Journal of Asthma and Allergy

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

The Associations of Anaemia Status and Body Mass Index with Asthma Severity in Saudi Arabia: A Comparative Study

Alaa A Bugis[1–3], Bussma Bugis[4], Abdulsalam Alzahrani[1–3], Ali Hasan Alamri[1–3], Hamad Hani Almalki[1–3], Jamal Hassan Alshehri[1–3], Abdullah Ali Alqarni[1–3], Faisal A Turkestani[1–3,5]

[1]Respiratory Therapy Program, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia; [2]Research Office, King Abdullah International Medical Research Center, Jeddah, Saudi Arabia; [3]Respiratory Therapy Department, Ministry of National Guard Health Affairs- King Abdulaziz Medical City, Jeddah, Saudi Arabia; [4]Department of Public Health, College of Health Sciences, Saudi Electronic University, Dammam, Saudi Arabia; [5]Echo Cardiovascular Technology Department, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia

Correspondence: Faisal A Turkestani, Respiratory Therapy Program, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, P.O. Box 9515, Jeddah, 21423, Saudi Arabia, Tel +966122246134, Email turkestanif@ksau-hs.edu.sa

Purpose: This study aimed to investigate the associations of anaemia status and body mass index (BMI) with asthma severity in adult subjects.

Methods: The study included 300 adults who had asthma and admitted to King Abdulaziz Medical City from about 2017 to 2022. The subjects' demographic data, BMI, anaemia status, and number of asthma-related hospital admissions were analyzed. Associations between anaemia, BMI, and asthma severity were investigated within a cross-sectional comparative design. Anaemia status as well as BMI variations may have an impact on the frequency of asthma-related hospitalizations.

Results: Most subjects in the study were female (74.3%) and over the age of 65. Mild anaemia was the most common condition (41.7%), and (42.3%) of subjects were classified as obese and (22.7%) were overweight. Age was found to be a significant factor in asthma-related hospital admissions (p-value = 0.0002), however sex was not significant. Subjects with mild or moderate anaemia and those who were obese had a higher frequency of asthma-related hospital admissions. Furthermore, the study revealed significant differences in the mean number of asthma-related hospital admissions among the different BMI and anaemia status categories. Subjects with severe obesity had a significantly greater number of asthma-related hospital admissions with a mean of 2.21 compared with the other BMI groups (p-value= 0.029). Subjects with mild anaemia had a significantly greater number of asthma-related hospital admissions with a mean of 2.07 than those with severe anaemia (p-value=0.04). These results highlight the importance of considering comorbid conditions in the clinical assessment and management of asthma.

Conclusion: These findings highlight that anemia and BMI abnormalities can complicate asthma management. Health care professionals should be aware of these factors when assessing severity and developing treatment plans. Further research is needed to explore the underlying mechanisms and evaluate interventions targeting anaemia and BMI to improve outcomes.

Keywords: asthma, exacerbation, airway hyperresponsiveness, anaemia, iron deficiency, body mass index, BMI

Introduction

Asthma is a global chronic disorder characterized by partial or complete airway obstruction that results in airway inflammation and airway hyperresponsiveness,[1] defined by respiratory symptoms such as wheezing, chest tightness, shortness of breath, and cough.[2] The number of asthma subjects has increased worldwide over the last 40 years, and over 300 million people have been diagnosed with asthma.[3] Various factors put asthma subjects at risk of morbidity and mortality, such as environmental, psychological, and genetic factors.[4] The most important step in the management of this chronic disease is the diagnosis, which will help with the management of symptoms. The diagnosis depends on the subject's family history and clinical indicators, including the results of pulmonary function tests (spirometry) to

Received: 10 February 2025
Accepted: 26 May 2025
Published: 5 June 2025

determine airway obstruction and then reversibility tests.[5] The management, which is the key to maintaining a better quality of life, comes after the diagnosis. Asthma management depends on four elements recommended by the National Asthma Education Program expert panel: objective measurements and monitoring of lung function, pharmacologic therapy, environmental control, and subject education.[6] In this study, asthma severity was assessed based on the number of exacerbations that required hospital admission.[5]

Anaemia and asthma have a complex relationship. Anaemia affects the immune system and leads to viral infections, which in turn increase the risk of asthma. Furthermore, iron-deficiency anaemia is strongly associated with an increase in asthma attacks because it decreases haemoglobin, which leads to an increase in allergic reactions, a common cause of asthma. Subjects with anaemia have limited oxygen carriers in their bodies. This may cause asthma symptoms such as shortness of breath, dizziness, and headache.[6,7] In 2015, a published study in the United States on a population of (n=2906) detected an association between iron status and asthma. They concluded that reduced body iron stores were associated with lower lung function.[7] Anaemia is a common condition in which red blood cells are not healthy enough to carry oxygen to the tissues.[6] There are several classifications of anaemia. First is aplastic anaemia, a condition in which the body is not capable of producing enough new blood cells. The second is megaloblastic anaemia, which is a type of anaemia characterized by large and few red blood cells.[8] In addition, haemolytic anaemia is a disorder in which the destruction of red blood cells is faster than the production. Iron-deficiency anaemia is a disorder in which iron quantity in red blood cells affects oxygen transport.[7,8] The next classification is haemoglobinopathies, which are divided into two groups. The first is thalassemia syndrome, which is a genetic defect that affects haemoglobin quantity. The other group comprises structural haemoglobin variants that result from a single amino acid substitution in the α- or β-globin chain due to mutations.[6,9] Anaemia was graded based on the haemoglobin level: from 12 to 16 g/dL was considered normal, from 10.0 g/dL to the lower limit of normal was considered mild, from 8.0 to 10.0 g/dL was considered moderate, and from 6.5 to 7.9 g/dL was considered severe.[10]

Anaemia and BMI have an indirect relationship. A high BMI is associated with increased hepcidin, which is an iron-regulating hormone that controls iron delivery to the blood. An increase in hepcidin results in blockage of intestinal iron absorption and macrophage iron recycling, which will result in anaemia.[11] The BMI is a measurement of fat percentage in the body, and its measurement is based on sex, height and weight. The formula for calculating BMI is BMI=weight/height^2.[12] The BMI is divided into the following categories: underweight (below 18.5 kg/m^2), normal weight (18.5 to 24.9 kg/m^2), overweight (25 to 29.9 kg/m^2), obesity (30 to 39.9 kg/m^2), severe obesity (40 to 44.9 kg/m^2), morbid obesity (45 to 49.9 kg/m^2), and super obesity (50 kg/m^2 and above).[13] The BMI is associated with the percentage of body fat. In other words, the higher the BMI is, the higher the percentage of fat in the body.[14] A high BMI is associated with several illnesses affecting cardiopulmonary functions.[15] A high BMI is related to asthma severity and frequent asthma attacks. Moreover, a high BMI is associated with a lower response to different asthma medications, which consequently reduces the quality of life of asthma subjects.[16] A retrospective case–control study in 2016 included 218 subjects diagnosed with asthma between September 2012 and March 2013 in Ankara based on the history of symptoms and signs of reversible airway obstruction. As a result, the findings revealed that obese and overweight subjects had poor asthma control, and subjects who gained weight during the follow-up period had even worse asthma control.[17] Another prospective study on subjects with uncontrolled asthma and moderate-to-severe obesity was conducted in 2013, with the goal of determining the level of asthma control after a 6-month weight-loss program. The results showed that weight loss was associated with a considerable improvement in asthma control.[18] Upon reviewing the literature, we found that there were limited studies investigating the effects of anaemia and BMI on asthma severity, although the prevalence of obesity in Saudi Arabia in 2016 reached 35% and the prevalence of anaemia was 25.5%.[19,20] Furthermore, different BMI and anaemia status categories have an important role in asthma severity.[8,15,16] Therefore, our study aimed to determine the associations of anaemia status and BMI categories with asthma severity to investigate the severity of the disease and its risk factors in Jeddah, Saudi Arabia, and fill the gap of limited research on this topic.

This study primarily aimed to assess if anemia and BMI independently associated with asthma severity in patients hospitalized at King Abdulaziz Medical City (KAMC) in Jeddah. Additionally, it sought to characterize the relationship between BMI and asthma severity in these patients and investigate the correlations of anemia status and BMI categories

with asthma severity. The secondary objective was to investigate the relationships between demographic variables (age and gender) and asthma severity in the same hospitalized sample.

Material and Methods

Study Setting

The study focused on adults with asthma who were admitted to the intensive care unit, operating room, and general wards of KAMC in Jeddah from 2017 to 2022.

Study Design

This study employed a cross-sectional comparative design to investigate the associations of anaemia and BMI with asthma severity in adult asthma subjects. This design was chosen to capture prevalence of anaemia and BMI in asthma patients. Data were collected retrospectively from the medical records of subjects admitted to KAMC in Jeddah between 2017 and 2022. The study compared the number of asthma-related hospital admissions among subjects with different BMI and anaemia status categories.

Sample Selection and Study Population

The required sample size was estimated at the 95% confidence level with margin of error of 5% from 1300 asthma patients at KAMC. The Raosoft software was used to calculate the sample size using the formula of $n=Z^2P(1-P)/d^2$ and the minimum required sample is 297 patients. Where, n; initial sample size, Z; the standard variable of the normal distribution corresponding to 95% confidence level, P; anticipated population proportion, and d; the absolute statistical precision on either side of anticipated population proportion, using 95% confidence, $d = 5\%$ and $P = 50\%$.

The study recruited 302 adult subjects with asthma who met the predetermined criteria for inclusion. Two subjects were excluded due to incomplete data, resulting in a final of 300 subjects included. The inclusion criteria comprised adult subjects (18 years and older) with a confirmed diagnosis of asthma and a documented history of asthma-related hospital admissions. However, the exclusion criteria are subjects lacking complete medical records, non-asthmatic patients and paediatric or neonatal patients aged below 18-year-old were excluded from the study.

Sample Size

The minimum required sample size was 297, which was estimated at the 95% confidence level with a margin of error of 5% from 1300 asthma subjects at KAMC who were admitted from 2017 to 2022.

Sampling Technique

The simple random method was used with data taken from electronic health records.

Data Collection

Data were obtained from the electronic medical records of the subjects. The following variables were collected: sex, age, haemoglobin level, height, weight, and the number of asthma-related hospital admissions. Anaemia status was categorized into four groups based on the haemoglobin level: normal haemoglobin levels (12 to 16 g/dL for females and 14 to 16 g/dL for males), mild anaemia (10.0 g/dL to lower limit of normal), moderate anaemia (8.0 to 10.0 g/dL), and severe anaemia (6.5 to 7.9 g/dL). The BMI was categorized into four groups based on height and weight: normal (18.5 to 24.9 kg/m²), overweight (25 to 29.9 kg/m²), obese (30 to 39.9 kg/m²), and severely obese (≥40 kg/m²).

Data Analysis

Descriptive statistics were used to summarize the demographic characteristics of the sample, including frequencies and percentages for categorical variables (sex, age groups, anaemia status categories, and BMI categories). The associations of sex, age, anaemia status categories, and BMI categories with the number of asthma-related hospital admissions were analysed using the chi-square test. The differences among the BMI and anaemia status categories for the mean number of

asthma-related hospital admissions were assessed using one-way analysis of variance (ANOVA) followed by post hoc tests with least significant difference (LSD) correction. A *p*-value of less than 0.05 was considered to indicate statistical significance.

Ethical Considerations

Ethical approval for this study was granted by the King Abdullah International Medical Research Centre's (KAIMRC) Institutional Review Board (IRB) for access to patient data from *BestCare*, the medical record system at KAMC in Jeddah. Patient informed consent was waived, as the study is retrospective and anonymized data were used. No identifiable personal information was included in the study report to ensure subject confidentiality and privacy. The study protocol was scientifically approved by KAIMRC.

Results

Descriptive Statistics

Out of 302 subjects, a total of 300 adult subjects with asthma were admitted to KAMC between 2017 and 2022 and met the predetermined criteria for inclusion in the study. The two remaining subjects were excluded from the investigation due to incomplete data. The majority of the subjects were female (74.3%). Furthermore, the age group of 65 and older accounted for the majority of subjects (41%), followed by the age groups of 55–64 (28%), 45–54 (14.7%), 35–44 (8.7%), 25–34 (4.7%), and finally, the minority age group of 24 and younger (3.0%). The anaemia status of the subjects was categorized into four groups based on haemoglobin level, with the percentages of subjects in each category occurring as follows: 41.7% had mild anaemia (10.0 g/dL to the lower limit of normal); 34.3% had moderate anaemia (8.0 to 10.0 g/dL); 17.7% had normal haemoglobin levels (12 to 16 g/dL for female subjects and 14 to 16 g/dL for male subjects); and 6.3% had severe anaemia (6.5 to 7.9 g/dL). Additionally, the BMI of the subjects was categorized into four groups, with most of the subjects being obese (30 to 39.9 kg/m²; 42.3%) or overweight (25 to 29.9 kg/m²; 22.7%), followed by severe obesity (40 kg/m²; 20.7%) and finally, the normal BMI group (18.5 to 24.9 kg/m²; 14.3%). Further information referred in Table 1.

Inferential Statistics

Association Between Sex and the Number of Asthma-Related Hospital Admissions

Regarding sex, female subjects had a greater number of asthma-related hospital admissions than male subjects in the categories of one, two, and three or more admissions, with insignificant relation depending on chi-square tests with *p*-value=0.927 and frequencies of 35.0%, 75.5%, and 73%, respectively, as shown in Figure 1.

Table 1 Chi-Square Analysis on the Association Between BMI and the Number of Admissions

	Number of Asthma Admission n (%)		
	1	**2**	**≥ 3**
BMI Classification			
Normal n = 43 (14.3%)	15 (14.3%)	20 (18.9%)	8 (9%)
Overweight n = 68 (22.7%)	22 (21%)	29 (27.4%)	17 (19.1%)
Obese n = 127 (42.3%)	50 (47.6%)	41 (38.7%)	36 (40.4%)
Severe Obesity n = 62 (20.7%)	18 (17.1%)	16 (15.1%)	28 (31.5%)
Total N = 300	105 (35%)	106 (35.3%)	89 (29.7%)
Chi-square Tests	**x^2 = 13.302; *DF* = 6; *p*-value = 0.038**		

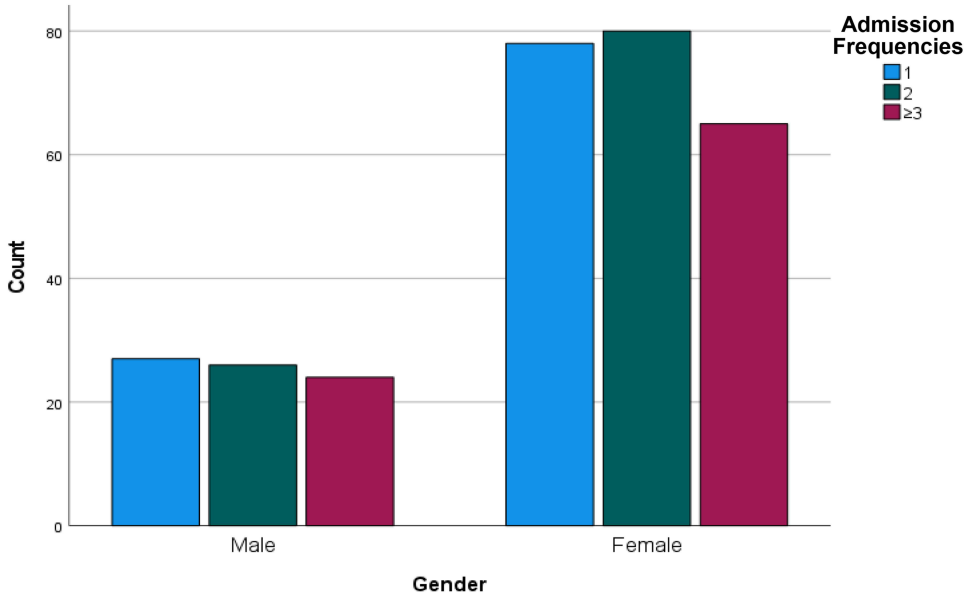

Figure 1 Bar chart showing the number of asthma patients by gender for different admission groups.

Association Between Age and the Number of Asthma-Related Hospital Admissions

The chi-square tests show a *p*-value of 0.927 suggests that there is no significant association between sex and the number of asthma-related hospital admissions, as presented in Table 2. According to age, the majority of subjects who were admitted one, two, and three or more times were 65 years of age or older, with respective frequencies of 28.6%, 46.2%, and 49.4%, whereas the minority of subjects who were admitted once or twice were 24 years of age or younger, with respective frequencies of 1.9% and 1.9%. Additionally, the minority of subjects who were admitted three times or more were between the ages of 35 and 44, with a frequency of 1.1%, as shown in Figure 2. Furthermore, the chi-square tests show a *p*-value of 0.0002 (α=0.01) suggests a strong association between age and the number of asthma-related hospital admissions, as shown in Table 3.

Association Between Anaemia Status and the Number of Asthma-Related Hospital Admissions

Regarding anaemia status, it was observed that the asthma subjects who were admitted once had moderate anaemia (40%), while those who were admitted two and three or more times had mild anaemia (48.1% and 47.2%, respectively). Remarkably, subjects with severe anaemia were in the minority at all levels of admission, with percentages of 9.5%, 3.8%, and 5.6% for one, two, and three or more admissions, respectively, as shown in Figure 3. Furthermore, the

Table 2 Chi-Square Analysis on the Association Between Gender and the Number of Admissions

	Number of Asthma Admission n (%)		
	1	**2**	**≥ 3**
Gender			
Male n = 77 (25.7%)	27 (25.7%)	26 (24.5%)	24 (27%)
Female n = 223 (74.3%)	78 (74.3%)	80 (75.5%)	65 (73%)
Total N = 300	105 (35%)	106 (35.3%)	89 (29.7%)
Chi-square Tests	**x^2 = 0.151; *DF* = 2; *p*-value = 0.927**		

https://doi.org/10.2147/JAA.S521888

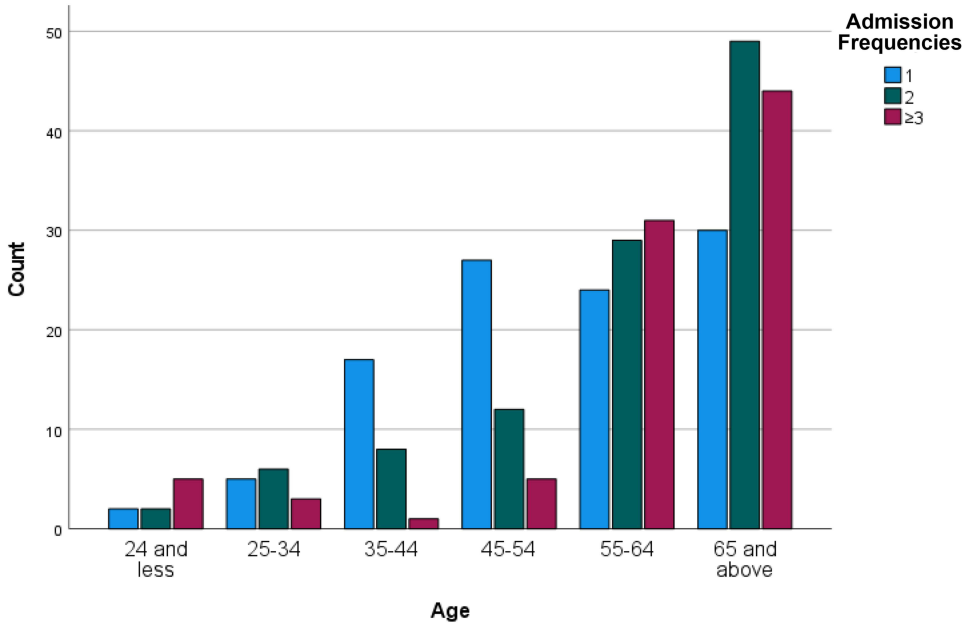

Figure 2 Bar chart showing the number of asthma patients by age for different admission groups.

statistical analysis of the data the chi-square tests resulted in a p value of 0.039 (α=0.05), indicating a significant association between anaemia status and the number of asthma-related hospital admissions, as presented in Table 4. Hospital readmission frequency is affected by the severity and frequency of symptoms, along with the number of exacerbations. The observed significance suggests that the severity of anaemia is inversely correlated with the number of asthma-related hospital admissions.

Association Between BMI and the Number of Asthma-Related Hospital Admissions

According to the BMI, the subjects who exhibited obesity constituted the majority at one, two, and three or more admissions, with respective frequencies of 47.6%, 38.7%, and 40.4%. Remarkably, the minority of subjects who

Table 3 Chi-Square Analysis on the Association Between Age and the Number of Admissions

	Number of Asthma Admission n (%)		
	1	**2**	**≥ 3**
Age			
24 and younger n = 9 (3.0%)	2 (1.9%)	2 (1.9%)	5 (5.6%)
25–34 n = 14 (4.7%)	5 (4.7%)	6 (5.7%)	3 (3.4%)
35–44 n = 26 (8.7%)	17 (16.2%)	8 (7.5%)	1 (1.1%)
45–54 n = 44 (14.7%)	27 (25.7%)	12 (11.3%)	5 (5.6%)
55–64 n = 84 (28.0%)	24 (22.9%)	29 (27.4%)	31 (34.8%)
65 and older n = 123 (41%)	30 (28.6%)	49 (46.2%)	44 (49.4%)
Total N = 300	105 (35%)	106 (35.3%)	89 (29.7%)
Chi-square Tests	**x^2 = 39.506; *DF* = 10; *p*-value = 0.0002**		

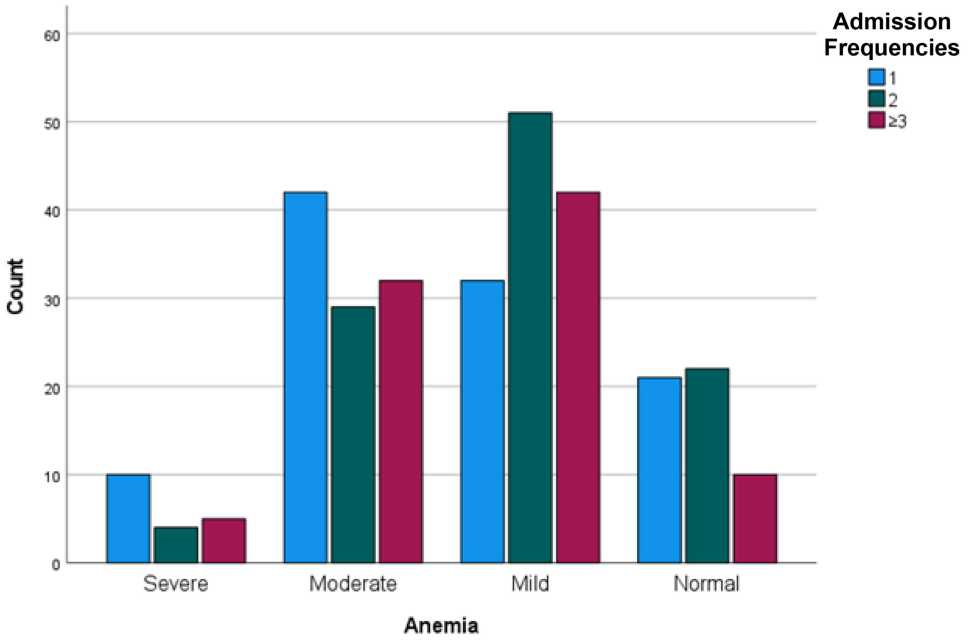

Figure 3 Bar chart showing the number of asthma patients by anemia level for different admission groups.

underwent one and three or more admissions were characterized by a normal BMI, with respective frequencies of 14.3% and 9%. Furthermore, the minority of subjects who underwent two admissions had severe obesity, with a frequency of 15.1%, as shown in Figure 4. The chi-square tests show *p*-value of 0.038 (α=0.05) indicated a significant association between BMI and the number of asthma-related hospital admissions, as presented in Table 1. Therefore, obesity, which is defined as having a BMI between 29.9 and 39.9 kg/m², was found to be associated with an increased number of asthma-related hospital admissions. Moreover, individuals with asthma who were classified as obese were at a higher risk of requiring inpatient care.

Differences in the Mean Number of Asthma-Related Hospital Admissions Among the Different Anaemia Categories

The study found that the mean number of asthma-related hospital admissions for asthma was 1.95 (SD±0.804). Additionally, the mean number of asthma-related hospital admissions varied based on anaemia status, with a mean of

Table 4 Chi-Square Analysis on the Association Between Anemia Level and the Number of Admissions

	Number of Asthma Admission n (%)		
	1	**2**	**≥ 3**
Anemia Level			
Normal n = 53 (17.7%)	21 (20%)	22 (20.7%)	10 (11.2%)
Mild n = 125 (41.7%)	32 (30.5%)	51 (48.1%)	42 (47.2%)
Moderate n = 103 (34.3%)	42 (40%)	29 (27.4%)	32 (36%)
Severe n = 19 (6.3%)	10 (9.5%)	4 (3.8%)	5 (5.6%)
Total N = 300	105 (35%)	106 (35.3%)	89 (29.7%)
Chi-square Tests	**x^2 = 13.252; *DF* = 6; *p*-value = 0.039**		

https://doi.org/10.2147/JAA.S521888

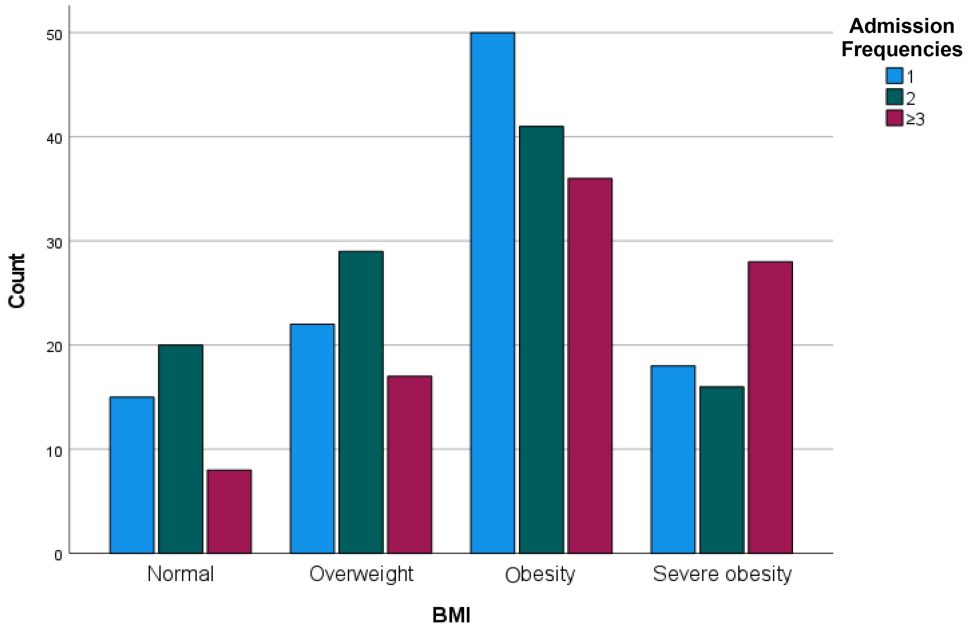

Figure 4 Bar chart showing the number of asthma patients by BMI for different admission groups.

1.88 (SD±0.773) for nonanemic subjects, 2.07 (SD±0.767) for those with mild anaemia, 1.90 (SD±0.838) for those with moderate anaemia, and 1.57 (SD±0.811) for those with severe anaemia, as shown in Table 5. Furthermore, the results indicated statistically significant differences in the mean number of asthma-related hospital admissions across different anaemia status subgroups, as determined by one-way ANOVA ($F(3,296)=2.800$, p-value=0.04; $\alpha=0.05$). Post hoc tests using LSD correction revealed that there was a significant difference in the mean number of asthma-related hospital admissions between patients with mild anaemia and those with severe anaemia, and the mean number of asthma-related hospital admissions in the mild anaemia group (2.07) was significantly higher than that in the severe anaemia group (1.57). These findings indicate that individuals with mild anaemia had a significantly greater number of asthma-related hospital admissions than those with severe anaemia.

The Differences in the Mean Number of Asthma-Related Hospital Admissions Among the Different BMI Categories

With relation to BMI, it was observed that the mean number of asthma-related hospital admissions for asthma was 1.77 (SD±0.729) for subjects with a normal BMI, 1.93 (SD±0.738) for those who were overweight, 1.90 (SD±0.817) for individuals who were classified as obese, and 2.21 (SD±0.868) for subjects who were severely obese, as shown in Table 6. The results indicated that there are statistically significant differences in the mean number of asthma-related

Table 5 The Mean and Standard Deviation of Hemoglobin Levels (g/dL) by Anemia Level

Anemia Level	Mean ± SD
Normal	1.88 ± 0.773
Mild	2.07 ± 0.767
Moderate	1.90 ± 0.838
Severe	1.57 ± 0.811
Total	**1.95 ± 0.804**

Table 6 The Mean and Standard Deviation of BMI

BMI Classification	Mean ± SD
Normal	1.77 ± 0.729
Overweight	1.93 ± 0.738
Obesity	1.90 ± 0.817
Severe obesity	2.21 ± 0.868
Total	**1.95 ± 0.804**

hospital admissions across different BMI categories as determined by one-way ANOVA (F (3,296) = 3.050, *p*-value= 0.029; α=0.05). Further post hoc tests using LSD correction revealed that the mean number of asthma-related hospital admissions was significantly different between the severe obesity and obese, overweight, and normal BMI groups, and the mean number of asthma-related hospital admissions in the severe obesity group (2.21) was significantly higher than that in all other groups. These findings indicate that individuals with severe obesity had a significantly greater number of asthma-related hospital admissions than those in the other BMI groups.

Discussion

The comparative analysis presented in this study offers significant and noteworthy insights into the effects of anaemia and BMI on the severity of asthma in adult subjects. The observed associations of age, anaemia, BMI, and the number of hospitalizations with asthma severity underscore the intricate nature of this condition and the conceivable contribution of these factors to the exacerbation of symptoms and the need for inpatient care.

Association Between Age and the Number of Asthma-Related Hospital Admissions

Regarding age, there was a significant association between the age of subjects and the number of asthma-related hospital admissions, with a (*p*=0.0002). The majority of subjects in this study were aged greater than or equal to 65 years, and it was observed that such individuals experienced a more frequent rate of admission. The higher frequencies of asthma-related hospital admissions among elderly individuals can be attributed to a range of factors. Age-related physiological changes play a significant role, as the natural ageing process can weaken overall health and resilience, making elderly individuals more vulnerable to respiratory issues and complications. Additionally, the presence of comorbidities, such as chronic diseases or preexisting respiratory conditions, increases the likelihood of hospitalization for respiratory problems. Decreased lung function, which naturally occurs with age, also contributes to the higher rates of asthma-related hospital admissions, as it impairs the ability of the elderly to effectively manage respiratory challenges. Furthermore, the reduced resilience of the ageing population, both in terms of immune response and general physical endurance, makes it more difficult for them to cope with asthma and necessitates hospital care. These results are consistent with prior research that demonstrated that elderly individuals may experience a more challenging-to-manage form of asthma in comparison with younger subjects,[21] whereas other studies suggested that asthma is not impacted by age.[22]

Association Between Sex and the Number of Asthma-Related Hospital Admissions

The analysis of sex in relation to the number of asthma-related hospital admissions for asthma revealed interesting findings. It was observed that female subjects had a greater number of asthma-related hospital admissions than male subjects in all hospital admission categories. However, despite these differences in admission frequencies, the *p* value of 0.927 indicated that there was no significant association between sex and the number of asthma-related hospital admissions. This phenomenon can be attributed to the fact that asthma is primarily a respiratory condition influenced by factors such as airway inflammation and bronchial hyperresponsiveness, which may not be strongly influenced by sex-specific biological factors. The mechanisms of asthma development and exacerbation involve complex interactions

between genetic, environmental, and immunological factors that may have more relevance to asthma outcomes than sex alone. Furthermore, asthma management involves strategies such as medication adherence, inhaler technique, trigger avoidance, and regular monitoring. While these factors can influence the severity and control of asthma, there is no inherent reason to believe that they would vary significantly based on sex alone. Effective asthma management is more likely to be influenced by individual behaviours and environmental factors rather than sex-specific factors. These findings agree with previous studies that have indicated a lack of association between sex and asthma severity.[23]

Association Between Anaemia and the Number of Asthma-Related Hospital Admissions

The results of this study revealed a statistically significant association between anaemia and the number of asthma-related hospital admissions (p = 0.039). A greater proportion of admissions occurred among individuals with mild to moderate anaemia. This may be attributed to the diminished oxygen-carrying capacity of haemoglobin in anaemic individuals, which leads to tissue. Hypoxia can increase airway reactivity and inflammation, thereby exacerbating asthma symptoms and increasing the risk of hospitalization.[24] Additionally, compensatory mechanisms triggered by hypoxia, such as increased respiratory rate, may further stress the respiratory system in asthmatic patients. These findings align with previous studies that reported associations between reduced iron stores and impaired lung function, supporting the hypothesis that anaemia contributes to asthma morbidity via oxygen transport impairment and subsequent airway inflammation.[7]

Association Between BMI and Number of Asthma-Related Hospital Admissions

Regarding BMI, there was a significant association between BMI and the number of asthma-related hospital admissions (p = 0.038). Specifically, the majority of asthma subjects with a greater frequency of asthma-related hospital admissions had obesity. This phenomenon can be attributed to the fact that asthma patients with higher BMI are less responsive to treatments such as long-acting beta agonists, which in turn leads to poor symptom control and an increased likelihood of hospitalization. Furthermore, obese individuals tend to accumulate greater amounts of fat within their bodies, leading to potentially dangerous constriction of the lungs during asthma attacks. In addition, obesity is believed to worsen asthma through inflammatory pathways. Excess adipose tissue in obese individuals secretes pro-inflammatory cytokines (eg, IL-6, TNF-α) and adipokines such as leptin, which contribute to systemic inflammation. These inflammatory mediators can infiltrate the airways, increasing airway hyperresponsiveness and remodelling. Moreover, obesity may alter immune responses, shifting them toward a Th1-dominant profile rather than the typical Th2 response seen in classic asthma, potentially resulting in a phenotype that is less responsive to standard therapies.[25] These findings are in line with previous investigations that showed an association between obesity and asthma severity,[16,26] whereas other studies suggested that asthma was not impacted by obesity.[27]

The Differences in the Mean Number of Asthma-Related Hospital Admissions Among the Different Anaemia Status Categories

The outcome results demonstrated that the mean number of asthma-related hospital admissions among the participants was 1.95 (SD=0.804). Furthermore, the results revealed that there were significant differences in the mean number of asthma-related hospital admissions among subjects in different anaemia status categories (p=0.04). Subsequently, a post hoc test was carried out, which indicated that the mean number of asthma-related hospital admissions in the mild anaemia group was higher than that in the severe anaemia group. It is important to clarify that asthma subjects with mild anaemia could experience a decline in their capacity to carry oxygen, thus leading to the exacerbation of asthma symptoms and a higher probability of requiring hospitalization. Conversely, subjects with severe anaemia may receive specialized care or targeted interventions that could assist in preventing or managing complications. Additionally, these individuals may reduce their physical activity due to anaemia symptoms such as fatigue, weakness, and shortness of breath, as evidenced in a study conducted in 2018.[22] This decrease in physical activity may potentially contribute to a decreased likelihood of asthma exacerbations and the need for hospitalization.

The Differences in the Mean Number of Asthma-Related Hospital Admissions Among the Different BMI Categories

The outcome results demonstrated that the mean number of asthma-related hospital admissions among the participants was 1.95 (SD=0.804). The findings of this study included significant differences in the mean number of asthma-related hospital admissions based on BMI categories (p=0.029). Upon further examination via a post hoc test, it was discovered that there were significant differences in the mean number of asthma-related hospital admissions in the severe obesity group compared to those in the obesity, overweight, and normal BMI groups. This infers severe obesity is likely to have a stronger association with asthma-related hospital admissions compared with lower BMI categories. This phenomenon can be attributed to the fact that severe obesity frequently leads to elevated systemic inflammation within the body, which can further exacerbate the symptoms of asthma and amplify the probability of hospitalization. Moreover, individuals with severe obesity may experience reduced lung function, which impairs their ability to effectively regulate asthma symptoms and cope with respiratory challenges, thereby amplifying the necessity of hospital care. Persons with severe obesity may confront difficulties in attaining optimum asthma control, possibly due to the complex interactions between severe obesity, hormonal imbalances, and immune dysregulation. These outcomes agree with previous studies that indicated that subjects with severe obesity have poor asthma control, which ultimately leads to a higher probability of hospitalization.[17]

Limitations and Recommendations

This study had limitations regarding the local distribution of subjects, which may restrict the generalizability of our findings. Additionally, the study relied on existing medical records, which may be subject to incomplete or missing data. For example, there were certain details lacking in our assessments, such as pulmonary function test (PFT) results and asthma control assessment results, which could have provided a more comprehensive understanding of the relationship between anaemia, BMI, and asthma severity. Socioeconomic status and dietary habits were not accounted for in this study, despite their potential impact on the severity of the asthma. To address these limitations, future research should aim to include samples from different hospitals to enhance generalizability and consider incorporating additional variables such as PFTs, symptom assessments, and interference with daily activities to better capture asthma severity and its potential association with anaemia and BMI. Furthermore, future studies should measure and incorporate socioeconomic status and dietary habits to clarify their influence on asthma severity. Despite these limitations, this study provides valuable insights into the relationship between anaemia, BMI, and asthma severity, highlighting the importance of these factors in the management and treatment of asthma subjects. Future studies can provide a more robust and comprehensive examination of these relationships, contributing to improved management and treatment strategies for asthma subjects. In conclusion, this comparative study investigated the associations of anaemia and BMI with asthma severity in adult subjects. The results revealed that age had a significant association with the number of asthma-related hospital admissions, and elderly subjects were linked to a higher frequency of admissions. Moreover, the results revealed that anaemia and BMI were factors associated with the number of asthma-related hospital admissions. Mild-to-moderate anaemia and severe obesity were linked to a higher frequency of admissions. These findings emphasize the importance of considering anaemia and BMI as potential risk factors in asthma management. Further research is needed to better understand the underlying mechanisms and develop tailored approaches for subjects with these characteristics. Screening for anaemia as well as targeting BMI may improve asthma outcomes indeed, through addressing systemic factors that contribute to control and symptom burden. Anaemia sometimes can worsen dyspnoea and fatigue, which perhaps may impair asthma management further, while obesity associates with a more severe asthma phenotype, also treatment responsiveness reduces due to inflammatory mechanisms.

Future research must focus on trials of iron supplementation for anaemic asthmatic patients and on weight-loss interventions for obese people, which are interventional studies, so as to assess the impact that they have on asthma control and exacerbation rates, we suggest. With these studies, addressing both anaemia and BMI abnormalities may possibly be determined. Improved asthma outcomes and also even more effective management strategies may be as a result.

Conclusion

In conclusion, this study provides evidence about the impact of anemia and BMI as possible risk factors in the control of asthma. While no significant association was found between sex and the number of asthma-related hospital admissions, mild anaemia was more prevalent among individuals with higher admission frequencies compared to severe anaemia. Additionally, obesity, especially severe obesity, was strongly associated with increased hospital admissions. This may be due to the impact of severe obesity on systemic inflammation, lung function, and asthma control. Based on this, healthcare professionals should be aware of these factors when assessing asthma severity and developing personalized treatment plans. Further research is needed to explore the underlying mechanisms and evaluate interventions targeting anaemia and BMI to improve asthma outcomes.

Current Knowledge

Asthma is a chronic disorder characterized by airway obstruction and inflammation, affecting over 300 million people globally. The prevalence of this condition has been on the rise, necessitating a thorough understanding of its contributing factors. Asthma diagnosis relies on clinical tests and family history assessment, with management involving objective measurements, pharmacological therapy, environmental control, and subject education. Anaemia, a condition in which red blood cells are unable to efficiently carry oxygen, has been identified as a potential risk factor for asthma exacerbations. Specifically, iron deficiency anaemia shows a strong association with increased asthma attacks. Additionally, BMI, a measure of body fat percentage, has been linked to asthma severity, frequent attacks, and reduced response to asthma medications. A high BMI can lead to elevated levels of hepcidin, an iron-regulating hormone, potentially contributing to anaemia. Therefore, understanding the relationships among anaemia, BMI, and asthma severity is crucial for improving subject outcomes.

What This Paper Contributes to Our Knowledge

This study investigated anaemia, BMI, and asthma severity relate among 300 adult patients KAMC admitted from 2017 to 2022. Demographic data, anaemia status, as well as BMI, and then asthma-related hospital admissions were all investigated. Age served as an important factor since older subjects experienced additional hospital admissions due to asthma. Furthermore, subjects with mild or moderate anaemia as well as subject with obesity were admitted to the hospital more frequently for asthma. Subjects who have severe obesity significantly had a greatly greater number of admissions in comparison to other groups based on BMI. In contrast, those subjects with mild anaemia had significantly more of the admissions than those subjects with severe anaemia.

These findings show that considering both anaemia and BMI are important since they risk asthma severity and complicate treatment strategies. Instances of hypoxemia can be contributed to by anaemia, while cases of asthma can be exacerbated by an abnormal BMI, particularly obesity, through various inflammatory mechanisms. Therefore, a more thorough approach in terms of asthma management must assess and then manage both anaemia in addition to BMI so as to personalize treatment plans, which could increase patient outcomes through addressing the modifiable factors. The effects of these ailments can be understood to guide more targeted steps to increase patient health and lessen asthma's intensity.

Abbreviations

BMI, body mass index; ANOVA, one-way analysis of variance; LSD, least significant difference; SD standard deviation; PFT, pulmonary function test, KAMC, King Abdulaziz Medical City.

Ethics Statement

All aspects of this study were conducted with integrity and complies with the Declaration of Helsinki.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Gomez-Llorente MA, Romero R, Chueca N, Martinez-Cañavate A, Gomez-Llorente C. Obesity and asthma: a missing link. *Int J Mol Sci*. 2017;18(7):1490. doi:10.3390/ijms18071490
2. Marko M, Pawliczak R. Obesity and asthma: risk, control and treatment. *Postepy Dermatol Alergol*. 2018;35(6):563–571. doi:10.5114/ada.2018.77607
3. Asher I, Pearce N. Global burden of asthma among children. *Int J Tuberc Lung Dis*. 2014;18(11):1269–1278. doi:10.5588/ijtld.14.0170
4. Noutsios GT, Floros J. Childhood asthma: causes, risks, and protective factors; a role of innate immunity. *Swiss Med Wkly*. 2014;144:w14036. doi:10.4414/smw.2014.14036
5. Lommatzsch M, Virchow JC. Severe asthma: definition, diagnosis and treatment. *Dtsch Arztebl Int*. 2014;111(50):847–855. doi:10.3238/arztebl.2014.0847
6. Kacmarek RM, Stoller JK, Heuer A. *Egan's Fundamentals of Respiratory Care*. 12th ed. Mosby; 2020.
7. Brigham EP, McCormack MC, Takemoto CM, Matsui EC. Iron status is associated with asthma and lung function in US women. *PLoS One*. 2015;10(2):e0117545. doi:10.1371/journal.pone.0117545
8. Chamoli S. Clinical evaluation of different types of anemia. *World J Anemia*. 2018;2(1):26–30. doi:10.5005/jp-journals-10065-0024
9. Iolascon A, De Franceschi L, Muckenthaler M, et al. EHA research roadmap on hemoglobinopathies and thalassemia: an update. *HemaSphere*. 2019;3(3):e208. doi:10.1097/HS9.0000000000000208
10. Alshwaiyat NM, Ahmad A, Wan Hassan WMR, Al-Jamal HAN. Association between obesity and iron deficiency. *Exp Ther Med*. 2021;22(5):1268. doi:10.3892/etm.2021.10703
11. Misra A, Dhurandhar NV. Current formula for calculating body mass index is applicable to Asian populations. *Nutr Diabetes*. 2019;9(1):3. doi:10.1038/s41387-018-0070-9
12. Adab P, Pallan M, Whincup PH. Is BMI the best measure of obesity? *BMJ*. 2018;k1274. doi:10.1136/bmj.k1274
13. Lavie CJ, Alpert MA, Arena R, Mehra MR, Milani RV, Ventura HO. Impact of obesity and the obesity paradox on prevalence and prognosis in heart failure. *JACC Heart Fail*. 2013;1(2):93–102. doi:10.1016/j.jchf.2013.01.006
14. Sulaiman AL, Yunusa UM, Yunusa I, Bello HJ, Maryam AI. High Body Mass Index (BMI): a marker for cardiovascular diseases. *Int J Adv Acad Res Sci Technol Eng*. 2017;3(12):2488–9849.
15. Çelebi Sözener Z, Aydın Ö, Mungan D, Mısırlıgil Z. Obesity-asthma phenotype: effect of weight gain on asthma control in adults. *Allergy Asthma Proc*. 2016;37(4):311–317. doi:10.2500/aap.2016.37.3949
16. Dias-Júnior SA, Reis M, de Carvalho-Pinto RM, Stelmach R, Halpern A, Cukier A. Effects of weight loss on asthma control in obese patients with severe asthma. *Eur Respir J*. 2014;43(5):1368–1377. doi:10.1183/09031936.00053413
17. Peters U, Dixon AE, Forno E. Obesity and asthma. *J Allergy Clin Immunol*. 2018;141(4):1169–1179. doi:10.1016/j.jaci.2018.02.004
18. Kassebaum NJ, GBD 2013 Anemia Collaborators. The global burden of anemia. *Hematol Oncol Clin North Am*. 2016;30(2):247–308. doi:10.1016/j.hoc.2015.11.002
19. Ritchie H, Roser M. Obesity. Our World in Data; 2017. Available from: https://ourworldindata.org/obesity. Accessed April 10, 2022.
20. Badireddy M, Baradhi KM. Chronic anemia. In: *StatPearls*. StatPearls Publishing; 2022.
21. Baptist AP, Hao W, Karamched KR, et al. Distinct asthma phenotypes among older adults with asthma. *J Allergy Clin Immunol Pract*. 2018;6(1):244–249.e2. doi:10.1016/j.jaip.2017.06.010
22. Scherzer R, Grayson MH. Heterogeneity and the origins of asthma. *Ann Allergy Asthma Immunol*. 2018;121(4):400–405. doi:10.1016/j.anai.2018.06.009
23. Dursun AB, Kurt OK, Bayiz H, Ozkan E, Cakaloglu A, Karasoy D. Does gender affect asthma control in adult asthmatics? *Chron Respir Dis*. 2014;11(2):83–87. doi:10.1177/1479972314527468
24. Listyoko AS, Okazaki R, Harada T, Inui G, Yamasaki A. Impact of obesity on airway remodeling in asthma: pathophysiological insights and clinical implications. *Front Allergy*. 2024;5. doi:10.3389/falgy.2024.1365801
25. Peters U, Dixon AE, Forno E. Obesity and asthma. *J Allergy Clin Immunol*. 2023;152(1):1–14. doi:10.1016/j.jaci.2023.05.012
26. Myung J, Lee H, Kim TH, Han E. Relationships between self-reported asthma and pulmonary function and various measures of obesity. *J Asthma*. 2018;55(7):741–749. doi:10.1080/02770903.2017.1362701
27. den Dekker HT, Ros KPI, de Jongste JC, Reiss IK, Jaddoe VW, Duijts L. Body fat mass distribution and interrupter resistance, fractional exhaled nitric oxide, and asthma at school-age. *J Allergy Clin Immunol*. 2017;139(3):810–818.e6. doi:10.1016/j.jaci.2016.06.022