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Research Article

Estimation of Atopy and Allergies Among Sudanese Children with Asthma

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Abstract

Background: Bronchial asthma is a chronic respiratory problem characterized by a reversible hyper-responsive airway obstruction that is provoked by allergens, infections, or nonspecific triggers. The study aims to assess the coexistence of atopy and allergies among children with asthma.

Methods: This single-center study was conducted at Mohamed El-Amin H. Hospital, Sudan. A free online sample size calculator was used. A specially designed form was used for data collection. Data were analyzed using the SPSS version 20.0.

Results: A total of 300 participants were enrolled in the study, with a mean age of 7.46 ± 3.93 years. The male-to-female ratio was 1.3:1. A total of 215 (71.6%) children had a family history of asthma; atopy was allergic rhinitis in 108 (36%), eczema in 53 (17.7%), food allergy in 38 (14%), and allergic conjunctivitis in 29 (9.7%). A significant association was observed between male gender and family history of asthma, atopy, and coexisting personal history of atopy, P = 0.002, 0.004, and 0.001, respectively. All participants who had atopy had allergic rhinitis; 53 (49%) had atopic dermatitis, 29 (26.8%) had coexisting allergic conjunctivitis, and food allergies were found in 38 (35.2%) participants. Common food allergies found were eggplants, fish, cow milk, and banana. Atopy and allergies were common among those who were 6–10 years old, however, only allergic rhinitis was statistically significant with age (P = 0.021).

Conclusion: Combined family history of asthma and atopy was common, few had atopy only, and fewer had neither family history nor atopy. Atopy found was allergic rhinitis, conjunctivitis, eczemas, and food allergy.

Keywords: atopy, allergy, asthma, family history, genetic

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1. Introduction

Bronchial asthma is a common chronic respiratory problem in children, characterized by hyper-responsive airway obstruction that reverses and responds to bronchodilators, provoked by many stimuli, like allergen, infection, and/or nonspecific triggers. Asthma can affect over 300 million children and adults worldwide according to the global initiative for asthma GINA guidelines [1, 2]. The symptoms of asthma include recurrent

wheezing, coughing, dyspnea, and tightness of the chest, which may be nocturnal or early in the morning. It can be manifested in early life, and nearly 33% of children have wheezing during their first three years of age, and most of them may stop wheezing by the age of six. Moreover, 40% of them may continue to wheeze and develop asthma later in their lifetime [2]. At puberty, symptoms may be severe, especially in those with mild attacks. However, it may persist or revert during early adulthood [3]. The atopy is a phenotype that has an increased risk of IgE-mediated diseases. Its etiology probably has a genetic predisposition, which in combination with environmental factors leads to asthma risk [3].

Allergy and other atopic diseases may coexist with asthma. A possible sensitization can lead to an allergic march paradigm and may occur with the early initiation of cow's milk, as it can lead to cow's milk allergy that vanishes in 95% of toddlers [4]. Other systemic allergic manifestations such as dermatitis, rhinitis, and asthma were possible. About 60–75% of school-age children are sensitized to one or even many allergens. On the other hand, recurrent wheezing, cough, and chest tightness may develop without allergic sensitization. Therefore, asthma is considered a heterogeneous disease that has many phenotypes [5].

The use of inhaled steroids since the 1980s has led to better control of asthma exacerbation and allowed children to participate in social activities and sports. Increased knowledge about possible triggers is momentous alongside medication usage. However, few children with severe asthma are exceptions [5]. In practice, many other diseases have the same clinical manifestations as asthma; it is better to commence asthma treatment after excluding other conditions.

Approximately 60–75% of school-age children with asthma have allergies. Asthma incidence and prevalence are higher in boys till the age of 14 years, this ratio reversed at puberty. Boys have more asthma remissions, while females have severe attacks, which are influenced by sex hormones, as with menarche, there is a decline in lung function [6, 7]. Bronchial asthma burden is higher among Black than White children and is not explained by the differences in background or clinical features due to scarce data [8]. Environmental and genetic factor interactions may lead to functional and structural airway changes in the form of bronchospasm, mucosal edema, and mucus plugs [8]. Alveolar hypoxia causes vasoconstriction, which contributes to mismatch as an adaptive response [9]. Asthma has a significant health burden and affects sleep quality, daily activities, school attendance, and academic performance. Night waking can contribute to parental work absence, and family disruption [10].

Many children are transient wheezers, who have symptoms that vanish around preschool or early primary school. They are rarely allergic, and their lung function is frequently abnormal because of their small lungs [11]. Several triggers are present in most cases of asthma in children, and reactivity patterns may vary with age [12]. There have been two types of broncho-constrictor reactions to allergens in patients with asthma – early and late. Within minutes of exposure, IgE-induced mediator release from mast cells causes early asthmatic responses. Late asthmatic responses develop 4–12 hr after antigen exposure, resulting in more severe symptoms that might linger for hours and contribute to the disease's duration and severity. Foods, household inhalants (e.g., animal allergens, molds, fungus, roach allergens, dust mites), and seasonal outdoor allergens (e.g., mold spores, polenta) are all forms of allergies [12–18]. Exposure to tobacco in utero has also been linked to DNA hyper-methylation in babies [19]. Atopic dermatitis is a commonest chronic childhood skin problem. It is characterized by remission and recurrent pruritus, with various manifestations and severity. Its diagnosis is challenging because there are no standard diagnostic criteria due to the diversity of its clinical features. Many criteria were used – for example, Hanifin-Rajka criteria (HRC) were used commonly in hospital settings and depend on clinical experience and expert consensus. The United Kingdom Working Party criteria (UKC) are the refined versions of HRC; both being used in hospitals as well as in community settings. Also, the International Study for Asthma and Allergy in Childhood (ISAAC), and the Reliable Estimation of Atopic-dermatitis in Childhood (REACH) are used in epidemiological surveys [20–22].

Effective asthma management requires the identification of asthma triggers [23, 24]. To the best of the authors' knowledge, there is no available published data about the magnitude of this problem among patients attending the study area. The study aims to assess the coexistence of atopy and allergy with asthma among children attending the asthma clinic.

2. Materials and Methods

This descriptive, cross-sectional single-center study was conducted over six months, from June 1st to December 31st, 2019 at the Asthma Clinic at Mohamed El-Amin Hamid Hospital for Children, Omdurman city, Khartoum state, Sudan. The hospital is a referral center for pediatrics in Sudan and provides emergency inpatient and outpatient medical services. The asthma clinic was established in January 2012 and held once per week. A free online sample-size calculator was used (https://www.calculator.net/). There were

800 registered patients with asthma in the clinic. A confidence level of 95%, a margin of error of 5, and a population proportion of 50%. The minimal sample size was 260. The National Institute for Health and Care Excellence (NICE) guidelines were used to diagnose asthma, allergy case definition, and the International Study of Asthma and Allergies in Children (ISAAC) criteria to define atopy.

Definition of an asthma case: Recurrent attacks of reversible breathlessness, cough, and wheezing that resolved with bronchodilators or spontaneously, that is, hyper-responsiveness airway with reversible spirometry after exclusion of other causes of cough and wheezing.

Allergy: A child/family member with a known case of allergy, or having symptoms suggestive of allergies, like food allergy or allergic rhinitis.

Atopy: Positive skin-prick test for common allergens, pollens, or certain types of foods.

Atopic dermatitis: Fulfilled, which included itchy skin rash that comes and goes at least for six months, itchy skin rash during the past year that affects the elbows, popliteal fossa, ankles, buttocks, around the ears, eyes, around the neck, and/or self-reporting that they had eczema diagnosed by a physician. It also includes a history of atopy that was aggravated by environmental factors.

A convenient sampling method was used for data collection; with consecutive recruitment of 300 children aged 2–17 years, known cases of asthma, and their mothers/caregivers, who voluntarily accepted to enroll in the study. Children who had comorbidity were excluded. The selected participants were interviewed. The primary data were collected using a detailed questionnaire that included patients' demographic data, habits, home environment, presence of pets, confirmed diagnosis of asthma, suggestive symptoms of atopy, and allergies such as eczema, allergic conjunctivitis, rhinitis, and sinusitis. The skin-prick test (not available in Sudan) was obtained from a few patient records with confirmed allergy as secondary data. All work in this research was done in line with the Declaration of Helsinki. Data were cleaned, coded, and entered into a Microsoft Excel data sheet and analyzed using SPSS version 20.0. Categorical data were represented in the form of frequencies and proportions. The Chi-square test was used as a test of significance for qualitative data. *P*-value (probability that the result is true) <0.05 was considered statistically significant.

3. Results

The study covered 300 children. Of them, 134 (44.7%) were aged between 5 and 10 years, 91 (30.3%) were <5 years old, and 75 (25%) were between the ages of 11 and 17

years. The mean age was 7.46 ± 3.93 years, and while the minimum age was 2 years, the maximum age was 17 (Table 1).

The distribution of gender showed male dominance – 169 (56.3%) participants were males while 131 (43.7%) were females, giving a male-to-female ratio of 1.3:1 (Table 1).

Furthermore, the results in Figure **1** show that 215 (71.6%) children had a positive family history of asthma, and there was a coexistence of asthma and allergic rhinitis in 108 (36%), eczema in 53 (17.7%), food allergy in 38 (14%), and allergic conjunctivitis in 29 (9.7%). Family history of asthma and a personal history of atopy (e.g., atopic dermatitis, drug allergy, and food allergy) were observed in 187 (62.3%) participants, and of them, 28 (9.3%) had only a family history of asthma without atopy, 60 (20%) had only atopy, 25 (8.3%) had no family history nor coexistence atopy. Table 2 shows a strong association of the male gender with a family history of asthma, atopy, and coexisting personal history of atopy, with a *P*-value of 0.002, 0.004, and 0.001, respectively. All participants who had atopy had allergic rhinitis; 53 (49%) had associated atopic dermatitis, 29 (26.8%) had coexisting allergic conjunctivitis, and food allergy was found in 38 (35.2%) participants. The common food allergy was found in eggplant, fish, cow milk, and bananas. This means that there is an overlap of more than one allergy. Atopy was found more among males but it is statistically insignificant (*P*-value > 0.05). Table 3 shows the comparison of the family history of asthma, atopy, and personal history of atopy with age groups, it is common among 6–10 years old. Personal history of atopy with age showed a significant association (*P*-value = 0.032) but only allergic rhinitis is statistically significant with age (*P*-value = 0.021).

Table 1: Participant distribution according to their age and gender (*N* = 300).

		Frequency	Percentage (%)
Age (yr)	<5	91	30.3
	5–10	134	44.7
	11–17	75	25
	Total	300	100.0 (%)
Gender	Male	169	56.3
	Female	131	43.7
	Total	300	100.0 (%)

4. Discussion

Asthma is a complex disease with several phenotypes that may occur in children. The study included 300 participants, of who 134 (44.7%) were school-aged children aged

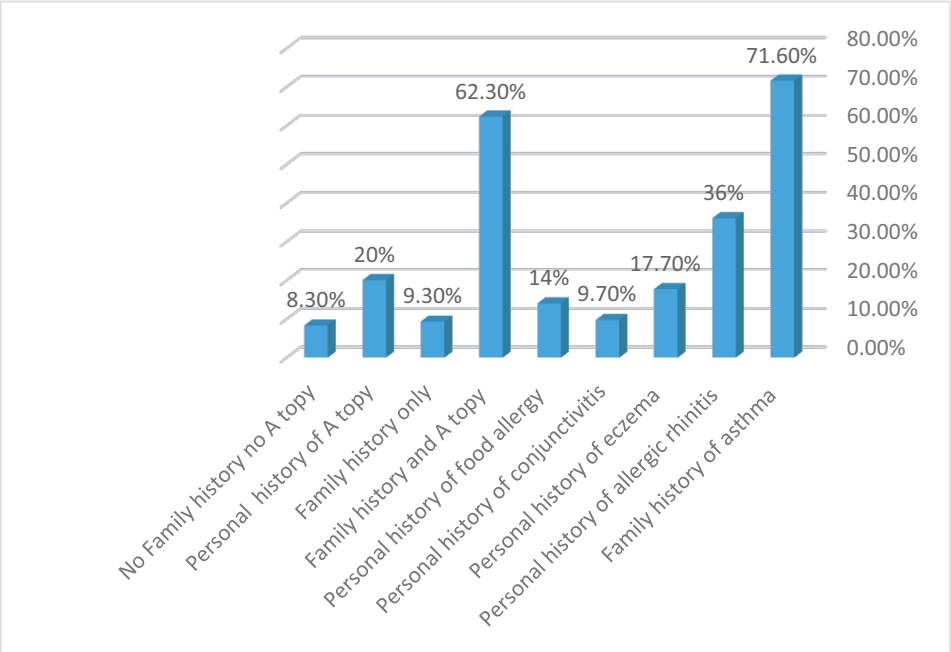

Figure 1: Distribution of participants according to the associated atopy.

TABLE 2: Association between the atopy and allergy with gender (*N* = 300).

Parameter	Total	Gender		P-value
		Female (n = 131)	Male (n = 169)	
FH of Asthma	215	82	133	0.002
		(38.1%)	(61.9%)	
FH of Atopy	187	70	117	0.004
	(100%)	(37.4%)	(62.6%)	
Personal history of Atopy	108	34	74	0.001
		(31.5%)	(68.5%)	
Allergic rhinitis	108	34	74	0.001
		(31.5%)	(68.5%)	
Atopic dermatitis	53	17	36	
		(32.1%)	(67.9%)	0.04
Allergic conjunctivitis	29	12	17	0.477
		(41.4%)	(58.6%)	
Food allergy	38	13	25	0.139
		(34.2%)	(65.8%)	

between 5 and 10 years, 91 were <5 years (30.3%), and 75 (25%) were aged between 11 and 18 years. The mean age was 7.46 ± 3.93 years, with a minimum age of two years and maximum age of seventeen years. Children who get wheezing secondary to

Table 3: Association between the allergens with age (*N* = 300).

Parameter	Age (yr)				P-value
	≤5	6–11	≥12	Total	
FH of Asthma	63 (29.3%)	103 (47.9%)	49 (22.8%)	215 (100%)	0.171
FH of Atopy	53 (28.3%)	91 (48.7%)	43 (23.0%)	187 (100%)	0.200
Personal history of atopy	27 (25.0%)	52 (48.1%)	29 (26.9%)	108 (100%)	0.032
Allergic rhinitis	27 (25.0%)	52 (48.1%)	29 (26.9%)	108 (100%)	0.021
Atopic dermatitis	16 (30.2%)	24 (45.3%)	13 (24.5%)	53 (100%)	0.054
Allergic conjunctivitis	10 (34.5%)	12 (41.4%)	7 (24.1%)	29 (100%)	0.87
Food allergy	11 (28.9%)	16 (42.1%)	11 (28.9%)	38 (100%)	0.834

allergies at a young age are more likely to develop wheezing when they are 6–11 years old. Correspondingly, children who begin wheezing after six years are more likely to have allergies, and wheezing is more likely to persist by the age of 11. Proper asthma control is important for better life quality [10, 11].

Overall, male predominance was noticed among the children – 56.3% males and 43.7% females. The male:female ratio was 1.3:1. Pre-pubertal males had a higher asthma prevalence than females, which may be attributable to the fact that asthma in boys was identified earlier, and wheezing lasts significantly longer, making them more likely to be observed and diagnosed earlier than girls. However, among adolescents, there was female dominance. This gender reversal at puberty is explained by decreased lung function influenced by hormones [25–27]. A family history of asthma, allergies, nasal polyps, sinusitis, eczema, or rhinitis in first-degree relatives must be included in the medical history. Factors that may contribute to nonadherence to asthma treatments and the use of illicit substances must be addressed in the social history [15].

The complex interaction between genetic, and nongenetic factors plays a role in the pathogenesis of asthma, as the occurrence of family history, especially among first-degree relatives, elevates the risk of asthma development. Demographic factors such as sex and obesity, and environmental factors such as smoking history and exposure to air pollution also had a role [26–33].

Carlo Caffarelli *et al.* [33] demonstrate the links between asthma and food allergy. They found that parental allergy, atopic eczemas, and allergen sensitization occur often. The severity can be worse with coexistence. However, food allergy can affect asthma control; early food sensitization can potentially begin in utero, or during the first year of life, which can predict the onset/severity of asthma. Asthma symptoms may result from ingestion, and/or inhalation of the offending food; which may be severe and

associated with fatal or near-fatal anaphylaxis. Therefore, offending foods identification and risk awareness were crucial to avert exposure [34]. Devika Rao *et al.* [35] argue that early exposure to allergens like dust mites, pets, cockroaches, mice, mold, cigarette smoke, endotoxin, and air pollution has implications for allergic sensitization and asthma development. On the contrary, other studies claimed that allergen remediation had advantages in minimizing asthma morbidity. Impermeable covering for dust-mite, air filtration, pest control, housing furbishing, ventilation amelioration, and pet removal can reduce allergen exposures.

About three-quarters of school-age children were sensitized to one or more than one allergen. On the other hand, asthma can occur without allergic sensitization, so coughing, chest tightness, and recurrent wheezing can occur among nonallergic patients. For this reason, asthma is considered to be a heterogeneous disease that has different sub-phenotypes [5].

Both family history and the atopy among participants were observed in 62.3% of cases, this is consistent with a study done by Abdulrahman Al-Frayh1, Zahid Shakoor, and Syed M. Hasnain [30] in Saudi Arabia.

Janssens and Ritz [17] argue that the gap in the knowledge about the possible potential asthma triggers may hinder the perception of these triggers; therefore, identification of the asthma triggers can prevent unnecessary avoidance of perceived triggers.

Abdulrahman Al Freyhi and Zahid Shakoor found in their study that 48.1% and 46.1% had positive asthma among family and close relatives. Asthma was 4.2 times more likely to occur in parents or siblings than in cousins. About 18% of asthmatics had no family history of asthma, and 20.6% of respondents had asthma in their first-degree relatives. The presence of rhinitis or eczemas in the immediate family increases the risk three times. Cigarette smoke exposure imparts a twofold increased risk. There were no significant predictors in both eczemas in the family or interaction with domestic pets (birds or cats) [29].

Due to the relevance of perceptions about asthma triggers identification, interventions targeted toward increasing asthmatic trigger verification should focus on them. Educational interventions, daily life exposure, and monitoring of asthma triggers are needed to enhance asthma control [35, 36].

5. Conclusion

Three hundred children were enrolled in the study with an overall male predominance of 1.3:1. The participant's age ranged from 2 to 17 years, with a mean age of 7.46 $\pm$ 3.93

years. The common age was between 5 and 10 years. Most participants had a positive family history of asthma. Atopy found were: allergic rhinitis, conjunctivitis, eczemas, and food allergy. While most children had a combined family history of atopy with bronchial asthma, few had atopy only. Fewer participants had neither family history nor coexisting atopy. Future multi-center studies were needed with control groups to answer questions and overcome the limitations of this research.

Study limitations: This study is a single-center study and lacks a control group. The respondent's answer is liable to subjectivity.

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Ethical Considerations

All work done in this research was in line with the Declaration of Helsinki. Ethical acceptance was obtained from the administrative authorities at the hospital. Written informed consent was obtained from caregivers after interviewing them and explaining the study's purpose to guard the patient's autonomy. Data were used only for research purposes to ensure privacy and confidentiality.

Competing Interest

None declared.

Availability of Data and Material

Data generated and analyzed during this study are included in this article, and additional supporting files whenever possible.

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