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The Impact of Obesity and Gender on Physiological Response and Lipid Profile in Hypertensive Patients: A Comparative Study

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ABSTRACT

Obesity and being overweight, as defined by body mass index (BMI), lead to a cascade of harmful physiological responses in the body and a wide range of systemic diseases. This study focuses on examining the effect of obesity and gender on physiological responses and changes in blood lipids by comparing healthy individuals with a BMI of less than 25 Kg/m² and hypertensive patients with a BMI greater than 30 Kg/m². The aim is to reveal the nature of the interaction among BMI, gender, and cardiovascular health indicators. A comparative analysis was carried out in 4 separate groups (n = 6 per group), classified as follows: Healthy control groups (C1 and C2), consisting of men and women (BMI < 25 kg/m²); and hypertensive patient groups (H1 and H2), consisting of men and women (BMI > 30 kg/m²).The assessment included measurement of BMI, blood pressure (systolic and diastolic in mmHg), and a comprehensive lipid profile analysis, including Total Cholesterol, TG, HDL, LDL, and VLDL (mg/dL). Physiological Response and Body Indices; Statistical analysis revealed statistically significant differences (P < 0.05) in BMI and blood pressure when comparing the obese and hypertensive patient groups with the control (healthy) groups. The hypertensive men's group (H2) had the highest mean BMI (34.04 ± 1.80), while the hypertensive groups (H1 and H2) showed significantly higher systolic and diastolic blood pressure measurements compared to their healthy counterparts. Accompanied by significant changes in lipid levels, the results showed differences in lipid distribution between obese and hypertensive individuals compared to the control groups. A significant decrease in HDL cholesterol levels was observed in the hypertensive men's group (H2), with a mean of 29.88 ± 2.83 mg/dL. Regarding the effect of sex, when analyzing the differences between the sexes within the healthy control groups, the differences in physiological indicators and lipid levels were found to be minor and not statistically significant (P > 0.05). Although the mean blood pressure readings in the women with hypertension (H1) were slightly higher than in the men in the group (H2), this difference did not reach statistical significance, indicating a similarity in the pathological effect between the sexes in the study sample. The conclusion of the current study revealed that morbid obesity (BMI above 30 kg/m²) is the primary factor that detects the body physiology imbalance and impaired fat distribution, and then leads to hypertension directly. While the sex factor was a limited and independent physiological variable. But the overweight or high BMI related to men was associated with lipid deterioration levels, especially when HDL is lower.

INTRODUCTION

Obesity has emerged as one of the most significant health challenges of the 21st century. The number of people with a high body mass index BMI (obesity) exceeded one billion worldwide in 2022, representing approximately one in eight adults. By 2024, according to the World Health Organization (WHO), around 43% of adults were classified as overweight or obese (Ahmed & Mohammed, 2025). The risks of obesity are highlighted by the excessive accumulation of fat tissue, which leads to high blood pressure and dyslipidemia (Banerjee, D., & Mani, 2025; Ahmed et al., 2021), particularly high levels of LDL (bad) cholesterol and low levels of HDL (good) cholesterol (Mossavarali et al., 2025).

Research also reveals clear biological differences between men and women in the metabolic responses resulting from weight gain and fat accumulation (Kim et al., 2025). Obesity is no longer defined simply as excess weight, but as a chronic metabolic disease that radically and permanently alters the dynamics of cardiovascular function. The enlargement of this adipose tissue leads to an increase in total blood volume and cardiac output to meet the increased metabolic demands, causing significant biological stress. This stress is a key factor in determining long-term heart health, as it leads to early vascular complications and changes in the structure of the heart muscle. Accordingly, the body mass index remains a reliable standard and indicator for predicting these health risks and working to reduce their serious effects in the future.

Increased body mass is associated with high blood pressure due to sympathetic and renin-angiotensin-aldosterone system stimulation, leading to increased sodium uptake and peripheral vascular resistance. Fat cells also secrete inflammatory mediators such as cytokines and adipokines, which impair the function of the vascular endothelium. These mechanisms combine to increase the risk of developing clinical hypertension once the body mass index exceeds the obesity threshold (BMI > 30) (Młynarska et al., 2025; Hall et al., 2019).

Disruption of blood lipid levels is a hallmark of metabolic disorders associated with obesity and overweight. Lipid-protein metabolism is markedly altered, leading to elevated triglycerides and very low-density lipoprotein (VLDL) cholesterol, accompanied by a significant decrease in high-density lipoprotein (HDL) cholesterol. This creates a favorable environment for blood clot formation and atherosclerosis. The low levels of HDL cholesterol are of particular concern due to the body's reduced ability to remove excess cholesterol from the walls of vital arteries (Chaudhari et al., 2025; Stadler & Marsche, 2020) The body responds to weight gain, blood pressure variation, and fat distribution, affected by sex differences. Men typically tend to aggregate visceral fat, in contrast to premenopausal women, who tend to store fat subcutaneously. This difference or variation is due to the protective properties of sex hormones, such as estrogen, which safeguard the inner lining of blood vessels. Conversely, research indicates that disruptions in these protective hormonal mechanisms can lead to obesity. This, in turn, can cause health risks such as high blood pressure and sex-specific lipid imbalances, making therapeutic and preventative interventions essential before the patient's health deteriorates further, to address these complex physiological changes. Ultimately, understanding these metabolic dynamics remains key to reducing the risk of obesity-related cardiovascular disease (CVD).

Raised BMI with hypertension binds to form a compounding risk that exceeds the effect of each factor alone. This connection elevates the dynamic load on the heart and kidneys, and then accelerates a fall in metabolic health. To address clinically significant and lower health risks, therefore, understanding the important role of weight management and stabilizing fat distribution highlights the mechanisms of physiological and immunological responses that are considered key to controlling the complications of systemic obesity (Patel et al., 2025; Landi et al., 2018). The

specialized nutritional interventions and intestinal health participate efficiently in modulating inflammatory responses and improving vital function, as some research has also addressed (Bakheet et al., 2020). As a consequence, the current study focuses on examining the effect of obesity and gender on physiological responses and changes in blood lipids by comparing healthy individuals with a BMI of less than 25 Kg/m2 and hypertensive patients with a BMI greater than 30 Kg/m2. The aim is to reveal the nature of the interaction among BMI, gender, and cardiovascular health indicators.

METHODS

Study design, and participants

This cross-sectional non-interventional study, carried out in Najaf Governorate, Iraq, from September 2025 to January 2026, included 24 participants aged 33 to 65 years, selected using simple random sampling to ensure the accuracy of the results. To reduce the margin of error and the impact of confounding factors, participants with chronic illnesses, heart disease, and those taking blood pressure medication were excluded.

Six participants were drawn from each of the four groups, and their sex, weight, and blood pressure status were recorded. The first (C1) and second (C2) groups consisted of healthy individuals with normal blood pressure and a BMI less than 25 kg/m², while the third (H1) and fourth (H2) groups consisted of individuals with hypertension and a BMI exceeding 30 kg/m². As well as, the first C1 and third H1 groups were women, and the second C2 and fourth H2 were for men. This was done to accurately determine and compare the health differences between the selected groups.

Body weight and BMI examination

After obtaining informed consent, anthropometric measurements were taken using standardized protocols. Stature was measured with a stadiometer, while body weight was recorded using a calibrated digital scale. Body Mass Index (BMI) was then calculated as weight in kilograms divided by the square of height in meters (kg/m^2) [16]. Since BMI is a ratio of two BMI values, a person who has a BMI less than 18.5 is classified as underweight; from 18.5 to 25.0 is classified as normal; greater than 25 is classified as overweight; and greater than 30 is classified as obese, categories according to the World Health Organization's (WHO)guidelines (Yusni & Meutia, 2019).

Blood pressure examination

Blood pressure was checked using a calibrated digital sphygmomanometer between 9:00 a.m. and 12:00 p.m. Participants were advised to get adequate rest and sleep, avoid stress, refrain from consuming coffee for at least 4 hours before measurement, and not to use blood pressure-lowering medications. Blood pressure was measured while seated, and the average of two readings was calculated. Systolic and diastolic blood pressure readings were categorized as follows: normal status was defined as 120/80 mmHg; while hypertension was identified at levels exceeding 130/80 mmHg (Muntner et al., 2019).

Lipid profile Analysis

The serum was extracted from blood samples drawn after an overnight fast of 10 to 12 hours for all study participants, and the lipid profile (mg/dl) of Cholesterol (TC), Triglyceride (TG), and High-Density Lipoprotein Cholesterol (HDL) was assessed using commercial diagnostic kits. The remaining values were calculated using the Friedwald equation when triglyceride levels were below 400 mg/dL.

VLDL= TG/5

LDL = TC – HDL – (TG/5)

Statistical Analysis

Data management was performed using Microsoft Excel, while statistical calculations were performed using SPSS (version 25.0). Continuous variables were summarized as mean ± standard deviation. One-way analysis of variance (ANOVA) was used to assess differences among the four study groups. Furthermore, Pearson's correlation coefficient was applied to examine the relationship between body mass index (BMI) and blood pressure parameters (systolic/diastolic pressure). Statistical significance was defined as a p-value less than 0.05.

RESULTS AND DISCUSSION

This study provides a statistical analysis of the relationship between body mass index (BMI) and blood pressure. The results in Figure 1, showed a clear difference in weight between the control group (C) and the hypertensive group (H). The control group had a BMI of less than 25 kg/m², while the hypertensive group significantly exceeded this limit. The data also revealed statistically significant differences ($P<0.05$) among the four studied groups. The BMI values of the hypertensive group (H1 and H2) were considerably higher 30 kg/m² than those of the control groups. Women in the control group (C1) recorded the lowest mean BMI at 23.78 ± 0.33, while the mean for men in the control group (C2) was approximately 24.41± 0.17. In contrast, women with hypertension (H1) showed a higher mean BMI of 31.75± 2.20, while men with hypertension (H2) recorded the highest mean BMI of all, at 34.04 ± 1.80. This confirms the strong association between increased body mass and hypertension in both sexes.

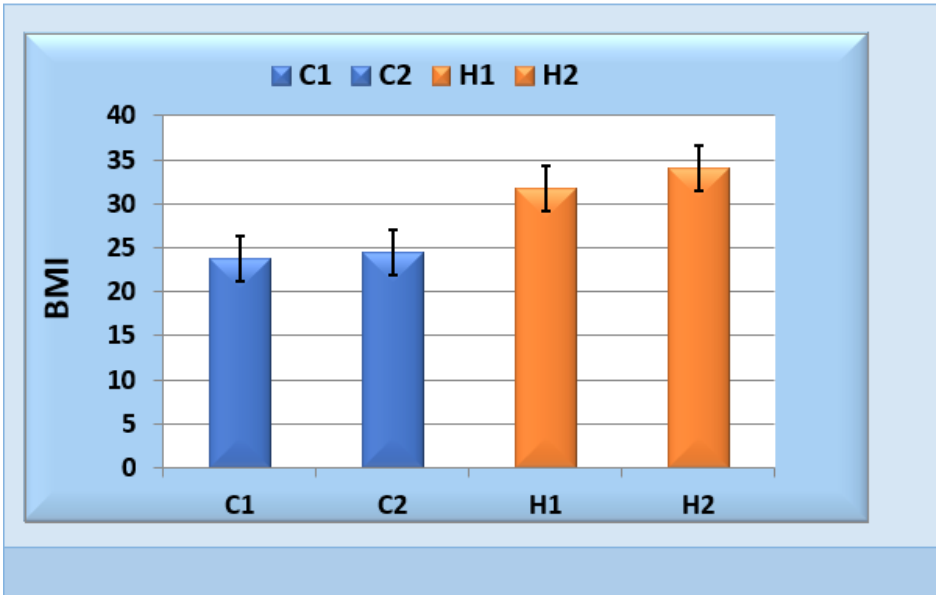

Figure 1. Comparison of Body Mass index (BMI) across the four study groups. N=6 samples. Mean±SE. C1; Healthy women (BMI < 25 kg/m^2), C2; Healthy men (BMI < 25 kg/m^2), H1; Hypertensive women (BMI > 30 kg/m^2), H2; Hypertensive men (BMI > 30 kg/m^2).

Figure 2. Comparison of Systolic (SBP) and Diastolic (DBP) blood pressure levels across the four study groups. N=6 samples. Mean±SE. C1; Healthy women (BMI < 25 kg/m^2), C2; Healthy men (BMI < 25 kg/m^2), H1; Hypertensive women (BMI > 30 kg/m^2), H2; Hypertensive men (BMI > 30 kg/m^2).

Figure 2 illustrates the statistical analysis of systolic and diastolic blood pressure levels in four study groups. The results revealed clear statistically significant differences ($P < 0.05$) between hypertensive patients (BMI > 30 kg/m^2) and the two healthy control groups (BMI < 25 kg/m^2). The results also showed that the differences between the sexes in the healthy groups were very slight, and the blood pressure levels were almost identical. The average systolic pressure in the C1 was 12.16 ± 0.16, and in C2 was 12.50 ± 0.22, while the diastolic pressure remained stable at 8.00± 0.00 in both healthy groups. In contrast, those with hypertension showed a significant increase in readings, especially among women in the first group 15.83±0.65/10.50±0.50, who recorded higher values compared to men in the second group 15.66±0.61/10.00±0.25. Despite this noticeable variation in the numbers, the difference between the sexes within the group of those with hypertension did not reach the required level of statistical significance ($P>0.05$). It is worth noting that all values included in this analysis were expressed in millimeters of mercury (mmHg) according to the medical standards followed in measuring blood pressure and linking it to the body mass index of the study participants.

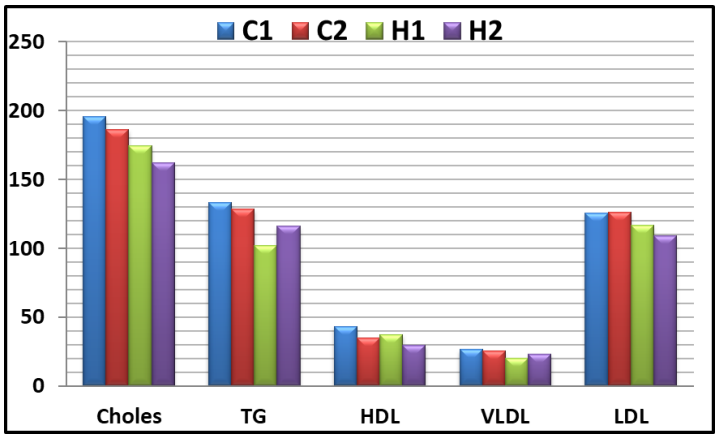

Figure 3. Comparison of Lipid Profile (mg/dl) parameters across the four study groups. N=6 samples. Mean±SE. C1; Healthy women (BMI < 25 kg/m^2), C2; Healthy men (BMI < 25 kg/m^2), H1; Hypertensive women (BMI > 30 kg/m^2), H2; Hypertensive men (BMI > 30 kg/m^2).

Figure 3 illustrates the lipid profile parameters (mg/dL) across the four study groups. Analysis of the healthy control groups (C1 and C2, BMI < 25 kg/m^2) revealed minor sex differences, with total cholesterol, triglycerides, high-density lipoprotein (HDL), very-low-density lipoprotein (VLDL), and low-density lipoprotein (LDL) cholesterol levels remaining almost identical (P > 0.05). The mean values for group C1 were recorded as follows: (195.53 ± 7.23, 133 ± 12.75, 43.15 ± 5.50, 26.6 ± 2.84, and 125.78 ± 6.44), respectively. Similarly, group C2 showed similar results, with values of (186.25±7.48, 128.33±8.78, 34.71±2.83, 25.66±2.52, and 125.86±6.15).

In contrast, individuals with hypertension (BMI > 30 kg/m^2) exhibited different lipid distributions. Statistical analyses indicated statistically significant differences (P<0.05) in lipid indices between the two hypertensive groups (H1 and H2) and the two healthy control groups. The values for group H1 were (174.5±14.27, 102.16±17.83, 37.35±5.50, 20.43±5.00, 116.71±19.03), while group H2 recorded the following values for the same indicators: (162.16±9.00, 116±14.57, 29.88±2.83, 23.2±6.91, 109.08±11.07). All values are presented as mean ± standard error.

Discussion

This study is an assessment that included measurement of body mass index (BMI), blood pressure (systolic and diastolic in mmHg), and a comprehensive lipid profile analysis, including Total Cholesterol, TG, HDL, LDL, and VLDL (mg/dL), and the impact of obesity and sex on these levels. The results of the current study show a clear positive correlation between hypertension and increased BMI. The increase in systolic and diastolic blood pressure values in the third H1 and fourth H2 patient groups, associated with a BMI exceeding 31, is statistically significant P< 0.05 (Yusni et al., 2024). This explains the complex physiological changes, such as increased peripheral vascular resistance and marked activation of the sympathetic nervous system. The fourth group H2 consisted of men with a high BMI and hypertension, reinforcing the hypothesis that obesity is a major contributing factor to the development of this chronic disease. Physiologically, the body requires increased cardiac output to support the excess weight associated with chronic low-grade inflammation, which reduces vascular elasticity and gradually promotes atherosclerosis (Zhang et al., 2025). All of this highlights the relationship between excess weight and blood pressure levels in this study, which aligns with previous international research conducted by Patel *et al*. (2025); Chaudhari *et al*. (2025) and Landi *et al*. (2018), these studies confirmed that BMI is the primary indicator of disease prevalence and progression across different age groups. This strong relationship persisted even after controlling for other variables such as gender and age. All of the above indicates that excess weight contributes significantly, effectively, and directly to the development of high blood pressure and is considered a major contributing factor among individuals.

The study results showed that the third group H1 had an average blood pressure of 15.83 in women with systolic hypertension, compared to the first group C1, who maintained normal blood pressure, which was 12.16 in healthy women, this was attributed to natural biological protection against fat accumulation, this advantage gradually diminishes with the onset of obesity, as compared to the patient groups, statistical analysis revealed no statistically significant differences P>0.05 between the sexes. This confirms that the physiological stress resulting from excess weight outweighs the importance of hormonal advantages specific to each sex, especially in individuals weighing over 30 kg/m^2. Therefore, the results confirm that exceeding the 30 BMI threshold represents a critical pathological turning point, leading to physiological changes that transcend normal biological differences. Furthermore, the sharp decrease in the levels of good cholesterol HDL in patients with high blood pressure, which is essential for the process of reverse osmosis and the protection of blood vessels, is a cause for concern and creates a favorable environment for hardening and narrowing of the arteries, which further complicates the health condition of those affected,

therefore, controlling lipid levels and weight is an urgent necessity to prevent the continued deterioration of blood vessels (Durrington et al., 2025).

The structural and immunological integrity of the intestine significantly affects overall physiology and cardiovascular health. The risk of vascular disease in this population depends on the quality of fat distribution in the body, specifically low levels of HDL cholesterol, and not just the total volume of blood fat. The study identified a body mass index of 30 kg/m^2 as a critical threshold; exceeding this threshold leads to a transition from normal ranges to pathological conditions, including hypertension and dyslipidemia (Kosami et al., 2024). Low HDL cholesterol is the main feature of the metabolic signature associated with obesity, making weight management crucial for restoring the metabolic stability necessary to protect the heart from various diseases. High body fat percentage is an independent risk factor for hypertension, consistent with scientific research linking visceral obesity to increased vascular resistance. Despite the complexity of the precise pathways, inflammatory mechanisms play a decisive role in this deterioration. Fat cells are highly active cells capable of secreting large quantities of pro-inflammatory cytokines that contribute to elevated blood pressure and organ damage. Hyperplasia of adipose tissue also leads to impaired secretion. Adipokines weaken the production of nitric oxide, which is very important for vasodilation and regulating the action of smooth muscles. Accordingly, a deficiency of nitric oxide is closely related to endothelial dysfunction and the development of chronic arterial hypertension, which necessitates intensive therapeutic and preventive intervention to reduce these serious health risks and ensure the maintenance of the integrity of the circulatory system and the balance of vital processes within the human body sustainably (Młynarska et al., 2025).

CONCLUSION

This study concluded that obesity is a major contributing factor to physiological disorders and hypertension. The results showed a strong association between high BMI and both types of hypertension (systolic and diastolic), confirming that the health risks of excess weight exceed natural hormonal protection in women. The study highlighted the deterioration of lipid levels, especially good cholesterol HDL, which increases the risk of heart disease. Therefore, the study recommended including weight management as a core component of treatment protocols, in addition to regular blood lipid profile testing, to prevent silent diseases such as atherosclerosis, particularly in obese individuals of both sexes, and to raise public awareness in general. The study also calls for expanding research into modern dietary interventions, such as intermittent fasting, to further support these health findings.

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