

The association between BMI and asthma exacerbation in paediatric patients in Makkah



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Abstract— The prevalence of both asthma and obesity is increasing, and studies have found a correlation between these conditions. Obesity is also related to poor asthma control(Pradeepan et al., 2013). **Objective:** The main study objective was to identify the impact of BMI on the frequency of ER visits and length of hospitalization among asthmatic patients aged 14 or less in Makkah from 2018 to 2022. **Method:** This was a retrospective cross-sectional quantitative study using data collected from the hospital system. **Results:** This study found no significant correlation between BMI and asthma control ($p = 0.935$), compared to previous studies. Additionally, the correlation between BMI and frequency of hospitalization and ER visit results was not statistically significant. Finally, this study found an association between male gender and BMI as the p -value found by a Pearson Chi-squared test was less than the level of statistical significance ($p < 0.05$). Obesity is more prevalent in boys than in girls, and boys are also more likely to suffer from asthma. **Conclusion:** Asthma is a major public health disease that affects the quality of life, and one of the most important factors affecting the disease is obesity but obesity does not affect the severity of asthma as our study showed.

Keyword: Bronchial Asthma , Asthma Exacerbation, BMI ,Hospitalization , ER visit

Introduction

Obesity is a global health problem. The percentage of overweight or obese children in underdeveloped countries was recorded at about 13% for boys and girls in 2013, while in developed countries the percentage was around 45% for both genders. The Kingdom of Saudi Arabia close to the percentage of developed countries

The World Health Organization (WHO) defined obesity and being overweight as ‘abnormal or excessive fat accumulation that may impair health’, so, to determine whether a person is obese or overweight, the Body Mass Index (BMI) Assessment was used (Table 1.1) This indicator is affected by gender and age group, either children or adults. (Kier & Forde, 2011).The weight status categories are shown in table 1.1.

Table 1.1 Paediatric BMI-for-age weight status categories

Weight Status Category	Percentile Range	Percentile Range in growth chart
Underweight	below 18.5 percent	Less than 5 th percentile
Healthy weight	between 18.5 and 24.9 percent	5 th percentile to less than the 85 th percentile
Overweight	between 25 and 29.9 percent	85 th percentile to less than 95 th percentile
Obesity	between 30 and 39.9 percent	95 th percentile or greater

The Centres for Disease Control and Prevention (CDC) criteria and growth charts are commonly used to measure the children and teens' size and growth patterns, BMI-for-age weight status, and the corresponding percentiles. The following categories are defined: less than the 5th percentile (underweight); 5th to less than the 85th percentile (healthy weight); 85th to less than the 95th percentile (overweight); and 95th percentile or greater (obesity) as shown in the previous table 1.1 (WHO,nd). BMI is calculated by dividing a person's weight in kilograms by their height in metres squared (Frankenfield et al., 2001).

Obesity is the most prevalent nutritional disorder affecting the pediatric population in the united states (Kumar, S., & Kelly, A. S , 2017) Obesity is the main risk factor for high blood pressure, diabetes mellitus, hyperinsulinemia, elevated levels of triglycerides, decreased levels of high-density lipoproteins, ischemic heart disease, stroke breast and endometrial cancer, gallbladder disease, menstrual irregularities ,infertility and death in adults (NIDDK ,2017). Likewise, obesity has an obvious effect on bronchial asthma, which changes the airways through mechanical, metabolic, and immunological mechanisms (Obesity and Overweight, n.d.).

The prevalence of asthma and obesity is increasing; evidence-based studies have found a correlation between highly abnormal body mass index (BMI) and bronchial asthma. (Pradeepan et al., 2013). Bronchial asthma is a chronic disorder characterized by airway inflammation, reversible airway obstruction, and airway hyperresponsiveness that leads to recurrent episodes of coughing, breathlessness, chest tightness, and wheezing (Nakagome& Nagata, 2011). It is considered the most common chronic inflammatory disease of the airways and affects people of all ages. It is a multifactorial disease with a combination of intrinsic and extrinsic factors (Jesenak et al., 2017).

Asthmatic attacks as well as poor control of asthma can be precipitated by constant exposure to smoke air borne allergens, environmental pollution (including cigarette smoking, traffic fumes, volatile organic compounds (VOCs), chlorine, phthalates, sulphur dioxide, and ozone), house dust mites and pets (Fainardi et al., 2022). Among children, asthma is widespread and increases

the frequency of emergency room visits. Several researchers have found that obesity increases the risk of asthma and changes its presentation, although this association remains unclear and needs further investigation (Kier & Forde, 2011).

1.1. Research Question and Objectives

This study's main question is whether BMI and the recurrence of emergency room (ER) visits, hospital admission and outpatient department (OPD) visits due to asthma exacerbation are correlated. The tripartite objectives of this thesis are:

Objective 1: To estimate the frequency of asthma exacerbation in overweight and obese children.

Objective 2: Determine whether obesity or gender difference affects the control of asthma.

Objective 3: Observe whether obesity differs between males and females gender and its effect on the disease

1.2. Significance of the Study

Asthma is understood as a chronic disease that is affected by different factors, so we sought to understand the relationship between being overweight or obese as a paediatric patient and asthma to enhance the management of asthma exacerbation.

1.3. Study Organization

The remainder of the thesis is structured as follows: The second chapter reviews the literature of related studies and identifies reported associations between BMI and asthma exacerbation. The third chapter details the research methodology, which includes the methods used to collect and analyse data. The methodology also delineates the tests selected, the research approach, the sample size, the calculation tools, and ethical considerations. The fourth chapter presents the results of the data analysis and the table of different variables and their relationships to asthma exacerbation. The fifth chapter discusses the research findings, the sixth chapters concludes the study by discussing its significance, policy recommendations, and limitations.

1.4. Chapter Summary

This chapter has discussed the problem of obesity and its side effects. It has also presented the factors that may exacerbate asthma in children and outlined the research objectives.

2. LITERATURE REVIEW

2.1. Introduction

This chapter summarizes the results of previous studies on each study variable and indicates that the differences in results were related to patients' asthma, which in turn is affected by BMI.

2.2. Obese Children Diagnosed with Asthma

Several recent studies showed that obesity is an independent risk factor for asthma and there are

environmental triggers that affect it, such as genetic factors, sedentary lifestyle, and composition of the diet. Bad eating habits, in the long run, is likely to promote the chronic inflammatory state seen in asthmatic patients with obesity. Regulating dietary habits contributes to preventing and managing asthma associated with obesity among children (Vijayakanthi et al , 2016 & Calcaterra et al 2021).

Quinto et al. (2011) reported that children with elevated BMI are prone to severe asthmatic attacks as well as poor response to therapeutic modalities.

The exact explanation for the association between increased BMI and asthma remains unclear. New information indicates that obesity in children increases their asthma risk and is associated with more severe exacerbation, poor response to management, and lower quality of life (Kier & Forde, 2011; Di Genova et al., 2018).

Obese asthmatic children are more likely to have severe forms of asthma exacerbation that require mechanical ventilation; poor asthma control; poor responses to asthma therapy; and reduced quality of life compared with asthmatic children of normal body weight (Lang, 2014; Marko & Pawliczak, 2018).

Being of African versus Mexican racial extraction also influences the association between increased BMI and asthma exacerbation among female paediatric patients. Male paediatric patients with increased BMI are associated with asthma exacerbation regardless of their ethnic background (Borrell et al., 2013).

Lang et al. (2014) showed that obese children do not respond well to inhaled corticosteroid therapy and management should include weight loss and routine exercise to improve asthma outcomes.

Forno and Celedón (2017) reported that a significant relationship between airway dysanapsis (an incongruence between the growth of the lungs and the airways) and childhood obesity that increases morbidity and reduces the response to medication (odd ratio (OR), 1.95; 95% Confidence interval (CI): 1.62–2.35).

Recently published research showed that obese and overweight children with asthma compared with normal-weight children with asthma had higher rates of going to the ER and being hospitalized, sometimes with primary admissions to the paediatric intensive care unit (PICU) from the ER (Muc et al., 2016; Mangova et al., 2020).

Papamichael et al. (2019) and Emil et al. (2020) found that forced expiratory volume in one second/forced vital capacity (FEV₁/FVC) in the lung function test showed a significant decrease

with increasing BMI. Forced expiratory flow $FEF_{25-75\%}$ also showed a linear regression in the overweight/obese group compared to the normal-weight group.

Jensen et al. (2013) and Okoniewski et al. (2019) showed that children who changed their diets and lost weight had improved asthma outcomes with less effect on lung function measures.

In contrast, Alhekail et al. (2017) showed no significant relationship between increased BMI, the frequency of visiting the ER, and the duration of frequency of hospitalization for asthma exacerbation.

2.5. Literature Gap

As far as we are aware, this work is the first to investigate the effect of BMI on asthma exacerbation among paediatric patients in Makkah.

3. MATERIALS AND METHODS

3.1 Introduction

The methodology includes the research design and the type of data, sampling methods, and sample size. It also shows the ethical approval date and validity techniques. The study used administrative data to observe the association between the study variables.

3.2 Research Approach

All visits that occurred during the study period at Maternity and Children's Hospital (MCH) in Makkah have been included, except for incomplete data. Patients' secondary data were analysed (It is previously collected data and saved in the system) to identify whether higher BMI increased the probability of hospital visits due to asthma.

3.2 Research Design

A retrospective quantitative study design was used to determine whether a relationship exists between BMI and asthma exacerbation in children that leads to ER visits and hospitalization, using data collected from the hospital system. This design was selected to gather information that could prove or disprove the research hypotheses.

3.3 Data Collection

Secondary data were utilized in this study; these were extracted in an Excel sheet from the MCH health informatics system. The data were received upon approval from the Ethics Committee and contain age, gender, height, weight, frequency of emergency visits, OPD visits, and frequency of admission. The BMI equation mentioned in the introduction, in which the weight in kilograms is divided by the height in metres squared, was added in Excel to calculate each patient's BMI.

3.4 Study Variables

Dependent variable: Asthma exacerbation. Episodes of progressively increasing shortness of

breath, coughing, wheezing, or chest tightness, or some combination of these symptoms are accompanied by decreases in expiratory airflow that can be quantified by measuring lung function.

Independent variables: Age, gender and BMI.

3.5 Sampling

3.5.1 Sample size and selection

This research was considered cross-sectional as it was conducted in Makkah among children 14 years of age or less who visited the ER and OPD or were admitted for asthma exacerbation to MCH from January 2018 to March 2022. This hospital had the highest bed capacity for children. We received 616 data of patients but we excluded 125 sample because of incomplete data or the age of patient oldest than 14 years.

3.5.2 Sampling techniques

The study population included patients who visited the ER, OPD, or were admitted to MCH hospital. The study population was selected through convenience sampling (also known as availability sampling), a probability sampling method that represents the population of children in Makkah who were conveniently available to participate in the study. The majority of the Makkah community used the MCH for their children. As there were 491 participants, the adequacy of the total sample size for this study was very good, as shown in Table 3.1 (Sudiyanti, 2009).

Table 3.1 Guidelines for the adequacy of the total sample size

Sample size	Level of adequacy
50	Very poor
100	Poor
200	Fair
300	Good
500	Very good
1,000	Excellent

3.6 Data Analysis

The primary outcome of the descriptive element analysis is to illustrate socio-demographic characteristics and present them as frequencies and percentages of the given sample. Research data were extracted in an Excel file and then converted to an SPSS file. Then, incomplete data were removed and a descriptive table was created that shows the largest group representing the study data.

Then, regression analyses were performed to illuminate the relationships between the dependent

and independent variables and confirm or refute the study hypotheses, accepting or rejecting the null hypothesis according to the inferential results. Moreover, Chi-square test was used for categorical variables and a p -value of <0.05 for statistical significance. An initial assessment with Spearman correlational analyses was conducted.

3.7 Ethical Considerations

The Declaration of Helsinki emphasised the need to obtain approval from an ethics committee when humans and animals are involved in research. Accordingly, this study has been reviewed, discussed, and approved by the two IRB

(bio medical ethical committees) at Umm Al-Qura University, Number HAPO-02-K-012-2022-03-1026 and the Directorate of Health Affairs in Makkah Region, IRB Number H-02-K-076-0621-528 (see Appendix II).

3.8 Data Security

Researchers are responsible for safeguarding against any disclosures, damages, or inappropriate use of data, as well as ensuring the security and anonymity of data (O'toole et al., 2018).

Accordingly, for secure data storage and access, we kept the data in three different locations. First, in a password-protected document on a similarly protected personal computer. Second, on a Cloud One Drive linked to the researchers' university account, and third, on an external drive where it was both backed up and encrypted.

3.9 Chapter Summary

In this chapter, we have outlined the general methodological approach and specific methods that we used to accomplish this research project. Additionally, we explained the research design – a cross-sectional quantitative study. Moreover, we described our research tools and data collection methods, as well as the ethical considerations we addressed. Lastly, we detailed our secure storage of the data obtained.

4. DATA ANALYSIS RESULTS

4.1 Preface

The main goal of this research was to study the association between BMI and asthma exacerbation among paediatric patients in Makkah. To achieve this purpose, descriptive and inferential statistical methods were used to assess the participants' data to the research question and analyse the relationships among the research variables. Data analysis was performed with the Statistical Package for Social Science (SPSS v.23), which was also used to check the validity of the hypotheses against the results.

4.2 Demographic Background Data Analysis

This section describes the results obtained by analysing the general demographic characteristics of 491 respondents. Results are reported in frequency tables and pie charts.

4.2.1 Gender

Figure 4.1 shows that most of the participants were male, representing 64.36% of the sample, while the percentage of female participants is 35.64%.

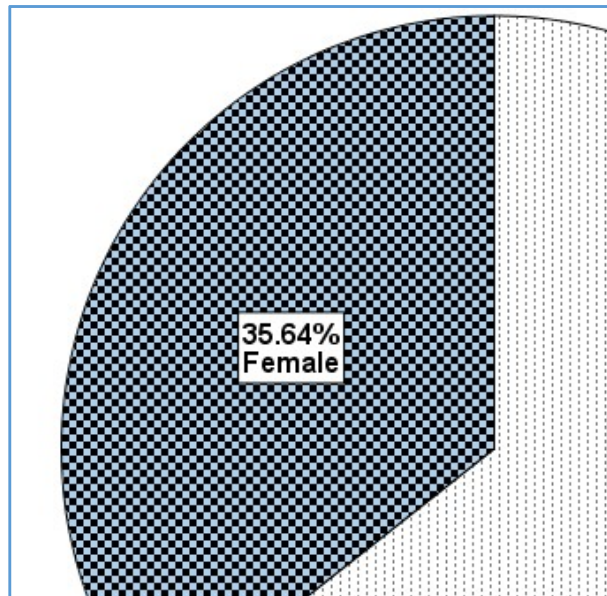


Figure 4.1 Participants' genders

4.2.2 Age

Figure 4.2 shows that 60.9% of participants were in the 5–9 years old category, while 18.94% of participants were in the 10–14 years old category, finally 20.16% of participants less than 5 years old category.

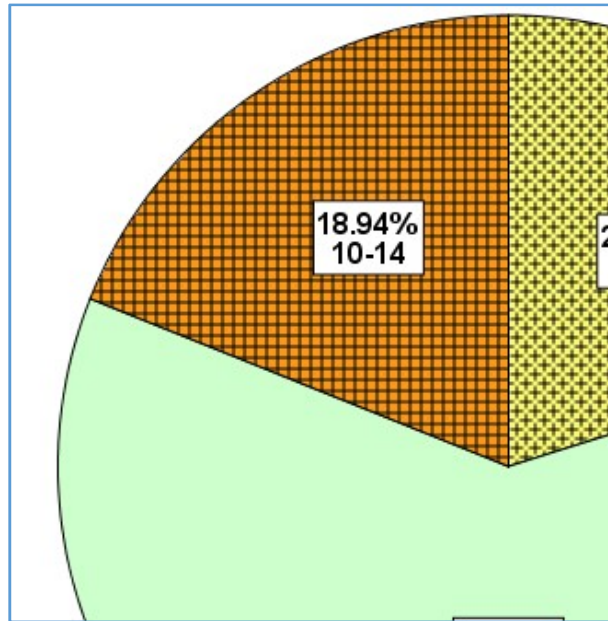


Figure 4.2 Participants' ages

4.2.3 Height

Table 4.1 shows participants' height frequencies.

Table 4.1: Participants' distribution by height

Height (cm)	Frequency	Percentage
15–49	11	2.2%
50–84	54	11.0%
85–119	213	43.4%
120+	213	43.4%
Total	491	100%

Table 4.1 shows that the majority of participants were 85–119 or 120+ cm in height, with 43.4% of participants in each category, while 2.2% of the sample was 15–49 cm tall.

4.2.4 Weight

Table 4.2 shows participants' weight frequencies.

Table 4.2: Participants' distribution by weight

Weight (kg)	Frequency	Percentage
<15.00	178	36.3%
15.00–34.24	262	53.4%
34.25–53.49	35	7.1%

53.50–72.74	12	2.4%
72.75–92	4	0.8%
Total	491	100%

Table 4.2 shows that the majority of participants were 15–34.24 kg, representing 53.4% of the sample, while 0.8% of the sample weighed 72.75–92 kg.

4.3 Assessment of Participants’ Pathologies

4.3.1 BMI

Figure 4.3 shows that 81.87% of participants had BMIs of less than 20 percentile in growth chart, while 0.14% of participants had BMIs of 59.9–79.87 percentile in growth chart.

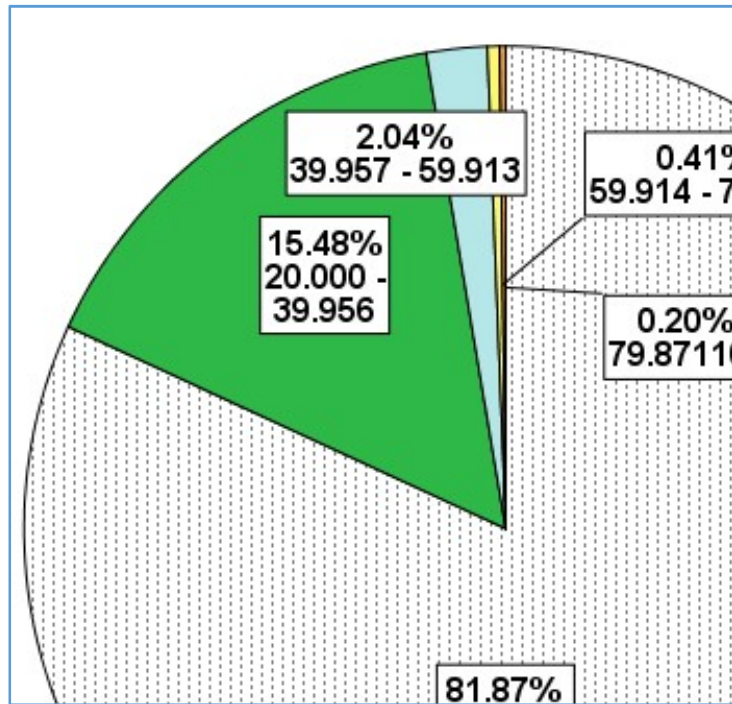


Figure 4.3 Participants’ BMI

4.3.2 Diagnoses

Table 4.3 shows participants’ diagnoses.

Table 4.3: Participants’ distribution by diagnosis (Diagnosis)

Diagnosis	Frequency	Percentage
Predominantly allergic asthma	277	56.4%
Status asthmaticus	86	17.5%
Family history of asthma and other chronic	18	3.7%
Non-allergic asthma	45	9.2%
Mixed asthma	65	13.2%
Total	491	100%

Table 4.3 shows that the majority of participants were diagnosed with predominantly allergic asthma, at 56.4% of the sample, while 3.7% of the sample had a family history of asthma and other chronic lower respiratory diseases.

4.3.3 Time to outpatient status

Table 4.4 shows the study outpatient cases.

Table 4.4: Participants’ distribution by time to outpatient status (OUT PATIENT)

OUT PATIENT (visit days)	Frequency	Percentage
<500	487	99.2%
827–1152	2	0.4%
1153+	2	0.4%
Total	491	100%

Table 4.4 shows that majority of participants were visited hospital as outpatients for less than 500 days after their discharge, with 99.2% of the sample.

4.3.4 Emergency

Figure 4.4 shows that the majority of the participants have less than 500 times EMR visit, with 99.19% of the sample, whereas only 0.20% of the participants have EMR visit of 808–1,113 times or 1,421–2,000 times. Only 0.41% of the participants have 500–806 times EMR visit.

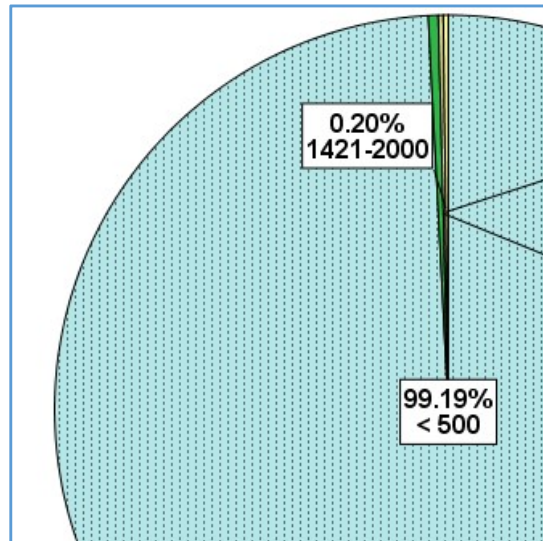


Figure 4.4 Participants’ EMR

4.4 Analyses of Associations Between Research Variables

4.4.1 Associations between participants’ gender and age

Table 4.5 shows the associations between participants’ gender and age.

Table 4.5: Chi-squared test to validate associations between participants’ gender and age

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-squared	24.391	14	.041
Likelihood ratio	25.575	14	.029
Linear-by-linear association	.019	1	.889
N of valid cases	491		

Table 4.5 shows an association between gender and age as the Pearson Chi-squared *p*-value is less than the statistical significance level (0.05). This association is for males.

4.4.3 Associations between participants’ gender and BMI

Table 4.6 shows the associations between participants’ gender and BMI

Table 4.6: Chi-squared test to validate associations between participants’ gender and BMI

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-squared	409.851	296	.000
Likelihood ratio	533.544	296	.000
Linear-by-linear association	.713	1	.398
N of valid cases	491		

Table 4.6 shows an association between BMI and asthmatic attack in males as the Pearson Chi-squared *p*-value is less than the statistical significance level (0.05).

4.4.4 Associations between participants’ gender and outpatient

Table 4.7 shows the associations between participants’ gender and outpatient.

Table 4.7: Chi-squared test to validate associations between participants’ gender and outpatient

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-squared	90.026a	78	.166
Likelihood ratio	112.483	78	.006
Linear-by-linear association	4.357	1	.037
N of valid cases	491		

Table 4.7 shows no association between gender and outpatient as the Pearson Chi-squared *p*-value is greater than the statistical significance level (0.05).

4.4.5 Associations between participants' gender and EMR

Table 4.8 shows the associations between participants' gender and EMR.

Table 4.8: Chi-squared test to validate associations between participants' gender and EMR

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-squared	90.026a	78	.166
Likelihood ratio	112.483	78	.006
Linear-by-linear association	4.357	1	.037
N of valid cases	491		

Table 4.8 shows no association between gender and EMR as the Pearson Chi-squared *p*-value is greater than the statistical significance level (0.05).

4.4.6 Associations between participants' gender and inpatient

Table 4.9 shows the associations between participants' gender and inpatient.

Table 4.9: Chi-squared test to validate associations between participants' gender and inpatient

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-squared	74.252a	81	.689
Likelihood ratio	99.203	81	.083
Linear-by-linear association	2.553	1	.110
N of valid cases	491		

Table 4.9 shows no association between gender and inpatient as the Pearson Chi-squared *p*-value is greater than the statistical significance level (0.05).

4.4.7 Associations between participants' age and BMI

Table 4.10 shows the associations between participants' age and BMI.

Table 4.10: Chi-squared test to validate associations between participants' age and BMI

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-squared	893.671a	592	.000
Likelihood ratio	849.677	592	.000
Linear-by-linear association	.008	1	.928
N of valid cases	491		

Table 4.10 shows an association between age and BMI as the Pearson Chi-squared *p*-value is less

than the statistical significance level (0.05). This association is for participants aged 5–9 years old.

4.4.8 Associations between participants' BMI and EMR

Table 4.11 shows the associations between participants' BMI and EMR.

Table 4.11: Chi-squared test to validate associations between participants' BMI and EMR

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-squared	796.489a	888	0.987
Likelihood ratio	45.965	888	1.000
Linear-by-linear association	.293	1	.589
N of valid cases	491		

Table 4.11 shows no association between BMI and EMR as the Pearson Chi-squared *p*-value is greater than the statistical significance level (0.05).

4.4.9 Associations between participants' BMI and outpatient

Table 4.12 shows the associations between participants' BMI and outpatient.

Table 4.12: Chi-squared test to validate associations between participants' BMI and outpatient

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-squared	355.458a	592	1.000
Likelihood ratio	36.606	592	1.000
Linear-by-linear association	.017	1	.895
N of valid cases	491		

Table 4.12 shows no association between BMI and outpatient as the Pearson Chi-squared *p*-value is greater than the statistical significance level (0.05).

4.4.10 Associations between participants' BMI and inpatient

Table 4.13 shows the associations between participants' BMI and inpatient.

Table 4.13: Chi-squared test to validate associations between participants' BMI and inpatient

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-squared	277.035a	592	1.000
Likelihood ratio	35.555	592	1.000
Linear-by-linear association	.170	1	.680

N of valid cases	491		
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Table 4.13 shows no association between BMI and inpatient as the Pearson Chi-squared *p*-value is greater than the statistical significance level (0.05).

4.5 Associations Between Study Variables

To test the associations between the dependent variable (Asthma Control) and the independent variables (Age, Gender and BMI), simple linear regression method used and table 4.14 is the result summary.

Table 4.14: Results of the simple linear regression

No.	Independent variables	Dependent Variable	R ²	β	Sig(p value)	Equation
1	Age	Asthma Control	0.009	0.093	0.039	Age _x Asthma=56.16 - 4.042
2	Gender		0.005	0.072	0.110	Gender _x Asthma=54.917 - 19.902
3	BMI		0.002	0.004	0.935	BMI _x Asthma=27.073 + 0.51

From table 4.14, there was statistical significant between dependent variable (asthma control) and independent variable (age) since sig = (0.039) , while other Independent variables did not show any statistical significant between them and asthma control , as the statistical significance level greater than p value (0.05).The linear equation between independent and dependent variables are listed in equation column. One can predict future variables of dependent variable using this equation and the value of independent variable.

4.6 Testing the Research Hypotheses

4.6.1 Testing hypothesis 1: Increased BMI affects asthma control and leads to asthma exacerbation

To validate hypothesis 1, the Pearson correlation coefficient was used to check whether BMI affects asthma control and leads to asthma exacerbation. See Table 4.15.

Table 4.15 Pearson correlation coefficient testing the correlation between BMI and asthma control

	BMI	
Asthma control	Pearson correlation	.004
	Sig.* (2-tailed)	.935
	N	491

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

Table 4.15 shows no statistically significant correlation between BMI and asthma control, as Sig. = 0.935 is greater than the significance level $\alpha = 0.05$.

Figure 4.5 also demonstrates no correlation between BMI and asthma control as no linear relationship between the two variables exists.

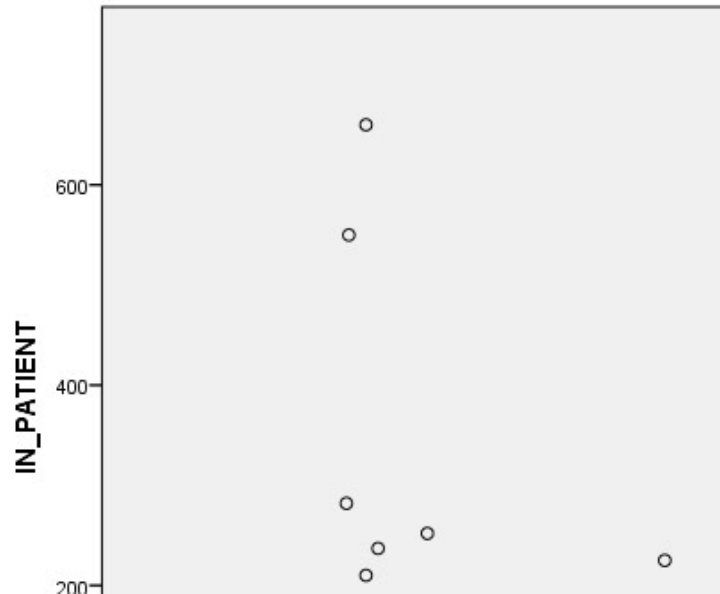


Figure 4.5: Scatter plot of BMI versus inpatient

4.6.2 Testing hypothesis 2: Increased BMI affects asthma control and leads to an increased frequency of hospitalization and ER visits

To validate hypothesis 2, a Pearson correlation coefficient was used to check whether BMI affects the increased frequency of hospitalization and ER visits. See Table 4.16.

Table 4.16: Pearson correlation coefficient to test the correlation between BMI and frequency of hospitalization and ER visits

		BMI
Frequency of hospitalization and ER visits	Pearson correlation	.049
	Sig.* (2-tailed)	.419
	N	277

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

Table 4.16 shows no statistically significant correlation between BMI and the frequency of hospitalization and ER visits as Sig. = 0.419 is greater than the significance level $\alpha = 0.05$.

Figure 4.6 also demonstrates no correlation between BMI and the frequency of hospitalization and ER visits as no linear relationship exists between the two variables.

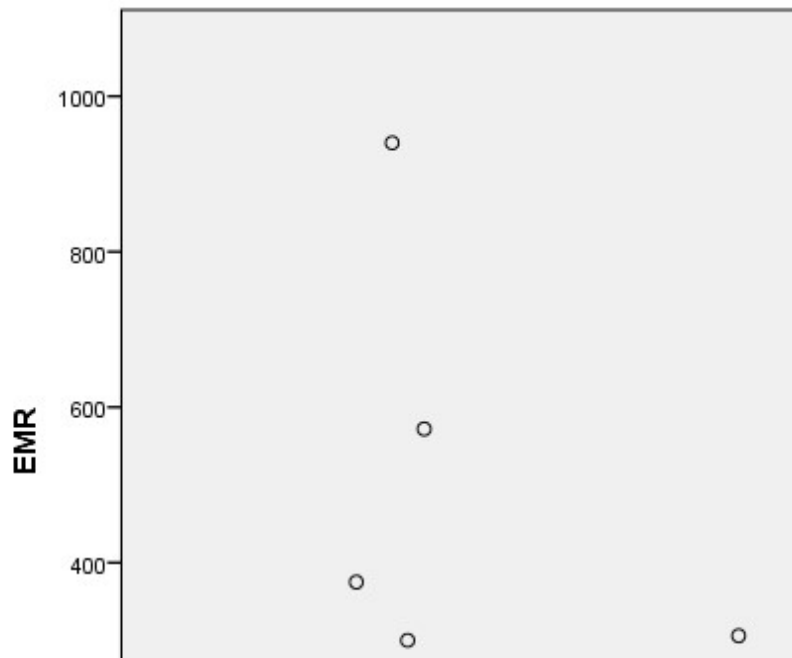


Figure 4.6: Scatter plot of BMI versus the frequency of hospitalization and ER visits

4.7 Chapter Summary

In this chapter, an analysis of the demographic information and the research variables were carried out using frequencies, percentages, and representation with graphs. The research question was answered, and two hypotheses were tested after analysing them, using chi-square, pearson correlation coefficient, and simple linear regression to verify the hypotheses. Results showed that the two hypotheses were not supported.

5. DISCUSSION

5.1 Introduction

In this chapter, we will discuss the results of this study and compare them with those of previous studies.

5.2 Research Findings

The results of this study related to each study dimension are discussed in the following sections.

5.2.1 The association between BMI and control of asthmatic attack in paediatric patients

The current study showed no significant correlation between BMI and control of asthmatic attacks in both sexes. The Pearson correlation test recorded that Sig. = 0.935, consistent with (Alhekail et al. ,2017), who also proved that BMI did not affect asthma control. This lack of correlation is probably due to relatively small sample size and / or age of participants. Some studies showed that children with increased BMI were prone to poor control of asthma attack as well as severity of asthmatic manifestations, need of mechanical ventilation, and reduced quality of life(Lang JE et al ,2018).

5.2.2 The correlation between BMI and the frequency of hospitalization and ER visits

The current study showed no statistical significance as far as correlation between BMI and frequency of hospitalization and ER visits in asthmatic participants. This is in contrast to (Gross et al, 2018) who demonstrated positive correlation even with overweight candidates.

5.2.3 The associations between participants' gender and BMI

The association between asthmatic male gender and BMI is remarkably proven statistically ($p < 0.05$). Among children 5–10 years old, obesity is more prevalent among boys than girls. Boys are also more susceptible to asthma, with worse manifestations than girls (Lang et al., 2013). The degree of reduction of FEV1/FVC is disproportionate to the severity of manifestations of asthma; this may indicate the greater negative impact of obesity on airway hyperactivity (Ross & Bibler Zaidi, 2019). Nahaas M et al. showed an association between BMI and worsening asthma manifestations in both sexes during pre-puberty. However, the symptomatology improves in both sexes during puberty and adulthood (Labaree, 2009).

This means that patients' hormonal profile have important effects on the association of BMI and the severity of asthma manifestations among children. The mechanisms driving the greater susceptibility of boys remain to be elucidated. They could be due to differences in hormonal profile, particularly gonadal sex hormones and adrenocortical androgenic hormones.

(Vangeepuram et al & Mamun AA et al) demonstrate strong associations between BMI and the severity of asthmatic manifestation. However, they reached no conclusions regarding the relationship between asthma and the gender or ethnic backgrounds of paediatric participants (Dharmage et al., 2019; 2030, n.d.). The association between asthma and obesity during childhood and adolescence is bidirectional (Shan et al., 2020). That is, obesity can increase the likelihood of recurrent asthma attacks, while asthma can increase the risk of obesity and its consequent complications. Studying this bidirectional relationship will improve our understanding of the pathophysiology of both asthma and obesity and lead to improved preventative strategies and therapeutic interventions for these important global problems.

5.2.4 correlation between BMI and asthma exacerbation in pediatric

The current study showed no significant correlation between BMI and exacerbation of asthmatic manifestation ($p = 0.935$)

6. RECOMMENDATIONS AND CONCLUSIONS

6.1 Introduction

This chapter of the research project consolidates its main findings, highlights its contributions via policy implications and recommendations arising from the findings, and outlines areas for future research.

6.2 Limitations of the Research

Study limitations represent weaknesses within the research design that may influence the study

outcomes and conclusions (Ross & Bibler Zaidi, 2019). Limitations also include characteristics of the design or methodology that influenced the applicability or interpretation of the study results and constraints on the generalizability and utility of findings that result from the study design or the internal and external validation methods (Labaree, 2009).

This project has two limitations. First, the sample was not drawn from all paediatric hospitals in Makkah. This research project was intended to draw from two hospitals, but we could not obtain all of the required data, like height and weight from one hospital, leading to the rejection of 1,500 samples. Our sample size is convenient but would be more valuable if it were larger. The second limitation is the lack of similar studies in the Kingdom of Saudi Arabia, which forced us to compare the study to research from abroad.

6.3 Recommendations

Asthma is a globally significant non-communicable disease with major public health consequences on both morbidity and mortality, in severe cases. It is ranked 16th among the leading causes of disability and affects patients' quality of life (Dharmage et al., 2019), and one of the most important factors affecting the disease is obesity or being overweight. This study shades light on one of the most common diseases that affect children's lives and their serious adverse sequences as well as raising awareness of people about such global health problems and their future improvement. This study strongly recommends children and parents to avoid the factors which provoke asthmatic attacks, especially children with increased BMI. Education of parents to take care of children's weight control cannot be over emphasized. Children should be protected from passive smoking whether at home, school or kindergarten, public assemblies, or wheresoever they are.

This study encourages researchers in the Kingdom of Saudi Arabia to investigate this topic in several regions at a larger scale and more depth to achieve better understanding of such serious health problems.

This thesis results in several recommendations based on the gathered data. Parents and children should be made aware of the danger of obesity, its impact on quality of life, and the increase in the severity of diseases such as asthma; for example, schools and neighbourhood centres should promote healthy eating to reduce the problem of obesity at all levels. Hospitals should also be encouraged to record data accurately and facilitate researchers' access to data for research purposes to improve society.

6.3 Contributions and Implications of the Research

The Saudi Ministry of Health aims to develop health studies and research that serve the health system to reduce the incidence of various diseases, as well as death rates. It also directs care to the most vulnerable groups in society, such as children and pregnant women, to develop and reform the health system and ensure high-quality healthcare in line with the Saudi Vision 2030

objectives. The results of this study provide valuable contributions to achieving these national goals.

6.4 Conclusion

This study aimed to identify the impact of BMI on the frequency of ER visits and length of hospitalization among asthmatic patients aged 14 or less in Makkah from 2018–2022 by answering the study questions and verifying two hypotheses.

The sample size was 491 patients, whose data were analysed and discussed. No significant correlation was found between BMI and asthma control as the Pearson correlation test resulted in Sig. = 0.935. The study showed a significant association between gender and BMI as the Sig. for the Pearson Chi-squared test was less than the statistical significance level (0.05). There was no statistically significant correlation between BMI and the frequency of hospitalization and ER visits, as Sig. = 0.419 is greater than the significance level $\alpha = 0.05$.

Finally the current study showed no significant correlation between BMI and exacerbation of asthmatic manifestation ($p = 0.935$)

7. REFERENCIELIST

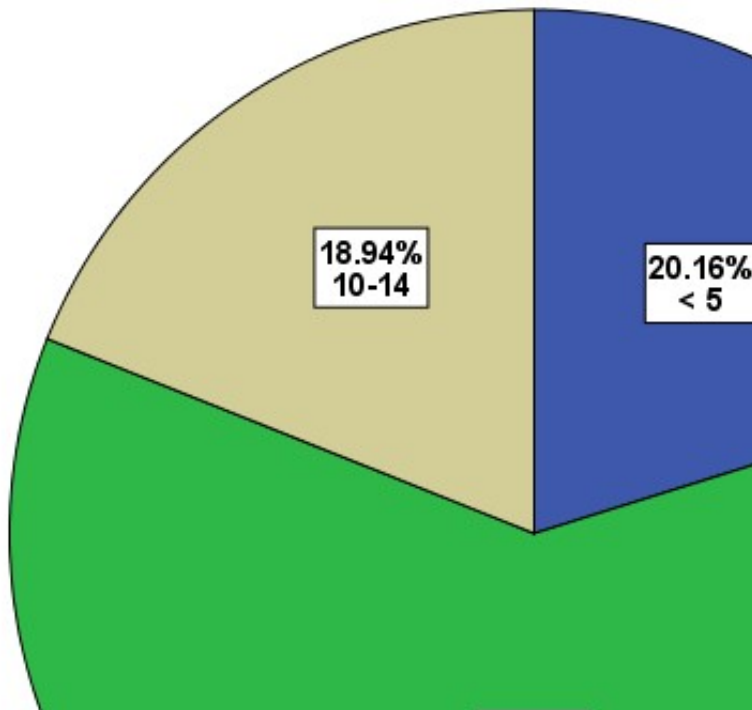
- [1] 2030, O. of vision. (n.d.). *2030, Vision Objectives*. Retrieved May 14, 2022, from <https://mufahras.com/Objectives of Vision 2030>
- [2] Alhekail, G. A., Althubaiti, A., & AlQueflie, S. (2017). The association between body mass index and frequency of emergency department visits and hospitalization for asthma exacerbation in a pediatric population. *Annals of Saudi Medicine*, 37(6), 415–419.
- [3] Borrell, L. N., Nguyen, E. A., Roth, L. A., Oh, S. S., Tcheurekdjian, H., Sen, S., Davis, A., Farber, H. J., Avila, P. C., & Brigino-Buenaventura, E. (2013). Childhood obesity and asthma control in the GALA II and SAGE II studies. *American Journal of Respiratory and Critical Care Medicine*, 187(7), 697–70.
- [4] Calcaterra, V., Verduci, E., Ghezzi, M., Cena, H., Pascuzzi, M. C., Regalbuto, C., Lamberti, R., Rossi, V., Manuelli, M., & Bosetti, A. (2021). Pediatric obesity-related asthma: The role of nutrition and nutrients in prevention and treatment. *Nutrients*, 13(11), 3708.
- [5] *Defining Childhood Weight Status | Overweight & Obesity | CDC*. (n.d.). Retrieved October 16, 2021, from <https://www.cdc.gov/obesity/childhood/defining.html>
- [6] Dharmage, S. C., Perret, J. L., & Custovic, A. (2019). Epidemiology of asthma in children and adults. *Frontiers in Pediatrics*, 7, 246.
- [7] Di Genova, L., Penta, L., Biscarini, A., Di Cara, G., & Esposito, S. (2018). Children with obesity and asthma: which are the best options for their management? *Nutrients*, 10(11), 1634.
- [8] Emil, G. E., Mohammed, A. F., & Mohamed, H. M. (2020). Effects of body weight and posture on pulmonary functions in asthmatic children. *African Health Sciences*, 20(4),

- 1777–1784.
- [9] Fainardi, V., Passadore, L., Labate, M., Pisi, G., & Esposito, S. (2022). An Overview of the Obese-Asthma Phenotype in Children. In *International Journal of Environmental Research and Public Health* (Vol. 19, Issue 2). MDPI.
<https://doi.org/10.3390/ijerph19020636>
- [10] Forno, E., & Celedón, J. C. (2017). The effect of obesity, weight gain, and weight loss on asthma inception and control. *Current Opinion in Allergy and Clinical Immunology*, *17*(2), 123.
- [11] Frankenfield, D. C., Rowe, W. A., Cooney, R. N., Smith, J. S., & Becker, D. (2001). Limits of body mass index to detect obesity and predict body composition. *Nutrition*, *17*(1), 26–30.
- [12] Gross, E., Lee, D. S., Hotz, A., Ngo, K. C., & Rastogi, D. (2018). Impact of obesity on asthma morbidity during a hospitalization. *Hospital Pediatrics*, *8*(9), 538–546.
- [13] Health Risks of Overweight & Obesity | NIDDK [Internet]. [cited 2022 May 28]. Available from: <https://www.niddk.nih.gov/health-information/weight-management/adult-overweight-obesity/health-risks>
- [14] Jensen, M. E., Gibson, P. G., Collins, C. E., Hilton, J. M., & Wood, L. G. (2013). Diet-induced weight loss in obese children with asthma: a randomized controlled trial. *Clinical & Experimental Allergy*, *43*(7), 775–784.
- [15] Jesenak, M., Zelieskova, M., & Babusikova, E. (2017). Oxidative stress and bronchial asthma in children—causes or consequences? *Frontiers in Pediatrics*, *5*, 162.
- [16] Kier, C., & Forde, S. A. (2011). Childhood overweight and obesity and their association with asthma. *Journal of Asthma & Allergy Educators*, *2*(3), 119–125.
- [17] Lang, J. E. (2014). Obesity and asthma in children: current and future therapeutic options. *Pediatric Drugs*, *16*(3), 179–188.
- [18] Lang, J. E., Fitzpatrick, A. M., Mauger, D. T., Guilbert, T. W., Jackson, D. J., Lemanske Jr, R. F., Martinez, F. D., Strunk, R. C., Zeiger, R. S., & Phipatanakul, W. (2018). Overweight/obesity status in preschool children associates with worse asthma but robust improvement on inhaled corticosteroids. *Journal of Allergy and Clinical Immunology*, *141*(4), 1459–1467.
- [19] Lang, J. E., Holbrook, J. T., Wise, R. A., Dixon, A. E., Teague, W. G., Wei, C. Y., Irvin, C. G., Shade, D., Lima, J. J., & Centers, A. L. A. C. R. (2013). Obesity in children with poorly controlled asthma: sex differences. *Pediatric Pulmonology*, *48*(9), 847–856.
- [20] Kumar, S., & Kelly, A. S. (2017, February). Review of childhood obesity: from epidemiology, etiology, and comorbidities to clinical assessment and treatment. In *Mayo Clinic Proceedings* (Vol. 92, No. 2, pp. 251-265). Elsevier.
- [21] Mangova, M., Lipek, T., Vom Hove, M., Körner, A., Kiess, W., Treudler, R., & Prenzel, F. (2020). Obesity-associated asthma in childhood. *Allergologie Select*, *4*, 76.
- [22] Marko, M., & Pawliczak, R. (2018). Obesity and asthma: risk, control and treatment. *Advances in Dermatology and Allergology/Postępy Dermatologii i Alergologii*, *35*(6), 563.

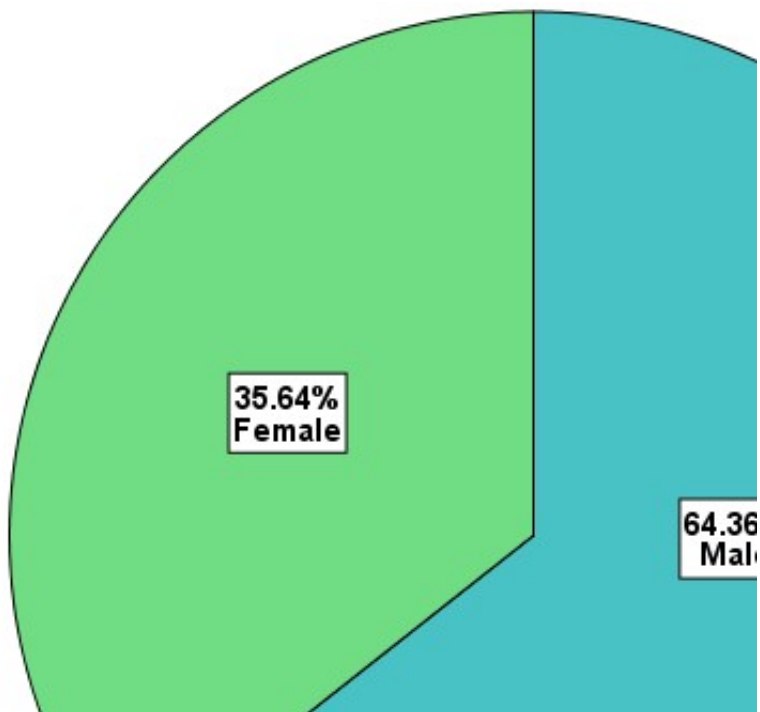
- [23] Mamun AA, Lawlor DA, Alati R, O’Callaghan MJ, Williams GM, Najman JM. Increasing body mass index from age 5 to 14 years predicts asthma among adolescents: evidence from a birth cohort study. *Int J Obes*. 2007;31(4):578–83.
- [24] Muc, M., Mota-Pinto, A., & Padez, C. (2016). Association between obesity and asthma—epidemiology, pathophysiology and clinical profile. *Nutrition Research Reviews*, 29(2), 194–201.
- [25] Nakagome, K., & Nagata, M. (2011). Pathogenesis of airway inflammation in bronchial asthma. *Auris Nasus Larynx*, 38(5), 555–563.
- [26] Nahhas M, Bhopal R, Anandan C, Elton R, Sheikh A. Investigating the association between obesity and asthma in 6-to 8-year-old Saudi children: a matched case–control study. *NPJ Prim care Respir Med*. 2014;24(1):1–7.
- [27] O’toole, E., Feeney, L., Heard, K., & Naimpally, R. (2018). *DATA SECURITY PROCEDURES FOR RESEARCHERS*.
- [28] *Obesity and overweight*. (n.d.). Retrieved May 26, 2022, from <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>
- [29] Okoniewski, W., Lu, K. D., & Forno, E. (2019). Weight loss for children and adults with obesity and asthma. A systematic review of randomized controlled trials. *Annals of the American Thoracic Society*, 16(5), 613–625.
- [30] Papamichael, M. M., Katsardis, C., Tsoukalas, D., Erbas, B., & Itsiopoulos, C. (2019). Weight status and respiratory health in asthmatic children. *Lung*, 197(6), 777–782.
- [31] Pradeepan, S., Garrison, G., & Dixon, A. E. (2013). Obesity in asthma: approaches to treatment. *Current Allergy and Asthma Reports*, 13(5), 434–442.
- [32] Quinto, K. B., Zuraw, B. L., Poon, K.-Y. T., Chen, W., Schatz, M., & Christiansen, S. C. (2011). The association of obesity and asthma severity and control in children. *Journal of Allergy and Clinical Immunology*, 128(5), 964–969.
- [33] Shan, L. S., Zhou, Q. L., & Shang, Y. X. (2020). Bidirectional Association Between Asthma and Obesity During Childhood and Adolescence: A Systematic Review and Meta-Analysis. *Frontiers in Pediatrics*, 8, 688.
<https://doi.org/10.3389/FPED.2020.576858/BIBTEX>
- [34] Shah B, Cost KT, Fuller A, Birken CS, Anderson LN. Sex and gender differences in childhood obesity: contributing to the research agenda. *BMJ Nutr Prev Heal*. 2020;3(2):387.
- [35] Sudiyanti, S. (2009). Predicting women purchase intention for green food products in Indonesia. 146 s. Available at: <https://Uia.Brage.Unit.No/Uia-Xmlui/Handle/11250/135342> (Accessed: 11 November 2021).
- [36] Vangeepuram N, Teitelbaum SL, Galvez MP, Brenner B, Doucette J, Wolff MS. Measures of obesity associated with asthma diagnosis in ethnic minority children. *J Obes*. 2011;2011.
- [37] Vijayakanthi, N., Greally, J. M., & Rastogi, D. (2016). Pediatric obesity-related asthma: the role of metabolic dysregulation. *Pediatrics*, 137(5).

8.Appendices

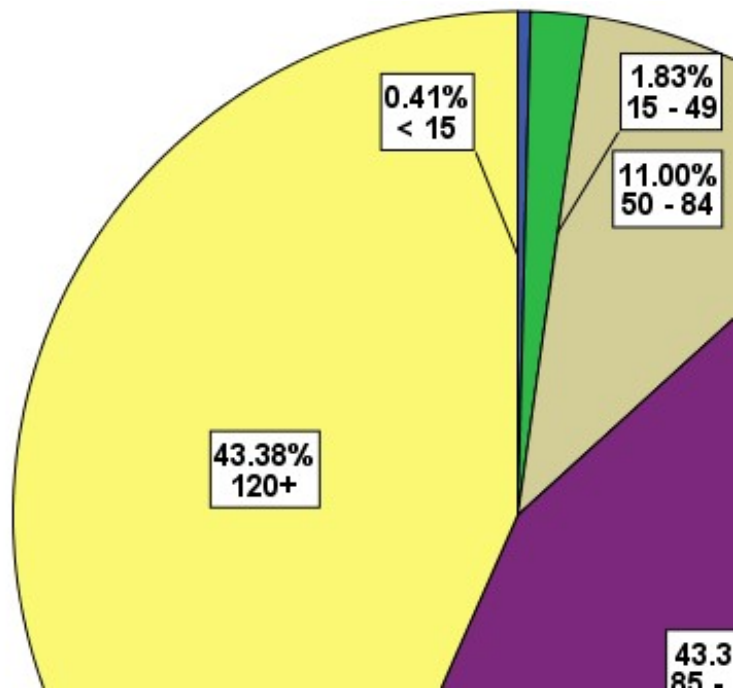
Graph 8.1 Age



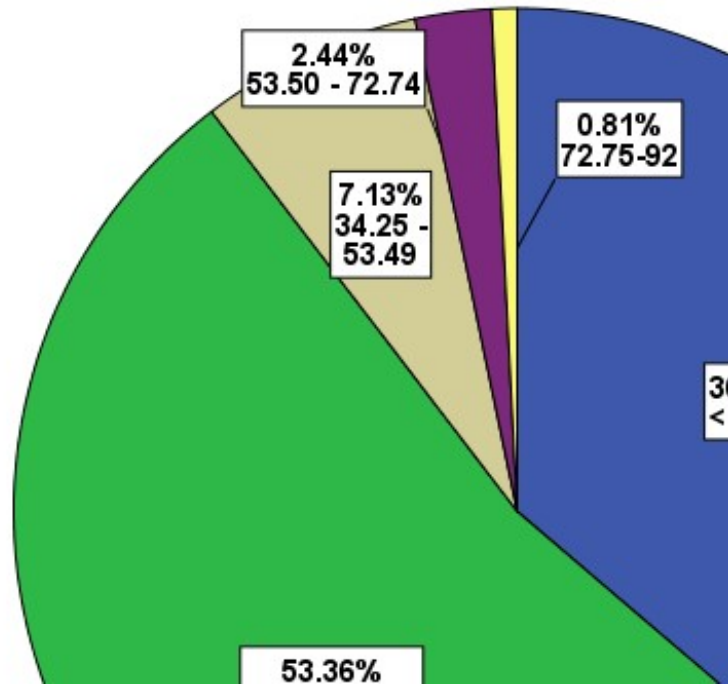
Graph 8.2 Gender



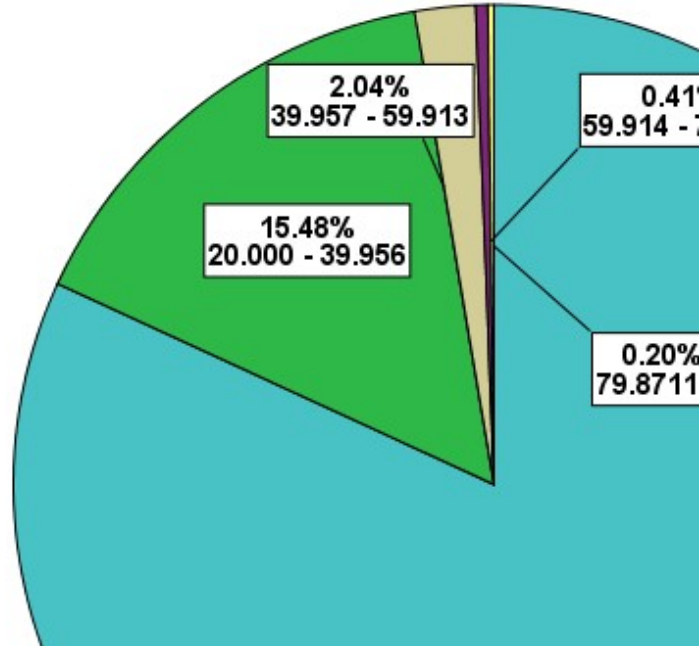
Graph 8.3 Height



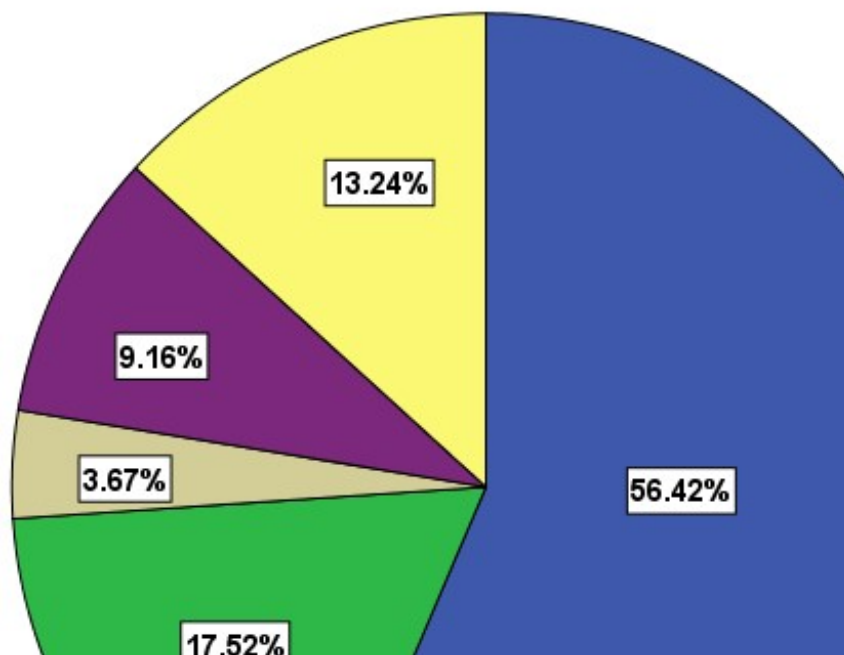
Graph 8.4 WEIGHT



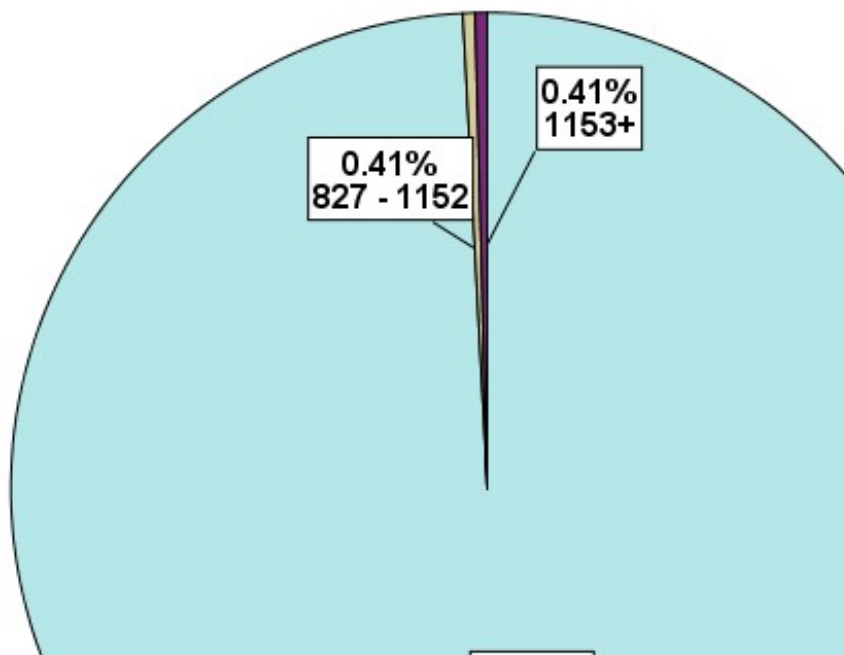
Graph 8.5 BMI



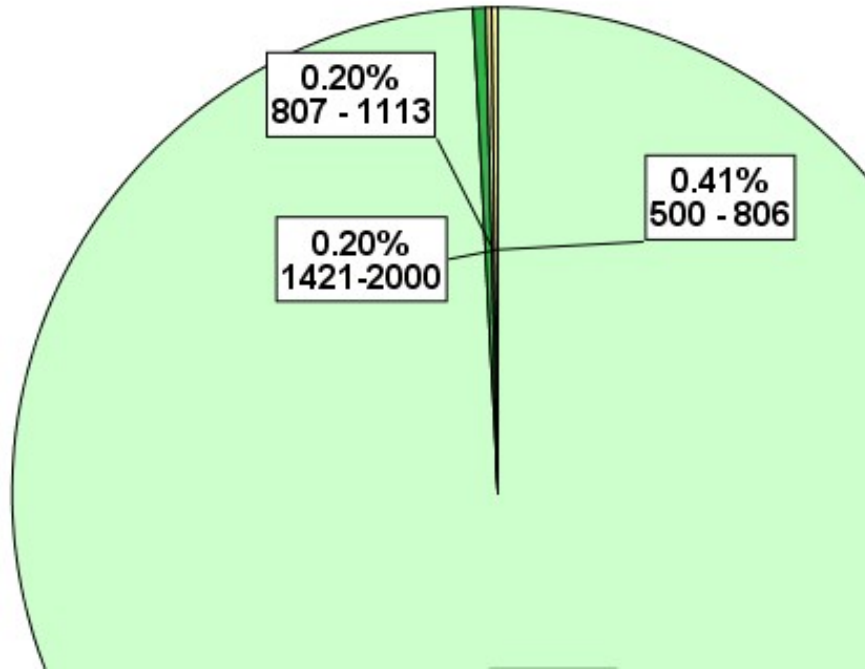
Graph 8.6 diagnosis_names

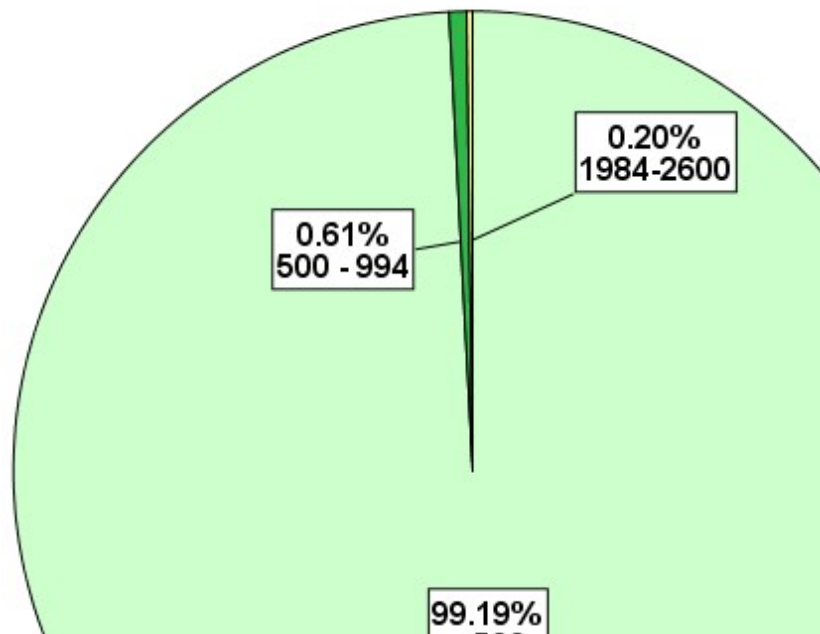


Graph 8.8 Outpatient



Graph 8.9 ER_Category





Graph 8.10 IN_PATIENT

8.2 study tables

Table 8.1 Participants' Age

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid < 5	99	20.2	20.2	20.2
5 - 9	299	60.9	60.9	81.1
10-14	93	18.9	18.9	100.0
Total	491	100.0	100.0	

Table 8.2 Participants' Gender

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Male	316	64.4	64.4	64.4
Female	175	35.6	35.6	100.0
Total	491	100.0	100.0	

Table 8.3 Participants' Height_Categoroy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 15	2	.4	.4	.4
	15 - 49	9	1.8	1.8	2.2
	50 - 84	54	11.0	11.0	13.2
	85 - 119	213	43.4	43.4	56.6
	120+	213	43.4	43.4	100.0
	Total	491	100.0	100.0	

Table 8.4 Participants' Weight_Category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 15.00	178	36.3	36.3	36.3
	15.00 - 34.24	262	53.4	53.4	89.6
	34.25 - 53.49	35	7.1	7.1	96.7
	53.50 - 72.74	12	2.4	2.4	99.2
	72.75-92	4	.8	.8	100.0
	Total	491	100.0	100.0	

Table 8.5 Participants' BMI_Category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 20.000	402	81.9	81.9	81.9
	20.000 - 39.956	76	15.5	15.5	97.4
	39.957 - 59.913	10	2.0	2.0	99.4
	59.914 - 79.870	2	.4	.4	99.8
	79.871100	1	.2	.2	100.0
	Total	491	100.0	100.0	

Table 8.6 Diagnosis name category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Predominantly allergic asthma	277	56.4	56.4	56.4
	Status asthmaticus	86	17.5	17.5	73.9
	Family history of asthma and other chronic lower respiratory diseases	18	3.7	3.7	77.6
	Nonallergic asthma	45	9.2	9.2	86.8
	Mixed asthma	65	13.2	13.2	100.0
	Total	491	100.0	100.0	

Table 8.7 Out_Patient_Category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 500	487	99.2	99.2	99.2
	827 - 1152	2	.4	.4	99.6
	1153+	2	.4	.4	100.0
	Total	491	100.0	100.0	

Table 8.8 ER_category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 500	487	99.2	99.2	99.2
	500 - 806	2	.4	.4	99.6
	807 - 1113	1	.2	.2	99.8
	1421-2000	1	.2	.2	100.0
	Total	491	100.0	100.0	

Table 8.9 IN_PATIENT_category

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 500	487	99.2	99.2	99.2
	500 - 994	3	.6	.6	99.8
	1984-2600	1	.2	.2	100.0
	Total	491	100.0	100.0	



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DEDICATION

This work is dedicated to my beloved parents, Prof. Khayriah Omar Hawsawi, and Dr Sami Omar Alsabbah

I would never succeed in achieving my dreams without their constant prayers, encouragement, and belief.

To my brothers and sisters
for their support and understanding.

To all of my family
for their unlimited prayers.
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Finally, I thank all the people who have supported me in completing this work, directly or indirectly.

Omamah Sami Alsabbah

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LISTOFABBREVIATIONS

BMI	Body Mass Index
CI	Confidence interval
CM	Centimetre
FEV1	Forced expiratory volume in one second
FEF _{25-75%}	Forced expiratory flow
FVC	Forced vital capacity
IRB	Committee of the Research Department in

	the Umm Al-Qura university
KG	Kilogram
KSA	Kingdom of Saudi Arabia
MCH	Maternity and Children's Hospital
N	Number of case
ER or EMR	Emergency room
OPD	Outpatient department
OD	Odd ratio
p	P-value
PICU	Pediatric intensive care unit
Sig	Significant
SPSS	Statistical Package for Social Science Software
VOC	Volatile organic compounds
WHO	World Health Organization

LISTOFAPPENDICES

Appendices
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