

Effect of Obesity on Hematological Parameters in Females from Babylon Province

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Abstract

Background: Obesity is a prevalent and significant health issue worldwide. In Iraq, the prevalence of overweight/obesity stands at 66.9%. It is more prevalent among women than men. Obesity can affect any system in the body, including hematological parameters. The pro-inflammatory state associated with obesity is reflected in the higher white blood cell (WBC) count observed in most obese individuals compared to those with normal weight. While the link with anemia remains less certain, obesity is associated with both higher platelet count and activity. **Objectives:** We evaluate the differences in hematological parameters based on complete blood counts among normal, overweight, and obese females in Babylon Province. **Materials and Methods:** This cross-sectional study involved 365 females from Babylon Province. After obtaining consent, their height and weight were measured at a private clinic, with blood samples collected for complete blood count assessment using a five-differential auto-analyzer. Body mass index (BMI) was calculated by dividing the weight in kilograms by the square of the height in meters. Based on BMI, participants were categorized into three groups: normal, overweight, and obese. **Results:** Among the participants, 105 had a normal BMI with a mean age of 26.6 ± 8.3 years and a mean BMI of $21.18 \pm 1.25 \text{ kg/m}^2$. Additionally, 125 were overweight with a mean age of 24.5 ± 5.3 years and a mean BMI of $23.8 \pm 0.47 \text{ kg/m}^2$. Furthermore, 135 were obese, with a mean age of 29 ± 5.3 years and a mean BMI of $29.85 \pm 5.34 \text{ kg/m}^2$. There were significant differences in WBC; $P = 0.02$ and absolute neutrophils count (ANC; $P = 0.03$) among the three groups, as well as in WBC ($P = 0.01$) and ANC ($P = 0.01$) between the obese and normal groups. Additionally, differences were observed in neutrophils/lymphocytes (N/L) ratio ($P = 0.05$) and platelet count ($P = 0.04$) between the overweight and normal groups. No significant differences were found in other parameters. **Conclusion:** Obesity exerts a significant impact on different body tissues, including the blood. Our study revealed that obesity is associated with a significant change in WBC, ANC, N/L ratio, and platelet count among different BMI groups of females in Babylon Province while showing no discernible effect on red blood cells and other platelet parameters.

Keywords: BMI, hematological consequences, obesity

INTRODUCTION

For a considerable period, obesity has remained one of the major health issues worldwide. It affects more than one billion individuals worldwide, as reported by the World Health Organization (WHO), with this number continuing to rise.^[1] Obesity can influence any organ or system in the body, leading to numerous diseases and health implications. Its onset may stem from a complex interplay of genetic, socioeconomic, and cultural factors, including pharmacological, pathological, and lifestyle influences.^[2]

The WHO defines obesity as a condition of excessive adiposity, which can be assessed using the body mass index (BMI).^[1] BMI is a measurement that relates weight to height. It is calculated by dividing the weight in kilograms by the square of the height in meters.^[1,3] It is now used to categorize individuals into underweight, normal weight,

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overweight, and obese categories. This classification is endorsed by both the National Institute of Health and the WHO. However, it should be noted that BMI thresholds may vary between Asian and non-Asian populations [Table 1].^[4]

Numerous complications are associated with obesity, including hypertension, type 2 diabetes mellitus, fatty liver diseases, obstructive sleep apnea, and impaired quality of life.^[6] One of the most significant implications of obesity is the alteration of hematological parameters, including white blood cells (WBCs), hemoglobin, and platelet parameters. The pro-inflammatory state of obesity reflects the cause behind the fact that most obese people have higher WBC counts than the normal population.^[7] While the link with anemia remains less certain due to limited studies, obesity is associated with both a higher platelet count and increased platelet activity.^[7]

Neutrophilic leukocytosis is associated with obesity, often accompanied by elevated acute phase reactant proteins, further indicating its relation with chronic inflammation. Additionally, lymphocyte levels were observed to be elevated in obese females, albeit not to the same extent as neutrophil elevation. This discrepancy may be explained by the dominant role of neutrophils in the inflammatory process.^[7] While the link with anemia remains less certain due to limited studies, some research suggests an association with disturbed iron metabolism due to high hepcidin levels, in addition to the tendency of obese individuals to consume diets low in iron.^[8] Obesity is also associated with both a higher platelet count and increased platelet activity.^[7] This may be explained by the expression of leptin receptors on the platelet surface, which can induce platelet aggregation.^[9]

Obesity is more prevalent in women than in men in many countries, primarily due to gender-related influences, such as societal ideas about body weight and parental feeding practices, as well as sex-related influences, such as body composition and hormones.^[10]

Traditionally, obesity was one of the major problems in Western countries. However, in the past two decades, urbanization in many Asian countries has led to a sedentary lifestyle and overnutrition, resulting in an increased incidence of obesity.^[11]

In Iraq, the prevalence of overweight/obesity was found to be 66.9%, and it has risen at an alarming rate, particularly among females. According to the Ministry of Health, the prevalence among reproductive-aged women is 38.2%.^[12]

In this study, we evaluated the differences in hematological parameters, including red blood cells (RBCs), WBCs, and platelets parameters, focusing on total leukocyte counts, ANC), neutrophils/lymphocytes (N/L) ratio, platelet count, and mean platelet volume (MPV) among normal, overweight, and obese females in Babylon Province. These groups were classified based on their BMI levels, and their complete blood counts were compared.

MATERIALS AND METHODS

This cross-sectional study was conducted over 2 months from the beginning of January to the end of February 2024, in private clinics, involving 365 female participants from Babylon Province. The sample size was determined according to Fisher's formula, considering the prevalence of obesity in women to be 38.2%.^[12] After obtaining consent, data were collected by measuring the participant's height and weight in private clinics. Blood samples were collected for complete blood count assessment using a five-differential hematology auto-analyzer (Mindray BC-5000, China). Body mass index (BMI) was calculated by dividing the weight in kilograms by the square of the height in meters, and participants were categorized into three groups based on their BMI: normal, overweight, and obese.

After obtaining consent, data were collected by measuring the participant's height and weight in a private clinic, and blood samples were taken for analysis.

Inclusion and exclusion criteria

All females of childbearing age were eligible for inclusion in this study, with the exception of pregnant women and individuals with a personal history of hematological disease or a family history of inherited hematological disease.

Statistical analysis

Comparison between the three groups was conducted using the Analysis of Variance single-factor test. Additionally, we compared the obese and normal BMI groups, as well as the overweight and normal groups, using the *t* test. The analysis was performed using the Statistical Package for the Social Sciences software program, version 20.0 (IBM, Armonk, NY, USA). A *P* value of ≤ 0.05 was considered statistically significant.

Ethical approval

This study was approved by the Research Ethics Committee at Hammurabi College of Medicine under Document No. 1123 on January 2, 2024.

Table 1: BMI classification according to WHO^[5]

BMI description	Non-Asian	Asian
Underweight	<18.5	<18.5
Normal weight	18.5–24.9	18.5–22.9
Overweight	25–29.9	23–24.9
Obese	>30	>25

RESULTS

The average age of the participants was 26.7 years. One hundred five of the participants were found to have a normal BMI, with a mean age of 26.6 ± 8.3 years and a mean BMI of $21.18 \pm 1.25 \text{ kg/m}^2$. One hundred twenty-five participants were classified as overweight, with a mean age of 24.5 ± 5.3 years and a mean BMI of $23.8 \pm 0.47 \text{ kg/m}^2$. One hundred thirty-five participants were classified as obese, with a mean age of 29 ± 5.3 years and a mean BMI of $29.85 \pm 5.34 \text{ kg/m}^2$.

Regarding hematological parameters, there is a significant difference between the three groups in the mean WBC count: $6.9 \times 10^9 \pm 2.22$ for normal, $7.65 \times 10^9 \pm 2.13$ for overweight, $8.9 \times 10^9 \pm 2.88$ for obese, with a *P* value of 0.02. Similarly, there is a significant difference in the

mean neutrophil count: $4.07 \times 10^9 \pm 1.78$ for normal, $4.80 \times 10^9 \pm 1.80$ for overweight, $5.49 \times 10^9 \pm 2$ for obese, and with a *P* value of 0.03. However, the other parameters show non-significant differences, as shown in Table 2.

Comparison of obese females to those with normal BMI revealed a significant difference in mean WBC count with a *P* value of 0.01 and mean neutrophil count with a *P* value of 0.01. However, the other parameters show non-significant differences, as shown in Table 3.

The comparison between overweight females and those with normal BMI showed a significant difference in mean neutrophil/lymphocyte ratio, with values of 1.92 ± 0.9 for normal and 2.59 ± 1.3 for overweight and a *P* value of 0.05. Additionally, there was a significant difference in

Table 2: Overall data of the participants

Parameters	Normal	Overweight	Obese	<i>P</i> value
Number	105 (28.8%)	125 (34.2%)	135 (37%)	
Age (mean $\pm$ SD)	26.6 ± 8.3 years	24.5 ± 5.3 years	29 ± 5.3 years	
BMI (mean $\pm$ SD)	$21.18 \pm 1.25 \text{ kg/m}^2$	$23.8 \pm 0.47 \text{ kg/m}^2$	$29.85 \pm 5.34 \text{ kg/m}^2$	
WBC (mean $\pm$ SD)	$6.9 \times 10^9 \pm 2.22$	$7.65 \times 10^9 \pm 2.13$	$8.9 \times 10^9 \pm 2.88$	0.02
Neutrophil (ANC) (mean $\pm$ SD)	$4.07 \times 10^9 \pm 1.78$	$4.80 \times 10^9 \pm 1.80$	$5.49 \times 10^9 \pm 2$	0.03
Lymphocyte (mean $\pm$ SD)	$2.20 \times 10^9 \pm 0.56$	$2.16 \times 10^9 \pm 0.58$	$2.75 \times 10^9 \pm 1.53$	0.08
Neutrophil/lymphocyte (N/L) ratio (mean $\pm$ SD)	1.92 ± 0.9	2.59 ± 1.3	2.37 ± 1.3	0.31
Hb (mean $\pm$ SD)	$11.8 \pm 1.38 \text{ g/dl}$	$11.9 \pm 1.23 \text{ g/dl}$	$12.4 \pm 1.4 \text{ g/dl}$	0.21
MCV (mean $\pm$ SD)	$81.5 \pm 8.14 \text{ fl}$	$80.44 \pm 8.84 \text{ fl}$	$80.88 \pm 7.55 \text{ fl}$	0.9
MCH (mean $\pm$ SD)	$26.5 \pm 2.88 \text{ pg}$	$26.25 \pm 3.17 \text{ pg}$	$27.03 \pm 2.93 \text{ pg}$	0.6
RDW (mean $\pm$ SD)	13.65 ± 2.1	14.03 ± 1.8	14.21 ± 2.4	0.65
Platelet (mean $\pm$ SD)	$232.5 \times 10^9 \pm 72.74$	$300.3 \times 10^9 \pm 134.62$	$278.7 \times 10^9 \pm 116.2$	0.12
MPV (mean $\pm$ SD)	10.2 ± 1.18	9.7 ± 0.93	9.8 ± 1.05	0.25
PDW-CV (mean $\pm$ SD)	15.6 ± 0.75	15.4 ± 1.23	15.5 ± 1.18	0.84
Platelet/lymphocyte (P/L) ratio (mean $\pm$ SD)	110.4 ± 40.88	140.8 ± 65	115.3 ± 53.55	0.12

Bold value indicates significance

Table 3: Comparison between normal and obese females

Parameters	Normal	Obese	<i>P</i> value
Number	105 (28.8%)	135 (37%)	0.22
Age (mean $\pm$ SD)	26.6 ± 8.3 years	29 ± 5.3 years	0.22
BMI (mean $\pm$ SD)	$21.18 \pm 1.25 \text{ kg/m}^2$	$29.85 \pm 5.34 \text{ kg/m}^2$	0.0001
WBC (mean $\pm$ SD)	$6.9 \times 10^9 \pm 2.22$	$8.9 \times 10^9 \pm 2.88$	0.01
Neutrophil (ANC) (mean $\pm$ SD)	$4.07 \times 10^9 \pm 1.78$	$5.49 \times 10^9 \pm 2$	0.01
Lymphocyte (mean $\pm$ SD)	$2.20 \times 10^9 \pm 0.56$	$2.75 \times 10^9 \pm 1.53$	0.13
Neutrophil/lymphocyte (N/L) ratio (mean $\pm$ SD)	1.92 ± 0.9	2.37 ± 1.3	0.18
Hb (mean $\pm$ SD)	$11.8 \pm 1.38 \text{ g/dl}$	$12.4 \pm 1.4 \text{ g/dl}$	0.14
MCV (mean $\pm$ SD)	$81.5 \pm 8.14 \text{ fl}$	$80.88 \pm 7.55 \text{ fl}$	0.8
MCH (mean $\pm$ SD)	$26.5 \pm 2.88 \text{ pg}$	$27.03 \pm 2.93 \text{ pg}$	0.55
RDW (mean $\pm$ SD)	13.65 ± 2.1	14.21 ± 2.4	0.40
Platelet (mean $\pm$ SD)	$232.5 \times 10^9 \pm 72.74$	$278.7 \times 10^9 \pm 116.2$	0.11
MPV (mean $\pm$ SD)	10.2 ± 1.18	9.8 ± 1.05	0.21
PDW-CV (mean $\pm$ SD)	15.6 ± 0.75	15.5 ± 1.18	0.7
Platelet/lymphocyte (P/L) ratio (mean $\pm$ SD)	110.4 ± 40.88	115.3 ± 53.55	0.7

Bold value indicates significance

Table 4: Comparison between normal and overweight females

Parameters	Normal	Overweight	P value
Number	105 (28.8%)	125 (34.2%)	0.4
Age (mean $\pm$ SD)	26.6 $\pm$ 8.3 years	24.5 $\pm$ 5.3 years	0.3
BMI (mean $\pm$ SD)	21.18 $\pm$ 1.25 kg/m ²	23.8 $\pm$ 0.47 kg/m ²	0.0001
WBC (mean $\pm$ SD)	6.9 $\times 10^9 \pm$ 2.22	7.65 $\times 10^9 \pm$ 2.13	0.25
Neutrophil (ANC) (mean $\pm$ SD)	4.07 $\times 10^9 \pm$ 1.78	4.80 $\times 10^9 \pm$ 1.80	0.17
Lymphocyte (mean $\pm$ SD)	2.20 $\times 10^9 \pm$ 0.56	2.16 $\times 10^9 \pm$ 0.58	0.82
Neutrophil/lymphocyte (N/L) ratio (mean $\pm$ SD)	1.92 $\pm$ 0.9	2.59 $\pm$ 1.3	0.05
Hb (mean $\pm$ SD)	11.8 $\pm$ 1.38 g/dl	11.9 $\pm$ 1.23 g/dl	0.85
MCV (mean $\pm$ SD)	81.5 $\pm$ 8.14 fl	80.44 $\pm$ 8.84 fl	0.68
MCH (mean $\pm$ SD)	26.5 $\pm$ 2.88 pg	26.25 $\pm$ 3.17 pg	0.76
RDW (mean $\pm$ SD)	13.65 $\pm$ 2.1	14.03 $\pm$ 1.8	0.51
Platelet (mean $\pm$ SD)	232.5 $\times 10^9 \pm$ 72.74	300.3 $\times 10^9 \pm$ 134.62	0.04
MPV (mean $\pm$ SD)	10.2 $\pm$ 1.18	9.7 $\pm$ 0.93	0.12
PDW-CV (mean $\pm$ SD)	15.6 $\pm$ 0.75	15.4 $\pm$ 1.23	0.5
Platelet/lymphocyte (P/L) ratio (mean $\pm$ SD)	110.4 $\pm$ 40.88	140.8 $\pm$ 65	0.07

Bold value indicates significance

mean platelet count, with values of $232.5 \times 10^9 + 72.74$ for normal and $300.3 \times 10^9 + 134.62$ for overweight, and a *P* value of 0.04. However, the other parameters showed non-significant differences, as shown in Table 4.

DISCUSSION

Obesity represents a significant health problem in Iraq, including the Babylon Governorate. This study evaluates the effect of obesity on the hematological parameters in female participants. It revealed a significantly higher WBC and neutrophil count in overweight and obese females, along with a significantly higher N/L ratio and platelet count between normal and overweight females. However, no significant differences were observed in other parameters. A study conducted at the Sourasky Medical Center revealed that obesity is associated with both leukocytosis and neutrophilia, especially in female patients.^[13] In Saudi Arabia, two studies evaluating hematological parameters in obese individuals found a significant correlation between obesity and both WBC and ANC, as well as hemoglobin levels, without gender differences.^[14,15] Additionally, similar results were obtained from two studies. One conducted in Turkey, Istanbul, also showed that obese individuals had significantly affected lymphocytes and platelet counts, as well as PDW.^[16] The other study, conducted in Kuwait, evaluated the effect of morbid obesity on hematological parameters before and after bariatric surgery.^[8] An Indian study revealed a significant correlation between obesity and WBC count, with no significant change in hemoglobin levels. However, this study included both male and female participants.^[17] A study by Leila *et al.* at Islamic Azad University revealed nearly average WBC and platelet counts, with significant differences observed in WBC and platelet counts in both overweight and obese females, suggesting an inflammatory cause for

this association.^[18] Another study conducted in the USA found that overweight and obese females have higher WBC and lymphocyte counts than normal individuals, suggesting a role in the production of leptin from adipose tissue.^[19] Samocha-Bonet *et al.*'s study showed a significantly higher platelet count in obese and overweight females compared to those with normal weight, without significant changes in other platelet parameters. This was explained by the effect of certain cytokines like IL6 on promoting megakaryocytopoiesis.^[9] In a study conducted by Haidari *et al.*, there was a significant correlation between obesity and low hemoglobin levels, explained by the increasing incidence of iron deficiency anemia in obese individuals.^[20] In a Korean study, it was found that obesity had a significant correlation with changes in WBC, hemoglobin, and platelet counts in adolescent girls, which may reflect their predisposition to have obesity-related diseases.^[21] Finally, in Southern Nigeria, a study revealed a significant correlation between obesity and N/L ratio, with no difference in hemoglobin, total WBC count, neutrophil and lymphocyte counts, as well as all platelet parameters, including platelet count, MPV, and platelet distribution width.^[22]

CONCLUSION

Obesity remains one of the most common and dangerous health problems worldwide, especially in Arabic countries. It significantly affects various body tissues, including the blood. Our study revealed that obesity is associated with significant changes in WBC, ANC, N/L ratio, and platelet count in different BMI groups of females in Babylon Province, without any effect on RBC and other platelet parameters. Therefore, careful attention should be given to interpreting the hematological profile of obese patients to avoid incorrect medical diagnoses.

STRENGTH AND LIMITATIONS

The strength point of this study lies in its evaluation of young obese females concerning various hematological parameters, including all RBC, WBC, and platelet parameters, using an auto-analyzer that is widely available and can serve as a predictor of obesity-related complications. However, it is recommended that a more significant number of participants, including both men and women from different provinces, be included to evaluate this subject. Additionally, measuring additional obesity determinant parameters such as wrist-hip ratio could provide a clearer understanding of the effect of obesity on hematological parameters.

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Conflicts of interest

There are no conflicts of interest.

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