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Asthma Control Assessment Using Asthma Control Test Among Pediatric Patients Attending a Tertiary Care Hospital in Saudi Arabia

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ABSTRACT

Background: There are not enough data on the epidemiology of asthma in pediatric patients. The goal of the study was toassess the level of asthma control using the childhood Asthma Control Test (c-ACT).

Methods: This cross-sectional descriptive study was conducted in the outpatient pulmonary clinic at King Fahad Medical City in Riyadh.Pediatric patients who were diagnosed with bronchial asthma by their primary treating physician were recruited over a one-year period. Patients completed the c-ACT and questionnaires, which were associated with the quality of asthma control.

Results: Two hundred and ninety-two asthmatic patients (n = 292) were enrolled, and 35.3% of these patients were female. The estimated prevalence of uncontrolled asthma at the time of the study was 45.2%. Factors that were significant in asthma control were female gender (P-value = 0.041), winter months (P-value = 0.01), allergic rhinitis (P-value = 0.036), and eczema (P-value = 0.039). However, the degree of asthma control did not appear to be related to the place of residence, the type of clinic visited, pet ownership, receipt of an influenza vaccine, or medication use.

Conclusion: This study identified evidence for the high prevalence of uncontrolled asthma in pediatric patients in out-patient clinics and several factors that may contribute to poor asthma control. Physicians should be aware of seasonality and of treating patients with comorbid eczema and allergic rhinitis.

Keywords: King Fahad Medical city (KFMC), asthma, pediatric, childhood Asthma Control Test (c-ACT).

INTRODUCTION

Asthma is a disease characterized by chronic inflammation of the airways that causes recurrent attacks of wheezing, shortness of breath and coughing, especially during the night and/or early morning. The hallmarks of asthma are intermittent and reversible airway obstruction, chronic bronchial inflammation with eosinophils, bronchial smooth muscle hypertrophy and hyperactivity, and abundant mucus secretion [1]. The primary goal in treating asthmatic patients is to achieve good asthma control. This result is achieved by minimizing symptoms, activity, airway narrowing and bronchodilator use, while preventing acute exacerbations [2,3].

Asthma is a significant health problem worldwide, and it is one of the most common chronic childhood diseases in many countries [4,5]. The prevalence in different countries ranges from 1% to mid-30%. In the United States, for example, asthma affects more than seven million children [6]. In Saudi Arabia, the local reports suggest that the prevalence of pediatric asthma is increasing and has been reported to be between 8% and 23% [7]. A study that was conducted in Khobar and included 1,482 school boys revealed a cumulative prevalence of asthma of 9.5% [8]. Additionally, a 17-year study of pediatric asthma in Saudi Arabia showed a cumulative prevalence of 21.7%, with the highest score in the eastern province (33.7%) compared to the central region (17.7%) and the western province (14.1%) [9].

In literatures, studies have shown alarming levels of uncontrolled asthma in patients worldwide and in Saudi Arabia. A study was conducted in the United States to assess the level of asthma control and showed that 45% of cases were controlled, whereas 55% were uncontrolled [10]. Another study was conducted in Europe and showed that only 36% of cases asthma cases were controlled [11]. Locally, a study was conducted in seven major hospitals in Riyadh and revealed that most of the asthma cases in Saudi Arabia are uncontrolled, which accounts for 64% of all cases, and only 5% of participants met the criteria for well-controlled asthma [12]. Another study of pediatric asthma patients with a smaller sample size has shown that 59.3% of cases were uncontrolled [13].

Assessment of asthma control level can be achieved using the Asthma Control Test, which has been validated and recognized as an effective patient-friendly tool to assess the level of asthma control [14]. The childhood Asthma Control Test (c-ACT) is a questionnaire composed of seven

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items to assess symptoms, bronchodilator use, and impact on daily activities [3]. A study performed at the University of Washington showed that the use of c-ACT and spirometry were equally effective methods to identify cases of not well-controlled asthma [15].

Another article comparing GINA criteria with the c-ACT has found a good correlation in predicting uncontrolled asthma [16]. The level of pediatric asthma control assessed using the c-ACT has not been studied in a comparable sample size as in a study of adult asthma control in Saudi Arabia [12]. The current study was undertaken to measure the percentage of uncontrolled asthma cases among participants, using the c-ACT, and to explore the factors that could affect outpatient asthma control at general, allergy and asthma pediatric clinics.

METHODS

This cross-sectional study was conducted at King Fahd Medical City in Riyadh outpatient clinics, including the allergy, asthma, and general pediatric clinics. We included all pediatric patients (4–11 years old) who had a documented diagnosis of bronchial asthma (BA) by their primary physician and were regular patients of asthma therapy. The study was conducted over a one-year period from January to December 2016. The exclusion criteria were as follows: documented pediatric patients in a different setting, such as the Emergency Department (ER) or Intensive Care Unit (ICU), admitted patients in wards, and patients with a recent diagnosis of bronchial asthma (less than four weeks) or those with an undocumented diagnosis of bronchial asthma. The study was approved by the local institutional review board (IRB Log No. 15-180) and an informed written consent taken from each participant in this study.

During the visits, trained co-investigators asked patients and caregivers to complete particular questions, which included demographic data, medications used for asthma, the location(s) of follow-ups at outpatient clinics, passive smoking exposure, receipt of an annual influenza vaccine and what allergic symptoms accompany the current bronchial asthma. The trained co-investigators verified the documented information by reviewing the medical record of each patient. The c-ACT was used to assess asthma control over the past four weeks. The c-ACT was translated into Arabic and validated for this study. A pilot study was carried out to validate the Arabic version of the c-ACT. We recruited 40 patients for the pilot study. An analysis of internal consistency reliability of the seven items on the c-ACT was conducted among all the patients recruited for the pilot study. The internal consistency reliability alpha value was 0.773, indicating a high consistency among the answers to the seven different questions of the c-ACT. There were no missing or unanswered questions in the pilot and main studies.

The data were analyzed using Statistical Package for Social Sciences (SPSS) Version 23. Descriptive statistics, such as counts and percentages, were used to summarize the data regarding demographics, allergic symptoms accompanying the disease, use of a metered dose inhaler (MDI), passive smoking exposure and administration of an influenza vaccine. Demographic and clinical variables in each group were compared according to c-ACT scores using a chi-square test. Statistically significant data, such as allergic symptoms (rhinitis and eczema) and the month of visit (winter), were compared with gender, which was statistically significant using a chi-square test.

RESULTS AND MAIN FINDINGS

We enrolled 292 patients in this study. Among these patients, 103 (35.3%) were girls. The patients' demographic and clinical characteristics are shown in Table 1. Uncontrolled asthma was defined as a c-ACT score ≤19. The prevalence of uncontrolled asthma in pediatric patients in this study was 45.2% (132 patients). Uncontrolled asthma and gender showed a significant relationship, with 13.4% of participants being female patients with uncontrolled asthma (P-value = 0.041). Uncontrolled asthma was significantly documented during clinic visits in the winter months (21.2%, P-value = 0.013). There was a significant relationship between uncontrolled asthma and allergic rhinitis (31.5%, P-value = 0.036). Additionally, uncontrolled asthma was more common in eczema patients (13.7%, P-value = 0.039).

Table 1: The association of uncontrolled asthma with demographic and clinical characteristics. (n=292)

CHARACTERISTICS	RESPONSE	UNCONTROLLED		CONTROLLED		p-value
		N	(%)	N	(%)	
Gender	Female	39	13.4	64	21.9	0.041*
	Male	93	31.8	96	32.9	
Residency	Riyadh	121	41.4	94	32.2	0.236
	Out Side of Riyadh	39	13.4	38	13	
Month of Visit	Summer	44	15.1	37	12.7	0.511
	Autumn	24	8.2	27	9.2	0.143
	Winter	62	21.2	34	11.6	0.013*
	Spring	30	10.3	34	11.6	0.097
Clinic Visited	General	58	19.9	36	12.3	0.065
	Allergy	32	11	35	11.9	0.12
	Asthma	70	24	61	20.9	0.381
Allergic Symptoms	Conjunctivitis	23	7.9	13	4.5	0.161
	Rhinitis	92	31.5	61	20.9	0.036*
	Eczema*	40	13.7	21	7.2	0.039*
	Food	19	6.5	23	7.9	0.092
Influenza Vaccine	No	96	32.9	92	31.5	0.055
	Yes	64	21.9	40	13.7	
Passive Smoking	No	135	46.2	108	37	0.335
	Yes	25	8.6	24	8.2	
Owning Pets	No	158	54.1	129	44.2	0.41
	Yes	2	0.7	3	1	
Route of Administration	MDI*	23	7.9	11	3.8	0.077
	MDI/S*	98	33.6	81	27.7	0.541
	Oral	22	7.5	21	7.2	0.361
	NEB*	17	5.8	19	6.5	0.213
Ventolin Inhaler	No	21	7.2	15	5.1	0.393
	Yes	16	5.5	11	3.8	0.389
	Yes/M	123	42.1	106	36.3	0.286
Cortisone Inhaler	Fluticasone 50 mcg	17	5.8	15	5.1	0.493
	Fluticasone 125 mcg	39	13.4	31	10.6	0.485
	Fluticasone 250 mcg	8	2.7	3	1	0.183
	Budesonide 160 mcg/Formoterol 4.5 mcg	1	0.3	0	0	0.548
	Fluticasone 50 mcg/Salmeterol 25 mcg	4	1.4	2	0.7	0.436
	Fluticasone 125 mcg/Salmeterol 25 mcg	9	3.1	7	2.4	0.558
	No	82	28.1	74	25.4	0.241
Nebulization	Ipratropium 125 mcg	9	3.1	8	2.7	0.534
	Budesonide 250 mcg	13	4.5	14	4.8	0.299
	No	138	47.2	110	37.7	0.298

*Significant at $\alpha = 0.05$ by chi-square test. Eczema: Atopic dermatitis. MDI: Metered dose inhaler. MDI/S: MDI with spacer.

Table 2 demonstrates the correlations between patients' allergic symptoms and the seasons of visit. There is a relationship between allergic rhinitis and visits in spring months (9.2%, P-value = 0.044). Patients with allergic rhinitis tend to have uncontrolled asthma, as shown in Table 1.

Table 2: The association of allergic symptoms and seasons of visit.

CHARACTERISTICS	RESPONSE	NO		YES		P-VALUE
		N	(%)	N	(%)	
SUMMER	Conjunctivitis	71	24.3	10	3.4	0.568
	Rhinitis	37	12.7	44	15.1	0.391
	Eczema*	65	22.3	16	5.5	0.452
	Food	72	24.7	9	3.1	0.566
AUTUMN	Conjunctivitis	46	15.8	5	1.7	0.369
	Rhinitis	25	8.6	26	8.9	0.472
	Eczema*	39	13.4	12	4.1	0.366
	Food	42	14.4	9	3.1	0.095
WINTER	Conjunctivitis	83	28.4	13	4.5	0.395
	Rhinitis	40	13.7	56	19.2	0.095
	Eczema*	75	25.7	21	7.2	0.442
	Food	86	29.5	10	3.4	0.452
SPRING	Conjunctivitis	56	19.2	8	2.7	0.555
	Rhinitis	37	12.7	27	9.2	0.044*
	Eczema*	52	17.8	12	4.1	0.388
	Food	59	20.2	5	1.7	0.224

*Significant at $\alpha = 0.05$ by chi-square test. Eczema: Atopic dermatitis.

Table 3 demonstrates the association of the type of clinic visited and allergic symptoms in asthma patients. This association shows at which clinics patients presented with asthma. Eczema patients suffering from asthma presented at the allergy clinic with a significant relationship (P-value = 0.006). Additionally, patients with asthma and having any food allergy also presented at the allergy clinic with a significant relationship (P-value = 0.002). Patients with asthma and any allergic symptoms could present at the general pediatric clinic. The association between asthma patients who presented at the general pediatric clinic and had allergic conjunctivitis was significant (P-value = 0.005). Additionally, patients with asthma and an allergy to food or allergic rhinitis were more likely to present at the general pediatric clinic (P-values = 0.047 and 0.045 respectively).

Table 3: The association of allergic symptoms and different clinics visited.

CHARACTERISTICS	RESPONSE	NO		YES		P-VALUE
		N	(%)	N	(%)	
GENERAL PEDIATRIC CLINIC	Conjunctivitis	75	25.7	19	6.5	0.005*
	Rhinitis	52	17.8	42	14.4	0.045*
	Eczema*	80	27.4	14	4.8	0.055
	Food	88	30.1	6	2.1	0.047*
ALLERGY CLINIC	Conjunctivitis	61	20.9	6	2.1	0.232
	Rhinitis	32	11	35	12	0.543
	Eczema*	45	15.4	22	7.5	0.006*
	Food	52	17.2	15	5.1	0.002*
ASTHMA CLINIC	Conjunctivitis	20	41.1	11	3.8	0.047*
	Rhinitis	55	18.3	76	26	0.053
	Eczema*	106	36.3	25	8.6	0.295
	Food	119	40.8	12	4.1	0.196

*Significant at $\alpha = 0.05$ by chi-square test. Eczema: Atopic dermatitis.

DISCUSSION

This study is one of the firsts to validate and investigate the prevalence of asthma control among a pediatric population using the c-ACT and to determine factors that can interfere with asthma control in the outpatient setting of general, allergy and asthma clinics at a tertiary center. The asthma control level was demonstrated using the c-ACT, which is a well-validated tool [14]. Our findings show that 45.2 % of patients had uncontrolled asthma.

Based on epidemiological data that show gender differences in asthma incidence, the prevalence and levels of severity have been reported worldwide [17]. Our study showed that asthma is more significant in girls than boys. Overall, the asthma prevalence, severity, exacerbation rate, hospitalization, and mortality are higher in girls than boys; however, the rates of visits to the clinic and emergency room and the rate of hospitalization in asthma patients aged 0–14 years are higher among boys than girls [18-24]. Before puberty, asthma and wheezing are more prevalent and severe in young boys [25,26]. The reason behind this gender difference is unknown, although it may be linked to immunological and hormonal factors and/or to the differences in gender-specific responses to occupational or environmental exposures [27-30]. Early childhood asthma was associated with the male gender, poor socioeconomic status, and exposure to exhaust, soot, household tobacco, and oil or wood smoke [31,32]. Asthma risk has been shown to increase by two-fold in girls who exhibit early menarche [33-35].

Parents and patients often complain of worsening asthma symptoms and exacerbation related to a change in weather. In this study, weather showed an association with poor asthma control, which is a dependent variable that should be of concern when treating patients with asthma. Extreme weather conditions have been shown to play a role in asthma epidemics [36-41]. Other studies in the US have shown that asthma exacerbations were correlated with humidity and low temperature [41], high barometric pressure [40], and a sudden decrease in temperature [41]. There is a strong relationship between temperature and humidity fluctuations and exacerbation of pediatric asthma [42]. Notably, these correlations were observed after controlling for levels of airborne pollutants and common aeroallergens [42]. Population-based epidemiologic studies have shown that the prevalence of respiratory symptoms experienced during cold temperatures is higher in people with a respiratory disease compared to healthy subjects [43-45]. This suggests that breathing cold air causes functional changes in the airways among people with asthma. Uncontrolled asthma increases the risk of cold weather-related respiratory symptoms both in boys and girls, and this association is strengthened by a dose-response pattern [46]. The effects of cold weather are exerted on the respiratory track either indirectly by skin cooling [47] or directly by inhaling cold air [48]. Changes that occur due to cooling of the skin cause unfavorable reflexive changes in the airway, and cooling and drying of the nasal and airway mucosa can lead to hyperosmolality, which could cause neural activation and bronchoconstriction [48]. The higher prevalence of cold weather-related respiratory symptoms among subjects with asthma could be a consequence of their reduced capacity to warm and humidify the inhaled air [49]. We could not prove that the influenza vaccine decreased the prevalence of uncontrolled asthma.

The impact of allergic rhinitis on asthma control was significant in this study. Allergic rhinitis is one comorbidity of asthma that contributes to its severity [50-51]. Allergic rhinitis is frequently under-diagnosed in a patient with asthma, although more than 80% of asthmatic patients have comorbid allergic rhinitis [52-54]. Allergic rhinitis is a common disease worldwide, affecting up to 40% of children [55]. Epidemiological findings show a strong association between allergens and asthma, in which the former will induce specific immunoglobulin E (IgE) antibodies and asthma [56-60]. In contrast, Burrows and colleagues found allergic rhinitis to be independent of serum IgE concentration but associated with cutaneous reactivity to common seasonal aeroallergens in most individuals tested. They concluded that "asthma is almost always associated with some IgE-related reaction and therefore has an allergic basis" [56]. This study found a strong relationship between allergic rhinitis and spring season, which increases the incidence of allergic rhinitis. The association between allergic rhinitis and the spring season has an impact on the asthma control level of the patient.

Individuals with skin diseases experience a broad range of symptoms that range from trivial

problems to major handicaps that affect their lives [61-64]. Patients with atopic dermatitis may develop a sequence of atopic dermatitis, allergic rhinitis, and asthma at certain ages, which is called the atopic march [65]. The concept of the atopic march has been supported by cross-sectional and longitudinal studies [66-75]. It has been found that children with eczema have three-fold increased odds of developing asthma and nearly three-fold increased odds of developing rhinitis at a 5-year follow-up when compared to children without eczema [76]. The estimated odds risk for the association of eczema at two years with asthma at six years is approximately 1.80 [77]. Nearly one in every three children with eczema develops asthma later during childhood [74]. This study found a correlation between eczema and asthma that supports the theory of the atopic march. The impact of eczema on the quality of life was studied in 239 patients aged 4–70 years with eczema, and the study found that patients with eczema had inferior scores on vitality, social functioning, and mental health subscales compared with individuals in the general population [78]. A worldwide study has been done on patients aged 6–14 years to measure the climate influence on the prevalence of atopic dermatitis symptoms. The study concluded that the prevalence of atopic dermatitis symptoms was positively correlated with latitude and negatively correlated with the mean annual outdoor temperature both worldwide (6–7-year-old subjects) and in Western Europe (both age groups) [79]. Worldwide, there was a negative correlation between indoor relative humidity and atopic dermatitis symptoms for 6–7-year-old patients [79].

CONCLUSIONS

The current study established the prevalence of uncontrolled asthma using the c-ACT, which no study had done before. Despite the small sample size and implementation at a tertiary center, it is obvious that asthma in pediatric patients is uncontrolled in Saudi Arabia, and other diseases such as allergic rhinitis and atopic dermatitis increase the risk of having asthma. Nevertheless, the winter months have a noticeable influence on the control of asthma in pediatric patients. Additional studies are needed to measure the prevalence of asthma in many cities in Saudi Arabia and to determine the impact of asthma on the quality of life of patients. This study calls for programs to increase the awareness of patients about the importance and proper means to control their conditions. Furthermore, our study calls for programs to educate the Saudi public about the importance of preventive strategies, early diagnosis and the appropriate management of asthma.

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