity and mitigating the risk of cardiovascular disease.Furthermore, the employment of Mendelian randomization methods, which employ genetic variants as instrumental variables to examine causal associations between exposures and outcomes, could potentially enhance our understanding of the connection between BMI, insulin resistance, and cardiovascular disease (CVD). The study has certain limitations that should be acknowledged. Firstly, the design of the study is cross-sectional, which means that it only provides a snapshot of the data at a certain point in time. This limits our ability to establish causal relationships between variables. Additionally, the study lacks information on lifestyle factors, such as food and physical activity, which could potentially influence the association between body mass index (BMI), insulin resistance, and cardiovascular disease (CVD). These lifestyle factors may function as confounding variables, making it difficult to accurately assess the true relationship between BMI, insulin resistance, and CVD. Further research should be conducted to go further into these parameters, so offering a more exhaustive comprehension of the correlation between body mass index (BMI), insulin resistance, and cardiovascular disease (CVD).

5. Conclusion

The results of our study emphasise the significance of using insulin resistance measurements alongside body mass index (BMI) evaluations in order to accurately evaluate the risk of cardiovascular disease (CVD). Additionally, the findings of our study indicate that therapies aimed at addressing insulin resistance and the distribution of fat in certain regions of the body may prove to be efficacious in mitigating the likelihood of cardiovascular disease (CVD). Further investigation is warranted to examine the influence of lifestyle factors, genetic factors, and gene-environment interactions on the aforementioned association. In summary, the association between body mass index (BMI), insulin resistance, and cardiovascular disease (CVD) is intricate and influenced by multiple factors. Our research contributes to the expanding body of information that underscores the significance of addressing both body mass index (BMI) and insulin resistance as crucial factors in mitigating the risk of cardiovascular disease (CVD). Additional investigation is required in order to comprehensively comprehend the fundamental mechanisms that connect these factors and to formulate efficacious strategies for the prevention and control of cardiovascular disease.

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