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Allergic and non-allergic asthma in children hospitalized in the University Children's Hospital in Lublin in 2016-2020

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ABSTRACT

Introduction. Bronchial asthma is a common disease characterized by chronic inflammation of the airways. Paediatric asthma is still a current problem and children with exacerbation frequently are hospitalized. The aim of the study was to determine the prevalence of allergic and non-allergic asthma in children hospitalized at the Department of Paediatric Pulmonology and Rheumatology of the University Children's Hospital in Lublin in 2016-2020, and to analyze the most common allergens associated with allergic asthma.

Materials and methods. The study group consisted of 667 patients, aged 6 to 215 months (average 64 months). The data collected for this retrospective study includes: gender, age, month, quarter of year, and year of hospitalization, type of asthma and type of allergens.

Results. We observed a decrease of hospitalization in the analyzed years: in 2016 – 160 children, and in 2020 – 74. Children with allergic asthma (375 children) were more frequently hospitalized than patients with non-allergic asthma, and we found correlations between age and type of asthma and between age and type of allergy. Non-allergic asthma was observed in the youngest children, while in older children, allergic-asthma dominated. We also observed significant differences in children's hospitalization depending on the season of the year. The most frequent allergen causing asthma was house dust mites.

Conclusions. The incidence of hospitalizations caused by asthma exacerbation is declining. Among the youngest population, exacerbations of asthma related to respiratory tract infection predominate, while in the older, allergy to inhalation allergens is the main cause.

INTRODUCTION

Bronchial asthma is a disease of complex aetiology that is characterized by chronic inflammation of the airways [1]. There are numerous causes for the triggering of asthma symptoms, among others, bronchial hyperreactivity to specific or non-specific stimuli and variable severity of obstruction. The symptoms can reverse spontaneously or more frequently after drug administration [2]. About 300 million people worldwide suffer from bronchial asthma [3], and it is worth emphasizing that asthma is also the most common chronic disease among children [1]. According to the National Health Fund (NHF) report, in 2019, in Poland the highest prevalence rate of asthma was observed among boys aged between 6 and 10 years old and reached 15.2 thousand per 100 thousand children in this group [4].

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The second half of the last century brought a dynamic economic growth that coincided with asthma incidence increase in some countries [5]. The aetiology of asthma is multifactorial and depends on both genetic predisposition and environmental and individual factors, such as obesity, diet, infections and the presence of allergies. The exacerbation of asthma can be characterized by the individual reaction of the organism to various factors, both allergic (e.g. house dust mites, pollen, animal fur, mould) and non-allergic (e.g. viral infections, cold air, humidity, exercise, tobacco smoke, air pollution) [3]. It is important to draw attention to the role of the exposure to inhalation of allergens in the school environment, especially in the case of urban areas [6]. Moreover, childhood asthma is frequently associated with the occurrence of an increased risk of chronic obstructive pulmonary disease in the post-childhood period [3].

The frequency of hospitalization of young children with asthma is still high. This has a negative impact on the family life, causing absence from school and the necessity for parents to withdraw from professional activity [7]. Importantly, to decrease the frequency of hospitalization, both parents and children should be educated about asthma and its specificity, and a clear treatment plan and treatment recommendations should be provided by medical staff [8].

The aim of the study is to determine the prevalence of allergic and non-allergic asthma in children hospitalized at the University Children's Hospital in Lublin in the years from 2016 to 2020, and to analyze the most common allergens associated with allergy-related asthma.

MATERIALS AND METHODS

Data for our work were taken from AMMS software of the Department of Paediatric Pulmonology and Rheumatology of the University Children's Hospital in Lublin. The J45.0 and J45.1 ICD – 10 codes were used to obtain the patients for this retrospective study, who were hospitalized for more than one day in the period between 2016 and 2020. Sociodemographic data such as gender, age, month, quarter of year and year of hospitalization, type of asthma (allergic/non-allergic) and type of allergens were collected in January 2021. The allergens were divided into 4 groups: house dust mites, grass and grains pollen, tree pollen (birch, alder, poplar, oak, hazel), animal allergens (fur and epidermis of dogs, cats, guinea pigs, hamsters, rabbits, horses or fish), mould and fungi allergens (*Alternaria alternata*, *Penicillium notatum*, *Cladosporium herbarum*, *Aspergillus fumigatus*) and food allergens (milk, bovine albumin, peanuts, walnuts, egg yolk, egg white, wheat products, apples). Patients allergic to more than one allergen were divided into the following groups: "inhaled polyallergy", "food allergy" or "food and inhaled polyallergy". In the case of patients with no data about allergens, "no data" category was assigned.

In total, from 2016 to 2020, due to allergic or non-allergic asthma 667 patients were hospitalized. The median age of the patients was 64 months, and the oldest patient was 215 months, while the youngest was 6 months old. Boys represented 61.62% of the respondents (411 children) and girls 38.38% (256 children).

The obtained data were analyzed by Statistica 13 software Statsoft. Pearson's Chi^2 test and non-parametric Kruskal-Wallis Test were applied. The statistical significance level was accepted as $p < 0.05$.

RESULTS

In total, in the years from 2016 to 2020, 667 patients were hospitalized in the Department of Paediatric Pulmonology and Rheumatology of the University Children's Hospital in Lublin due to asthma. A decrease of hospitalization rate was observed in the following years: in 2016 – 160 cases, and in 2020 – 74 cases (Fig. 1).

The hospitalizations required by allergic asthma symptoms were more frequent (375 children, 56% analyzed patients) than those required by non-allergic asthma. The percentage of allergic asthma patients has been increasing since 2018 (Fig. 2, p=0.01 in Chi^2 Test). In 2020, an increased frequency of hospitalizations for allergic asthma was observed when compared to previous years. Interestingly, no relevance between gender and the type of asthma (p=0.08 in Chi^2 Test) was noticed, and in 2020, both boys and girls suffered from allergic asthma more often than from non-allergic asthma (Fig. 3). Nevertheless, correlations between the age and the type of asthma (Fig. 4, p=0.000276 in Chi^2 Test) and between the age and the type of allergy (Fig. 5, p=0.0004 in Kruskal-Wallis Test) were noticed. Non-allergic asthma was observed in the youngest children, whereas allergic-asthma predominated in older children. In the group of children with allergic asthma, food allergy was observed only in the youngest children, allergy to house dust mite was observed more frequently in patients under 13 years, and inhaled polyallergy in older children.

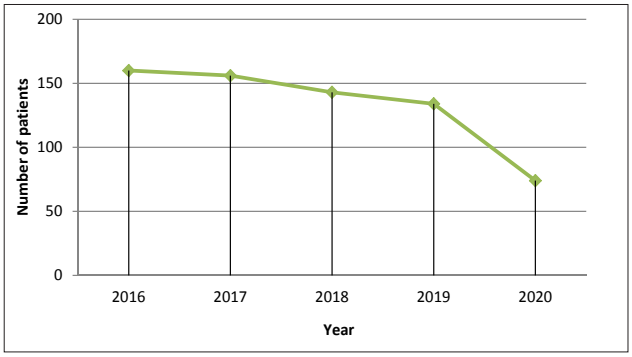

Figure 1. The number of hospitalized patients due to bronchial asthma in 2017-2020

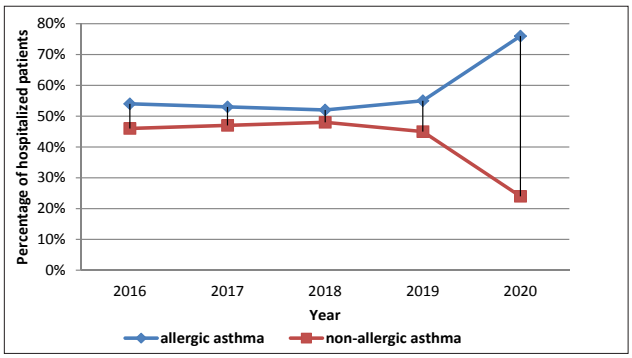

Figure 2. Percentage of children hospitalization due to allergic and non-allergic asthma in 2016-2020

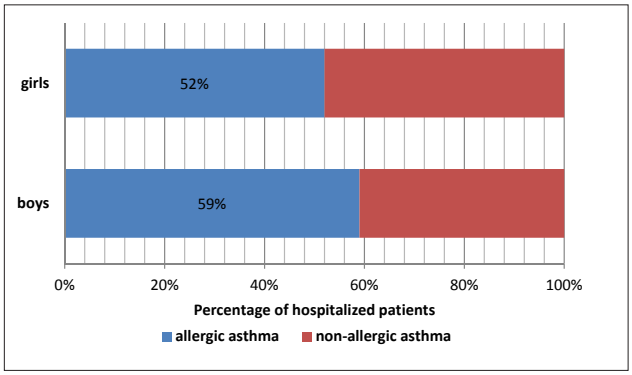

Figure 3. Correlation between gender and type of asthma in children hospitalized in 2016-2020

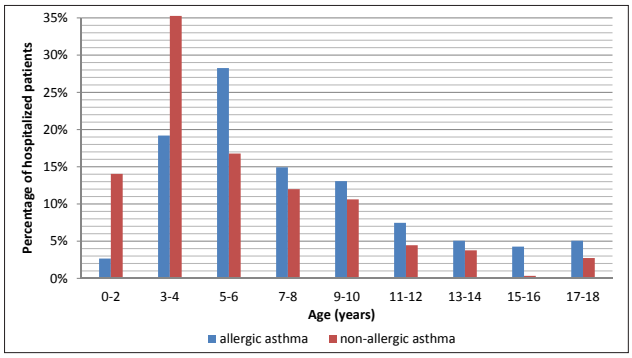

Figure 4. Correlation between age (years) and type of asthma (percentage of patients)

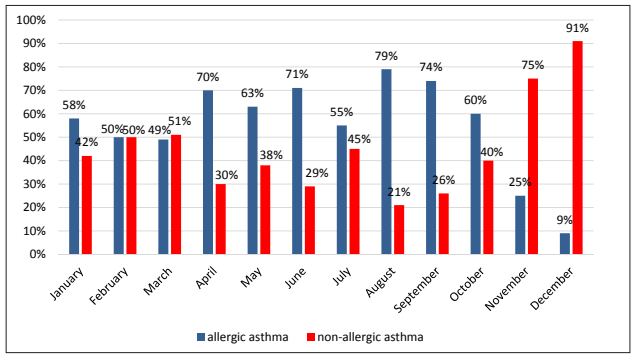

Figure 8. Percentage of patients with allergic and non-allergic asthma among hospitalized children per month in 2016-2020

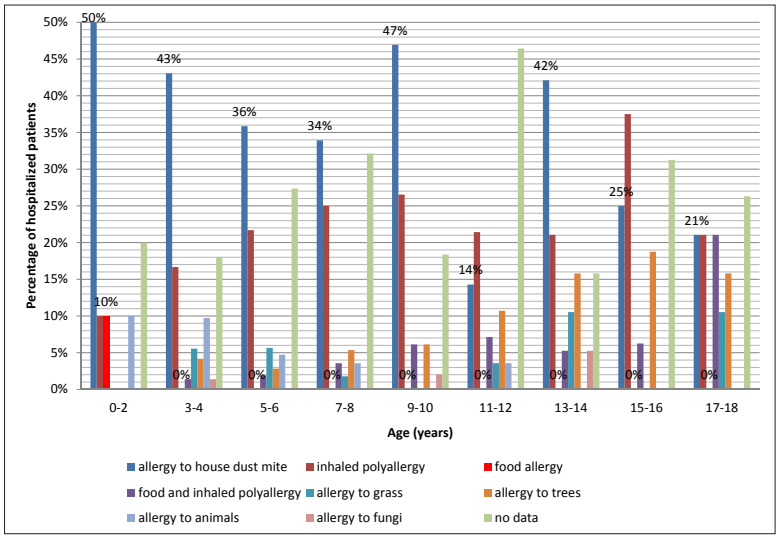

Figure 5. Correlation between age and type of allergy (percentage of all children in this age)

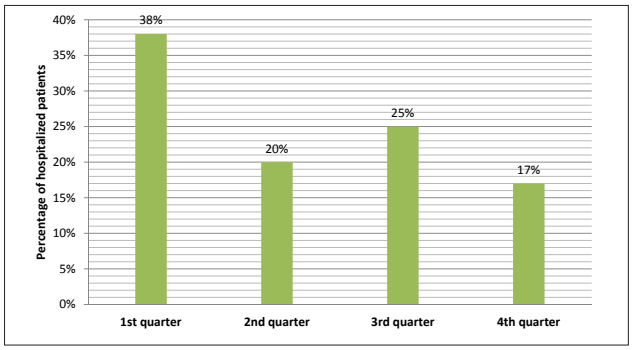

Figure 6. Percentage of hospitalized children due to bronchial asthma in 2016-2020 depending on quarter

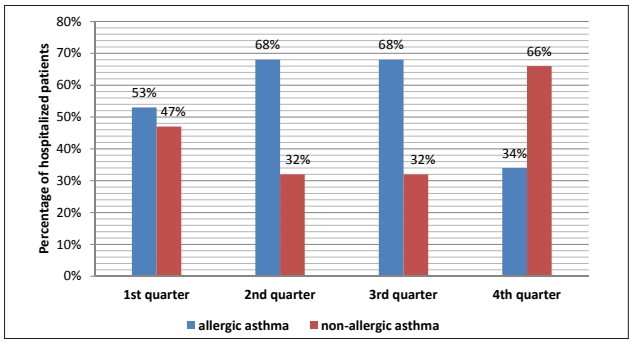

Figure 7. Percentage of patients with allergic and non-allergic asthma among hospitalized children per quarter in 2016-2020

A significant difference in children's hospitalization between summer and winter months ($p<0.01$ in Chi^2 Test) was discovered. The most frequent hospitalizations were observed in the 1st quarter (256 children), and the least frequent in the 4th quarter (116 children) (Fig. 6). Moreover, patients with allergic asthma dominated in the 2nd and 3rd quarter (Fig. 7). In the 4th quarter of the year, there was a noticeable decrease in hospitalization of patients due to allergic asthma compared to other months. The biggest number of hospitalizations for allergic asthma was observed in August and September, while patients with non-allergic asthma predominated in December (Figure 8, $p<0.01$ in Chi^2 Test: 71.84, df=12).

The greatest number of hospitalizations was required by patients with allergies to house dust mite or to inhaled allergens (Fig. 9), and they constituted approximately 57% of all admissions to hospital. House dust mites generated the highest number

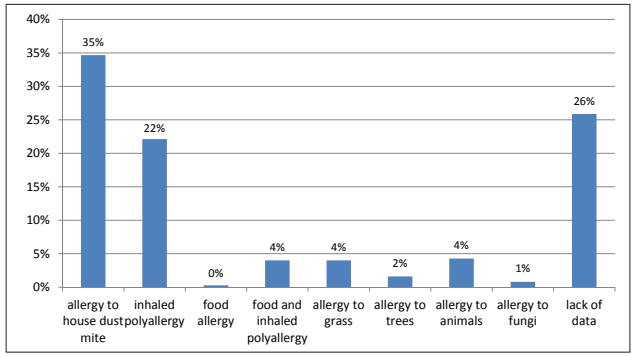

Figure 9. The type of allergy among hospitalized patients with allergic asthma in 2016-2020

of hospitalizations, followed by polyallergy. Both patients allergic to house dust mite and patients allergic to inhaled allergens were hospitalized mainly in the 1st and 3rd quarters of the year (Fig. 10, $p=0.02$ in Chi^2 Test).

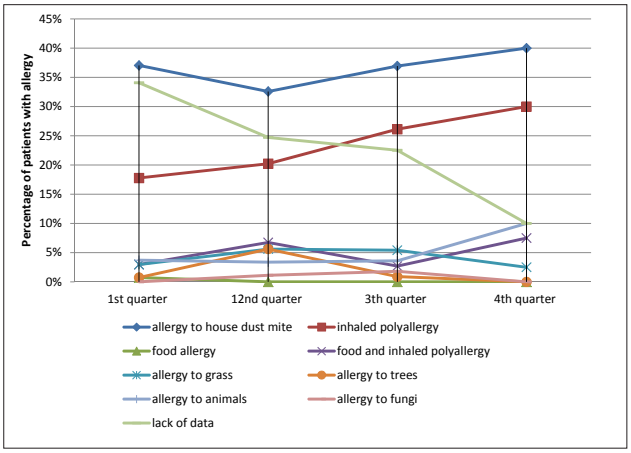

Figure 10. The type of allergy among hospitalized patients with allergic asthma per quarter in 2016-2020

DISCUSSION

The morbidity of bronchial asthma constantly increases all over the world, both in children and in adults. Most adult patients declare that the first symptoms of asthma or other allergic diseases first occurred in childhood [9,10]. Although the number of patients with asthma is constantly increasing, interestingly, in many hospitals the number of hospitalizations due to bronchial asthma has been declining in recent years. This phenomena is likely the result of generally better out-patients care, better education of the healthcare professionals concerning asthma – related treatment, and a greater awareness among patients themselves [11].

The research by Góra such as that of our study reveals that the years 2012-2017 showed a downward tendency, with 1339 asthma children being hospitalized at the University Children's Hospital in Lublin, that is, 266 asthma patients were hospitalized in 2012 and 215 in 2017. Contrarily, the data collected at two another hospitals, the Provincial Specialist Children's Hospital in Olsztyn with 29 children hospitalized in 2016, and 70 in 2017, and the Warsaw Hospital for Children with 2 children in 2012 and 3 in 2017 showed an upward tendency [12].

In this study, bronchial asthma constituted 10% of all the causes of admissions to the University Children's Hospital in Lublin related to respiratory diseases (both in 2012 and 2017), whereas an increased number of cases from 2.6% in 2012 to 7.8% in 2017 was reported in the Provincial Specialist Children's Hospital in Olsztyn, and a decreased number from 4.7% to 0.9% in the Warsaw Hospital for Children [12].

Furthermore, in our study, in 2020 a significant decrease in the rate of hospitalizations due to bronchial asthma at the University Children's Hospital in Lublin was noticed, that is 74 hospitalizations in total, which probably were linked to the COVID-19 pandemic. The analysis of hospitalizations in each month of 2020 showed the following: one case in April, lack of hospitalizations in May and June and an increased number of hospitalisations in July. The results of our investigation showed a similar trend to the results obtained by Abe *et al.*, who analyzed Japanese children suffering from bronchial asthma, and claimed that the number of hospitalizations decreased in 2020, in comparison to 2017-2019 since bronchial asthma was controlled better. Such results could be caused by fear experienced by family and concerning the exacerbation of bronchial asthma in children during the pandemics and the introduction of more effective prophylactic measures such as medication intake control, decline in second hand smoke inhalation, and protection against potential allergens.

What is more, the fact that both schools and public facilities were closed, and a sanitary regime more strictly followed also limited the spread of respiratory infections, and thus the exacerbation of asthma [13].

Allergic asthma predominates in the paediatric population. According to the concept of the allergic march, the development of allergic asthma is sometimes preceded by symptoms of allergic dermatitis and food allergy [9,14,10]. In the study conducted in Finland among 445 patients with asthma, 52% of them were allergic and 48% were without known allergies. At the time of diagnosis of allergic and non-allergic asthma, the median age was 19 and 35 years, respectively. In the case of non-allergic asthma, the lowest incidence was observed in children and young adults (0.7/1000/year), it increased in post middle-aged patients and it was the highest in the older population (2.4/1000/year at the age of 50-59) [15].

In our study of 667 patients, allergy was confirmed in 375 mainly preschool children. A statistical correlation between age and type of asthma was indicated, that is, allergic asthma ($p=0.000276$ in Chi^2 Test) was observed more frequently in younger patients. The boys constituted the majority of the analyzed patients (61,62%), yet the type of asthma was not correlated with the sex of participants ($p=0.08$ in Chi^2 Test). Nevertheless, according to other researchers, boys have a higher risk of atopy and developing allergic asthma in childhood than girls [16]. However, the prevalence of asthma increases with age in women. Moreover, late onset asthma is more often non-allergic and severe, and manifests as worse lung function than early-onset asthma [17-19].

Hospitalizations for asthma show different seasonality in the northern hemisphere. In our study, it was noticed that the highest number of asthma hospitalizations occurred in the 1st quarter (January and February) and in the 3rd quarter (September). Asthma exacerbations among children are more frequent in autumn months due to the return to school and co-occurrence of respiratory infections [20,21]. According to Lee *et al.*, asthma exacerbations in Korean children reported by the hospital emergency department were the highest in September in the 6-17 age group and in October in the 2-5 age group. These results indicated the strongest correlation between asthma exacerbation and rhinovirus infections in school children [22].

The analysis of asthma severity in different seasons is helpful in the process of making decisions concerning treatment options. According to the study by Sposato *et al.*, conducted in a group of patients aged from 5 to 17 in the moderate climate of Grosetto, in Italy, an increased number of admissions to the emergency department was observed in February, followed by the autumn, and with the peak occurring in December. As in our study, a significant drop in the number of hospital admissions was observed during the summer [23]. A study conducted in the USA by Suruki *et al.*,

indicated a reduction in the frequency of admissions to the emergency department and hospitalizations in July, and Sposato *et al.* concluded that summer asthma treatment reduction was not associated with the occurrence of an asthma exacerbation [23,24].

In our study, the diagnosis of allergic asthma dominated among patients hospitalized for asthma in the spring and summer months (Fig. 8). The following allergies were observed: allergy to grass, epidermis, birch (which dominated among the trees), and less frequently to animal fur (data not shown in the results), while children allergic to house dust mites and patients with inhaled polyallergy most frequently required admission to hospital.

Suzan A. AlKhater in her study presented similar results concerning the most common allergens causing asthma in children in Saudi Arabia. The author showed that among 100 children aged 5-14 and suffering from asthma that participated in the study, 54 manifested the symptoms of the allergy to house dust mites [25,26]. Moreover, another study conducted in Bengo Province in Angola, wherein children aged 5-14 were subjected to cross-sectional observations from September to November, 82 out of 1023 children had a positive SPT (skin prick test) result for aeroallergens, while 70.2% of 92 positive SPT were positive for house dust mites [27]. Inhaled polyallergy is also quite common in the paediatric population, mainly in older children. The Beck cohort study included 478 children aged 4-16 who were hospitalized due to asthma exacerbation symptoms. These observations revealed that nearly 70% of the patients surveyed were allergic to three or more indoor allergens. Of note, a significant percentage of the children hospitalized in the presented study were allergic to house dust mites, and in addition, the subjects were hypersensitive to fungi (*Alternaria, Aspergillus*), cat and dog fur [28].

In our study, inhaled polyallergy was found in 22% of all the children suffering from allergic asthma, and this was mainly caused by house dust mites and grass, trees or animal fur or epidermis. The other remaining allergens analyzed in our study constitute only a small percentage of the reason for hospitalizations, which may be considered to be an irrelevant factor for the increase of hospitalization rate.

To conclude, bronchial asthma still constitutes a serious problem for Polish healthcare. Although the incidence of asthma exacerbation hospitalizations is generally declining, episodes of severe exacerbation requiring hospital treatment with oxygen and systemic steroids are still observed. Among the youngest population, exacerbations of asthma related to respiratory tract infection predominate, while in the older, allergy to inhalation allergens is most frequent. Proper education of healthcare professionals, patients' relatives and the patients themselves regarding the treatment and prevention of asthma exacerbations can certainly contribute to the reduction of the number of patients hospitalized due to bronchial asthma.

CONFLICT OF INTEREST

The authors do not declare any relationships (conflict of interests) that could affect the objectivity and credibility of the work.

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