

Original article

# Clinical Predictors of Children with Bronchial Asthma admitted to the Intensive Care Unit at Tripoli Children's Hospital

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## INTRODUCTION

Asthma is one of the most common major noncommunicable diseases, and it significantly affects many people's quality of life. Asthma is ranked 16th globally in terms of years lived with disability and 28th in terms of disease burden, as measured by disability-adjusted life years. Asthma affects approximately 300 million people worldwide, with an additional 100 million expected by 2025 [1]. Asthma prevalence, severity, and mortality rates vary greatly by geography. While asthma prevalence is higher in high-income countries, the majority of asthma-related deaths occur in low- and middle-income countries [2].

Even though asthma treatment has advanced in recent decades, more can be done to enhance patient education, use innovative diagnostic techniques, and apply individualized case management. Children and adults exhibit different patterns in the incidence and prevalence of asthma. Asthma is known to start in childhood, but it can strike at any age, and some people get asthma for the first time in their adult lives. Children are more likely to have asthma, but adults are more likely to die from asthma-related causes and use healthcare services. It's interesting to note that asthma prevalence and incidence vary by sex throughout life. Compared to girls of the same age, prepubescent boys have a higher incidence,

## ABSTRACT

The severity of acute asthma is determined based on symptoms and signs such as respiratory rate (RR), wheezing, retractions, and oxygen saturation (OS). The main aim of the study is to compare the demographic and clinical characteristics of bronchial asthma among children admitted to the general ward with those among children admitted to the PICU. A cross sectional and analytical study, 100 patients with bronchial asthma were enrolled from January 2016 to January 2019 (70 admitted in the paediatric ward and 30 in Paediatric Intensive Care Unit). The data was collected by filling in the data by reviewing patient files and data included initial Heart Rate (HR), Respiratory Rate (RR), Oxygen Saturation in Arterial Blood (SaO<sub>2</sub>) and Partial Pressure of Carbon Dioxide in Arterial Blood (PaCo<sub>2</sub>). Male children were more commonly recorded than female children, and there is no significant gender dominancy between the two groups ( $P = 0.965$ ). Our data also indicate that there is not a significant age difference between the children in the PICU and general ward groups ( $P = 0.543$ ). There were significant differences in two groups (Ward admitted and PICU admitted) with respect to initial heart rate ( $P = 0.02$ ), respiratory rate ( $P = 0.03$ ), arterial oxygen saturation ( $P = 0.02$ ), PaCO<sub>2</sub> ( $P = 0.03$ ). There was a significant correlation between initial vital sign, blood gas analysis. It indicates usefulness of these factors as predictors of severe asthma attack. Age and gender were not risk factors for severe attack in our study.

prevalence, and hospitalization rate of asthma; however, this trend reverses during adolescence [3]. Females continue to have a higher prevalence of asthma than males well into their fifth decade of life. However, the female-male asthma burden gap closes around the fifth decade. Some even argue that the sex disparity in asthma incidence may reverse, following a sharp increase in asthma incidence in males around the fourth decade of life [3]. The sex reversal in asthma burden around major reproductive events suggests that sex hormones may be involved in asthma etiology. Asthma attacks are commonly caused by one or more triggers. Viral respiratory infections are still the leading cause [4,5]. Childhood allergic diseases significantly reduce a child's and their parents' quality of life [6]. As a result, it is critical to gain a better understanding of the risk factors associated with the development of asthma in children, as well as those associated with more severe asthma. A proportion of children who present to the emergency department with acute asthma are eventually admitted to the hospital, with an estimated rate ranging from 7% to 23% [7,8]. This is determined by several variables, including age, gender, the baseline severity of exacerbation [9].

Studies have shown that asthma is a significant cause of respiratory failure leading to ICU admission [10], although its prevalence varies by region and population. Some studies report that asthma accounts for approximately 5-10% of all ICU admissions for respiratory issues [11]. Research indicates that asthma patients admitted to the ICU often have a history of severe asthma, with many having been previously hospitalized for exacerbations. The demographic profile typically includes younger patients compared to those admitted for other respiratory conditions like COPD [12]. Some studies have explored the long-term effects of ICU admission on asthma patients, noting that many experience a decline in lung function or increased frequency of exacerbations post-discharge [13]. The main aim of the study is to compare the demographic and clinical characteristics of bronchial asthma among children admitted to the general ward with those among children admitted to the Pediatric Intensive Care Unit (PICU).

## **METHODS**

### ***Study design and period***

This was a retrospective cross-sectional study conducted during a 2-month period, starting from January 2016 to January 2019.

### ***Study setting and population***

This study was conducted in the general ward and PICU of Tripoli Children's Hospital. The study included 100 patients with asthma attacks who were enrolled in the study consecutively (70 admitted to the pediatric ward and 30 in the PICU).

### ***Data collection***

Data were gathered by reviewing the file records of all patients admitted with bronchial asthma at Tripoli Children's Hospital which included the following; demographic characteristics (such as age, gender), history of asthma, and asthma diagnosis prior to admission previous PICU admission. Predictors of PICU admission were investigated regarding to initial heart rate (HR), respiratory rate (RR), arterial oxygen saturation (SaO<sub>2</sub>), partial pressure of carbon dioxide in arterial blood (PaCO<sub>2</sub>), and clinically evident cyanosis.

### ***Inclusion and exclusion criteria***

We include children of both genders if they had a history of asthma or if their primary admission diagnosis was asthma. Patients with incomplete data were excluded.

### ***Data management and analysis***

The collected data were sorted, coded then entered and analyzed using the SPSS, version 25.0 statistical software. Descriptive statistics, like tabulation, frequencies, percentages, means, and standard deviation were used to present the descriptive result; and to test the association between dependent and independent variables Chi-square test was used. The independent t-test was used to test the significance of the difference in mean clinical predictors between studied group.

### ***Ethical considerations***

Permission was obtained from health authorization. The objectives of the study, expected benefits and types of information to be obtained, were explained to all participants, and informed consent from all participants was obtained. The data collection tools used were anonymous, and data confidentiality was maintained.

## RESULTS

### Demographic characteristics of study participants

During the study period, data was collected from 100 children's files retrospectively when they were admitted to the PICU at with bronchial asthma at Tripoli Children's Hospital.

In total bronchial asthma children (n=100), the study showed that male's percentage was about 16 (53.3%) in PICU admitted compared to 37 (52.9%) in normal ward admitted and females about 14 (46.7%) in PICU admitted compared to normal ward admitted by 33(47.1%) with no statistically significant differences between both studied groups (p= 0.965). Asthma was diagnosed before admission in 20(66.7%) of the children admitted to the PICU and in 45 (64.3%) of the children admitted to the general ward (Table 1).

Table 1. Demographic characteristics of studied group.

Item		PICU admission (30) n(%)		Ward admission (70) n(%)		P-value
Age in years (mean $\pm$ SD)		7.26 $\pm$ 2.58		7.84 $\pm$ 2.78		0.543 <sup>t</sup>
Gender	Female	14	46.7%	33	47.1%	0.965 <sup>c</sup>
	Male	16	53.3%	37	52.9%	
Asthma diagnosis prior to admission	Yes	20	66.7%	45	64.3%	0.819 <sup>c</sup>
	No	25	33.3%	25	35.7%	

<sup>t</sup>: independent sample T test <sup>c</sup>: Chi square test. P < 0.05 is statistically significant.

### Comparison of PICU versus normal ward regarding heart rate and respiratory rate

Table 2 revealed that the distribution of children heart rate for the study population. The heart rate of the children in PICU ranged from 99 to 125 Beat per minute, with a mean of 110.37  $\pm$  7.76 beat per minute. As for children admitted to word, their heart rate ranged between 73 to 100 beat per minute, and the mean was equal to 86.71 $\pm$ 6.97, and did find a statistically significant difference (P = 0.01) between these two studied groups. The respiratory rate of the children in PICU ranged from 52 to 88 beat per minute, with a mean of 73.20 $\pm$ 9.51 breaths per minute. As for children admitted to word, their heart rate ranged between 32 to 66 beat per minute, and the mean was equal to 48.62  $\pm$ 9.16 breaths per minute, and did find a statistically significant difference (P = 0.01) between these two studied groups.

Table 2. The results of comparison between two groups regarding heart rate.

Item	PICU admission (mean $\pm$ SD)	ward admission (mean $\pm$ SD)	P-value
Heart rate (beat per minute)	110.36 $\pm$ 7.75	86.71 $\pm$ 6.97	0.001 <sup>t</sup>
Respiratory rate (breaths per minute)	73.20 $\pm$ 9.51	48.62 $\pm$ 9.16	0.002 <sup>t</sup>

<sup>t</sup>: independent T test, P < 0.05 is statistically significant

### Comparison of PICU versus normal ward regarding arterial blood gases

Table 3 revealed the distribution of children arterial blood gases for the study population. Arterial oxygen saturation of the children in PICU ranged from 82 to 90, with a mean of 87.06  $\pm$  2.97. As for children admitted to word, their heart rate ranged between 90 to 96, and the mean was equal to 92.95  $\pm$  1.51, and did find a statistically significant difference (P = 0.01) between these two studied groups.

Regarding arterial carbon dioxide, we found arterial carbon dioxide of the children in PICU ranged from 50 to 58, with a mean of 55  $\pm$  5.33. As for children admitted to word, their heart rate ranged between 35 to 44, and the mean was equal to 40  $\pm$  5.43, and did find a statistically significant difference (P = 0.01) between these two studied groups.

Table 3. Comparison of PICU versus normal ward regarding arterial blood gases

Item	PICU admission (mean $\pm$ SD)	Ward admission (mean $\pm$ SD)	P-value
SaO2 Arterial oxygen saturation	87.06 $\pm$ 2.97	92.95 $\pm$ 1.51	0.001 <sup>t</sup>
PaCo2 Arterial Carbon Dioxide	55 $\pm$ 5.33	40 $\pm$ 5.43	

## DISCUSSION

Our study presents a comprehensive review of the characteristics and clinical predictors of children with bronchial asthma who were admitted to the PICU and general ward at Tripoli Children's Hospital in Tripoli, Libya, between January 2016 to January 2019. Age has been associated to an increased risk of PICU admission in previous studies, according to a study that Lasmar et al. carried out a retrospective analysis on 202 patients who had been hospitalized twice in less than 18 months, all of whom were under the age of fifteen [14]. Children with asthma reported a positive

correlation between younger age and a higher readmission rate [15]. Among the patients initially hospitalized at >12 months of age, the second admission happened sooner than that recorded for those first hospitalized at >12 months of age. These findings were also observed by a study conducted by Patricia et al. on 29391 children with asthma aged 2–17 years treated in an ED in Canada between over three years., which found that younger children with more severe acute or chronic asthma were more likely to have emergency department re-visits and hospitalizations [15].

According to our findings, there was no observable age difference between the children in the PICU and general ward groups. The age distribution of the two groups (admitted to the general ward and the PICU) was the same, with no statistically significant differences found. A PICU hospitalization following severe asthma exacerbations has been associated to male sex in previous studies. This is consistent with research by Boeschoten S. A. et al., which found that female children made up 62% of the total and male children made up 48% of a prospective, nationwide multicenter study of children with SAA (2–18 years) admitted to all Dutch PICUs and four general wards between 2016 and 2018 [16]. According to a study conducted in Iraq by Yassen et al., included 150 children under the age of 14 (cases) who were diagnosed with bronchial asthma based on their medical history and physical examination, and another 150 children in the same age group (controls) who were not given an asthma diagnosis, 30% of the children were female and 70% of the total were male [17].

In the present study, male children were more frequently recorded than female, and was not significant gender dominancy between two groups. Of the children admitted to the PICU, 33.3% had their first presentation. Hence, in these children, a PICU admission could not easily have been prevented except for education of the general public on asthma symptoms. Readmission following an acute asthmatic attack has an impact on children's quality of life and the cost of hospitalization. Previous admissions to the emergency department and PICU were also linked to higher hospital readmissions in previous studies. Vitsunthorn et al. conducted study in Thailand on seventy-six children where medical reviewed, the admissions were classified into two groups: admission and readmission, within one month to one year after the first admission. The results were 56 children who were admitted only once and 20 children who were readmitted, and 1-year readmission rate for children with asthma was 26.3% [18]. Another study in Saudi Arabia conducted by Alshehri et al. reviewed a retrospective of all hospital records of 73 patients over four years. Twenty-eight patients were readmitted within two months of their discharge from hospital [19]. In our study, the previous admission rate to the PICU was higher in the group admitted to the PICU, and this difference was statistically significant ( $p < 0.004$ ). Clinically predictors of severe attack in our study were initial heart rate, respiratory rate and oxygen saturation in room air. This finding was in accordance with Koga et al. investigated the clinical usefulness of evaluating modified Pulmonary Index Score (mPIS) for severe exacerbation in asthmatic children requiring hospitalization and concluded that mPIS was useful for predicting the clinical course after hospitalization [20].

The other study conducted by Carroll et al., used the Modified Pulmonary Index Score (MPIS) to assess the severity of asthma in children. It measures six categories: oxygen saturation, accessory muscle use, inspiratory to expiratory flow ratio, degree of wheezing, heart rate, and respiratory rate. The MPIS is highly reproducible and has high interrater reliability across caregiver groups. The study involved 30 patients and found that the MPIS is highly reliable and can be used as a predictive tool for asthma in children [21].

### **Conclusion and recommendation**

There was a significant correlation between initial vital sign, blood gas analysis. These findings were investigated by modified pulmonary index score in similar studies. It indicates usefulness of these factors as predictors of severe asthma attack and subsequent clinical course. Age and gender were not risk factors for severe attack in our study.

Conflict of interest. Nil

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## التنبؤات السريرية للأطفال المصابين بالربو القصبي الذين دخلوا وحدة العناية المركزة بمستشفى طرابلس للأطفال

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### المستخلص

يتم تحديد شدة الربو الحاد بناءً على الأعراض والعلامات مثل معدل التنفس والصفير والانتقاضات وتشبع الأكسجين. الهدف الرئيسي من الدراسة هو مقارنة الخصائص الديموغرافية والسريرية للربو القصبي بين الأطفال الذين تم إدخالهم إلى الجناح العام مع تلك الموجودة بين الأطفال الذين تم إدخالهم إلى وحدة العناية المركزة للأطفال. في دراسة مقطعية وتحليلية، تم تسجيل 100 مريض مصاب بالربو القصبي من يناير 2016 إلى يناير 2019 (70 تم إدخالهم إلى جناح الأطفال و30 في وحدة العناية المركزة للأطفال). تم جمع البيانات عن طريق ملء البيانات من خلال مراجعة ملفات المرضى وتضمنت البيانات معدل ضربات القلب الأولي ومعدل التنفس. تشبع الأكسجين في الدم الشرياني والضغط الجزئي لثاني أكسيد الكربون في الدم الشرياني. كان تسجيل الأطفال الذكور أكثر شيوعاً من الأطفال الإناث، ولا توجد هيمنة جنسية كبيرة بين المجموعتين ( $P = 0.965$ ). تشير بياناتنا أيضاً إلى عدم وجود فرق كبير في العمر بين الأطفال في وحدة العناية المركزة لحديثي الولادة ومجموعات الجناح العامة ( $P = 0.543$ ). كانت هناك اختلافات كبيرة في المجموعتين (الجناح ووحدة العناية المركزة لحديثي الولادة) فيما يتعلق بمعدل ضربات القلب الأولي ( $P = 0.02$ ) ، ومعدل التنفس ( $P = 0.03$ ) ، وتشبع الأكسجين الشرياني ( $P = 0.02$ ) ، وضغط ثاني أكسيد الكربون ( $P = 0.03$ ). كان هناك ارتباط كبير بين العلامة الحيوية الأولية وتحليل غازات الدم. يشير إلى فائدة هذه العوامل كمؤشرات لنوبة الربو الشديدة. لم يكن العمر والجنس عوامل خطر للنوبة الشديدة في دراستنا.

**الكلمات الدالة:** الربو، الأطفال، وحدة العناية المركزة للأطفال، التنبؤات.