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ASSOCIATION OF ANEMIA WITH BODY MASS INDEX

Muhammad Farooq[1], Ushna Ayub Butt[2], Zuha Salman[3], Samman Mehmood[4], Tanzeela Iqbal[5]

[1] Professor of Medicine, Department of Medicine, Rahbar Medical and Dental College / Punjab Rangers Teaching Hospital, Pakistan .Email: mfmalikdr@gmail.com
[2] House Officer, Department of Medicine, Rahbar Medical and Dental College / Punjab Rangers Teaching Hospital, Pakistan. Email: ushnaaabutt@gmail.com
[3] House Officer, Department of Medicine, Rahbar Medical and Dental College / Punjab Rangers Teaching Hospital, Pakistan .Email: zuhachaudhary@gmail.com
[4] House Officer, Department of Medicine, Rahbar Medical and Dental College / Punjab Rangers Teaching Hospital, Pakistan .Email: samanmehmood0925@gmail.com
[5] House Officer, Department of Medicine, Rahbar Medical and Dental College / Punjab Rangers Teaching Hospital, Pakistan .Email: tanzeelaiqbal444@gmail.com

ABSTRACT

Objective: To find out the association between anaemia and Body Mass Index (BMI) and determine how age, marital status, and anaemia-related fatigue in females are linked to BMI.

Study Design: It is a descriptive cross-sectional study.

Place and duration of study: It was conducted from May 2025 to November 2025, at Punjab Rangers Teaching Hospital, Lahore, Pakistan.

Methodology: In this study, convenience sampling was used to select 380 females aged 12 years and above. Data were gathered using a predesigned questionnaire and laboratory assessment. BMI was grouped into low, normal and high classes after calculating it from height and weight measurements. Likewise, anemia was categorised into microcytic hypochromic and normocytic normochromic subtypes based on MCV and MCHC values. $P < 0.05$ was considered statistically significant using chi-square test. SPSS version 27 was used for analysis at a 95% confidence level.

Results: Our findings established that anaemia and high BMI are correlated ($p = 0.007$) with microcytic hypochromic type appearing more among 68.5% (n=169) of obese participants. Similarly, age, marital status, and anemia-related fatigue were strongly linked to higher BMI group ($p < 0.001$). Both age groups (more than 40 and 58.3%, n=172 individuals under 40 years) comprised of greater BMI. Additionally, elevated BMI status was also seen among 79.2% (n=243) of participants who experienced anemia-related fatigue and 85.9% (n=219) of married females.

Conclusion: This study emphasised an important research gap within Pakistan that demands the formation of customized health and clinical initiatives by demonstrating a substantial relationship between anaemia and high BMI.

KEYWORDS: anemia, Body Mass Index, obesity, female health, Pakistan

INTRODUCTION

Two common health issues that are becoming more broadly known for their possible links and contribution to disease burden and fatality globally are obesity and anaemia.[1] Anaemia is defined by reduced red blood cell counts and/or haemoglobin levels below 12 g/dL in women and below 13 g/dL in men, resulting in impaired oxygen transport which compromises the fulfilment of physiological demands of the body and leads to the development of diverse clinical features ranging from fatigue to cognitive dysfunction.[2] Obesity, marked by excessive body fat, disrupts iron metabolism via a cascade of mechanisms specifically the adipocyte-induced release of interleukin-6 (IL-6), provoking hepcidin secretion and impairing iron absorption and distribution, leading to the development of anaemia.[3,4]

Body mass index (BMI), a widely used anthropometric indicator calculated from weight and height, is employed as one of the best markers by the World Health Organisation (WHO) to classify obesity.[5] Five categories were taken for BMI according to the Asia-Pacific classification: underweight (<18.5 kg/m^2), normal weight (18.5–22.9 kg/m^2), overweight (23.0–24.9 kg/m^2), obesity type I (25.0–29.9 kg/m^2), and obesity type II (≥30.0 kg/m^2).[6] Although an increasing number of studies link obesity to anaemia, the findings remain inconsistent. Some report a positive association, while others present contradictory or no significant bond between these variables.

Within Pakistan, data examining the relationship between anaemia and BMI remains limited and inconsistent. For instance, a study in Karachi found a lower prevalence of anaemia among overweight girls, whereas research in Kharian, Pakistan, reported a non-significant positive correlation between them.[7,8] Furthermore, international studies also demonstrated diverse patterns, emphasising the need for tailored research.

Thus far, there is currently a lack of studies explicitly addressing this connection within Lahore, Pakistan. Given the varied evidence and lack of localised data, this study seeks to investigate the relationship of anaemia with BMI

by evaluating the kinds of anaemia frequent across different BMI groups and examining how BMI relates to key demographic and clinical variables, specifically age, marital status and anaemia-related fatigue, aiming to enhance understanding of a complex clinical query. Accordingly, the key research question is: Is anaemia associated with BMI?

METHODOLOGY

This was a cross-sectional descriptive study undertaken at Punjab Rangers Teaching Hospital (PRTH), Lahore, Punjab, Pakistan, from May 2025 to November 2025 after approval from the Ethical Committee at PRTH under the approval number (Ref. No: 80/2025, Dated 13 May 2025). The targeted sample size was calculated to be approximately 363 participants based on the following formula : $n = Z^2_{1-\alpha/2}\ p^\wedge\ (1-p^\wedge)/e^2$, with a confidence level determined as 95.0% ($Z_{1-\alpha/2} = 1.96$), a margin of error of 5% (e = 0.05) and an estimated population proportion of 38.4% (p = 0.384).[9] With the use of a convenience sampling technique, 380 female participants were recruited. **Inclusion criteria**: Females aged 12 years or above and who provided consent to take part in the study were included. **Exclusion criteria**: Women who had chronic diseases, such as diabetes or hypertension, along with hepatic, renal and haematological disorders, were excluded. Moreover, those who refused to provide their consent or indicated that they were unwilling to participate, as well as pregnant females, were not included in this study. Every participant, after giving their informed agreement, received a comprehensive description of the study's purposes, a guarantee that their information would be treated with the utmost confidentiality and anonymity, along with the freedom to withdraw from the study at any time without facing any fine. Furthermore, a predesigned questionnaire was used to collect and document sociodemographic and clinical data, such as gender, age, height, weight, medical history, and laboratory results.

According to the World Health Organisation (WHO), anaemia was defined in this study as having haemoglobin levels below 12 g/dL.[10] Individuals had their blood samples taken with the assessment of the blood indicators by complete blood count (CBC) where haemoglobin (g/dL), platelet count ($\times 10^9$/L), white blood cell count ($\times 10^9$/L, WBC), mean corpuscular haemoglobin concentration (f, MCHC), and mean cell volume (f, MCV) were measured. According to the records of the Department of Pathology at Punjab Rangers Teaching Hospital, Lahore, Pakistan, anaemia was categorised as microcytic hypochromic (MCV < 83, MCHC < 31), normocytic normochromic (MCV 83–101, MCHC 31–34), and macrocytic hypochromic (MCV > 101, MCHC < 34) based on MCV and MCHC values.

BMI was calculated using the formula: kg/m^2 where weight (kg) was divided by height squared (m^2) and grouped according to the Asia-Pacific guidelines into five classes as established by WHO: underweight (<18.5 kg/m^2), normal weight (18.5–22.9 kg/m^2), overweight (23.0–24.9 kg/m^2), obesity type I (25.0–29.9 kg/m^2), and obesity type II (≥30.0 kg/m^2).[6] For analytical purposes, these classifications were further consolidated into three broader groups of BMI as low (<18.5 kg/m^2), normal (18.5–22.9 kg/m^2) and high (≥ 23.0 kg/m^2), encompassing those categorized as overweight, obesity type I, and obesity type II.

Data were analysed using the Statistical Package for Social Science (SPSS) program version 27. Mean ± SD was used to describe quantitative data. The chi-square test was performed to compare qualitative data for this study. P < 0.05 was considered statistically significant.

RESULTS

A total of 380 participants who were female and aged 12 years and above were selected for this study. BMI was grouped into low (<18.5 kg/m^2), normal (18.5–22.9 kg/m^2) and high (≥ 23.0 kg/m^2), with 24 (6.3%), 99 (26.1%) and 257 (67.6%) individuals presenting in low, normal and high BMI groups, respectively. Anaemia was categorised into microcytic hypochromic, normocytic normochromic and macrocytic hypochromic types based on MCV and MCHC levels. Since none of the subjects developed macrocytic hypochromic anaemia, there were only two groups that were included in the data: microcytic hypochromic anaemia and normocytic normochromic anaemia. The mean BMI was 24.27 ± 3.68, anaemia 10.80 ± 1.08 g/dL, age 32.63 ± 12.41 years, and anaemia-related fatigue 0.81 ± 0.39. Within both the low and high BMI categories, microcytic hypochromic anaemia was the predominant type as compared to normocytic normochromic anaemia. In contrast, the normal BMI group showed that 47.5% of the individuals (n = 47) had the microcytic type, while 52.5% (n = 52) had normocytic normochromic anaemia (p = 0.007, $\chi^2 = 10.055$), as illustrated in Figure I. Further stratification of BMI categories based on the Asia-Pacific Classification revealed notable variations in anaemia types. Among 35.8% (n = 136) of the individuals classified as obesity type I, a significant proportion of 62.5% (n = 85) presented with microcytic hypochromic anaemia, while 37.5% (n = 51) exhibited normocytic normochromic anaemia. In the underweight group 6.3% (n = 24), microcytic hypochromic anaemia was observed in 62.5% (n = 15) of participants, whereas 37.5% (n = 9) had the normocytic normochromic type. Among those with normal weight 26.1% (n = 99), 47.5% (n = 47) had the microcytic hypochromic type and 52.5% (n = 52) had normocytic normochromic anaemia. In the overweight category 26.6% (n = 101), microcytic anaemia was predominant, affecting 67.3% (n = 68), while 32.7% (n = 33) showed normocytic normochromic anaemia. Lastly, in 5.3% (n = 20) of the individuals with obesity type II, microcytic anaemia was markedly prevalent at 80.0% (n = 16), with only 20.0% (n = 4) showing the normocytic normochromic type (p = 0.014, $\chi^2 = 12.467$).

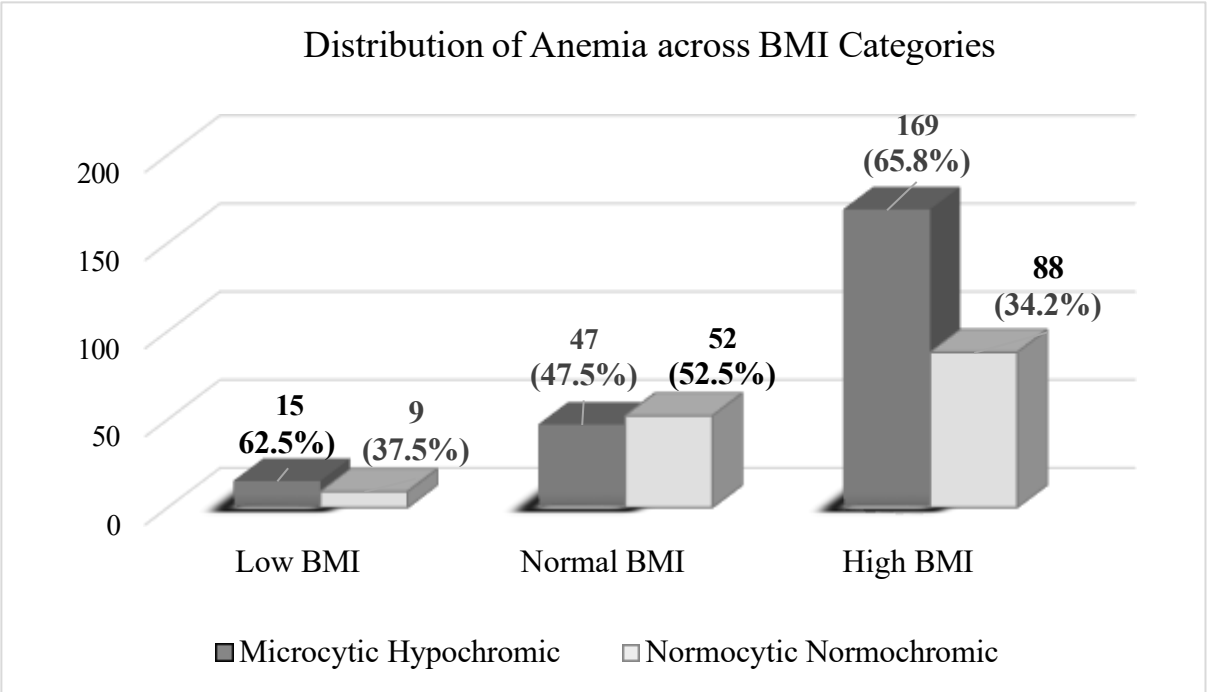

Figure I: Distribution of Anaemia across BMI categories

Among individuals under 40 years 77.6% (n = 295), BMI distribution revealed 8.1% (n = 24) had a low BMI, 33.6% (n = 99) had normal BMI and a majority 58.3% (n = 172) were classified as having high BMI. Notably, all individuals aged over 40, 22.4% (n = 85) fell exclusively within the high BMI category (χ^2 = 52.403). Additionally, among the 32.9% (n = 125) of individuals who were unmarried, 30.4% (n = 38) had a high BMI while 52.0% (n = 65) had normal and 17.6% (n = 22) had a low BMI. However, among married individuals 67.1% (n = 255), only 0.8% (n = 2) were in the low BMI category, 13.3% (n = 34) had a normal BMI, while 85.9% (n = 219) showed a high BMI pattern (χ^2 = 123.872). Regarding anaemia-related fatigue, individuals who did not report fatigue 19.2% (n = 73), showed 13.7% (n = 10) in the low BMI group, 67.1% (n = 49) in normal BMI category and only 19.2% (n = 14) classified as having high BMI. Conversely, participants who reported fatigue 80.8% (n = 307) were predominantly in the high BMI group 79.2% (n = 243), compared to only 4.6% (n = 14) with low BMI and 16.2% (n = 50) showing the normal distribution (χ^2 = 97.668). All these parameters were statistically significant ($p < 0.001$), as shown in Table I.

Table I: Comparative Distribution of Anaemia, Age, Marital Status and Fatigue according to BMI Groups.

Characteristics	**n (%)**	**Study Groups**			**ρ-value**
Anaemia		**Group A (Low BMI)**	**Group B (Normal BMI)**	**Group C (High BMI)**	
Microcytic Hypochromic	231 (60.8)	15 (62.5)	47 (47.5)	169 (65.8)	0.007*
Normocytic Normochromic	149 (39.2)	9 (37.5)	52 (52.5)	88 (34.2)	
Age					
Less than 40	295 (77.6)	24 (8.1)	99 (33.6)	172 (58.3)	<0.001*
More than 40	85 (22.4)	0 (0.0)	0 (0.0)	85 (22.4)	
Marital Status					
Unmarried	125 (32.9)	22 (17.6)	65 (52.0)	38 (30.4)	<0.001*
Married	255 (67.1)	2 (0.8)	34 (13.3)	219 (85.9)	
Anaemia-related fatigue					
No	73 (19.2)	10 (13.7)	49 (67.1)	14 (19.2)	<0.001*
Yes	307 (80.8)	14 (4.6)	50 (16.2)	243 (79.2)	

*Chi-square test was used for comparison, *A p-value less than 0.05 was considered statistically significant.

DISCUSSION

To the best of our knowledge, research exploring the relationship between anaemia and BMI within the Lahore population remains scarce, and no prior studies have specifically focused on this subject at Punjab Rangers Teaching Hospital. Therefore, the primary objective of this study was to find out the association between anaemia and BMI among all females aged 12 years and above at PRTH, guided by the hypothesis that anaemia is more prevalent among individuals with a high BMI. The secondary aim was to evaluate the relationship of BMI with sociodemographic and clinical variables, specifically age, marital status, and anaemia-related fatigue. According to our findings, a significant proportion of 65.8% (n=169) individuals with high BMI exhibited microcytic hypochromic anaemia, while 88 (34.2%) had normocytic normochromic anaemia. The findings of this research were consistent with a recent study carried out in Saudi Arabia, which found that 38.5% of overweight individuals had anemia, notably higher than that seen in participants of normal weight.[11] In a related study, anaemia was present in 33.1% of female students, with noticeably higher rates among those with elevated BMI values.[12] Likewise, 23.2% of the population reported a coexistence of anaemia among overweight individuals in Karnataka.[13]

In contrast, our findings diverge from other regional studies due to their inconsistent trends. For instance, research conducted at the University of Karachi reported decreased prevalence of anaemia among overweight students.[7] Similarly, obese women exhibited a lower frequency of anaemia in another research.[14] In line with these results, a Myanmar-based study also showed that anemia was more prevalent among underweight women as compared to the obese group.[15] A different study conducted in Pakistan among medical students at CMH, Kharian, revealed an insignificant relationship between them.[8] Correspondingly, research from Derna City, Libya, found no substantial relationship.[16] Likewise, a subsequent study in the US revealed that anaemia had no association with obesity among women.[17]

Our study demonstrated a statistically significant relationship of BMI with age, marital status and anaemia related fatigue. Based on the analysis, 172 (58.3%), < 40 years and 85 (22.4%), > 40 years of individuals had a high BMI. According to a US-based study, age and weight gain were significantly associated with an inverse relationship suggesting that the highest rates of weight gain were observed in young adults, gradually declining with each decade of age.[18] A notably high BMI was found in 85.9% (n=219) of married women in the present study, underscoring a significant association. This pattern was supported by a recent meta-analysis indicating that obesity is 88% more prevalent among married individuals.[19] However, there was a higher frequency of single individuals among the underweight category as compared to those who were married, according to a Korean study. [20] Our results demonstrated anaemia-related fatigue occurring more among 79.2% (n=243) of individuals with greater BMI, which was consistent with an Indian study that documented a notable link between fatigue and BMI.[21]

There were a few limitations in this study that affected our results, including difficulty in data collection, a sample containing only female participants, application of convenience sampling technique that generalised the findings and omission of biochemical profiling (serum iron, ferritin and transferrin) due to lack of resources. Nevertheless, our results addressed an important research gap in Pakistan by establishing a substantial link between anaemia and high BMI. Amid limited studies within Pakistan, there is a necessity for future investigations and the formation of tailored public health and clinical initiatives by using longitudinal approaches and integrating biochemical assessment.

CONCLUSION

Obese participants showed a frequent trend of microcytic hypochromic anemia according to our findings indicating a prominent correlation between elevated BMI status and anaemia. Demographic and clinical factors further strengthened their relationship. Due to limited regional data on this topic, our results underscore the necessity for future investigations and tailored public health initiatives.

Ethical Approval:
This study was carried out after acquiring ethical approval from the Ethical Committee of Punjab Rangers Teaching Hospital, Lahore, prior to the initiation of the study under the approval number Ref. No: 80/2025, Dated: 13 May 2025.

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Competing Interest:
The authors declared no conflict of interest.

Author's Contribution:

1. Muhmmad Farooq: Concept and design, analysis of data, drafting of the manuscript, critical review and supervision
2. Ushna Ayub Butt: Concept and design, data collection, analysis of data, drafting of the manuscript, critical review
3. Zuha Salman: Data collection, analysis of data, drafting of the manuscript, critical review

4. Samman Mehmood: Data collection, analysis of data, drafting of the manuscript, critical review
5. Tanzeela Iqbal: Data collection, analysis of data, drafting of the manuscript, critical review
All authors take full accountability for the content of the work and commit to addressing any issues related to its accuracy or integrity through proper investigation and resolution.

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