Environmental and Personal Factors Related to Asthma Severity among Children: Hospital Based Study, Egypt

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ABSTRACT

Background: Childhood asthma is a complex disorder in which many environmental and personal factors play a role. However, the contribution of these factors to asthma severity is poorly understood. This study aims to determine the relationship between environmental exposures, personal factors and asthma severity among asthmatic children.
Methods: This cross-sectional hospital based study was conducted on 180 asthmatic children; who were divided into mild, moderate and severe asthma, according to the forced expiratory volume in the first second. Environmental factors (*indoor and outdoor*), food allergy, history of other allergic diseases, family history of atopy, time trend of attacks as well as asthma outcome were reported.
Results: Severe asthma was significantly linked to younger age (8.9% ± 2.5, p=0.007), eczema (26.3%, p=0.001), fish and egg allergy (15.8%, p=0.01), poor housing conditions (57.9%, p=0.001), exposure to passive smoking (78.9%, p=0.004), gas stove (21.1%, p=0.026) and aerosol chemicals (68.4%, p=0.002). Additionally, severe asthma was insignificantly linked to female gender, younger age at first attack, family history of atopy, allergic rhinitis, milk allergy, contact with domestic pets, frequent upper respiratory tract infections and the presence of unauthorised factories in residential areas (31.6%, p= 0.64). Children with severe asthma had a significant poor school performance (92.1%, p=0.04).
Conclusion: This study highlights that environmental and personal factors were clearly linked to asthma severity among asthmatic children.

Key words: environmental exposure, severe asthma, childhood asthma, asthma outcome

INTRODUCTION

Asthma is by far the most common of all chronic childhood diseases where estimates of developed countries suggest that it affects between 11-20% of all school age children [1]. The prevalence of asthma among Egyptian children was reported to be 6.2% in Assiut district [2], 9.4% in Cairo city [3] and 7.7% in the Nile delta region [4]. The main risk factors related to severe asthma involve the patient, the environment and the society in general, with strong interrelationships between these factors [5].

From a public health perspective, asthma as a health problem has two separate dimensions. The first is the increasing proportion of asthmatic children. The second is the increase in the frequency of asthmatic attacks among asthmatic children. Environmental exposures are among the many possibilities that have been proposed to explain these increases [6]. The rise in asthma prevalence noticed in the past decades has been too rapid to implicate a genetic basis for the changes; however, various environmental factors or lifestyle factors have been implicated. Also, in the last decade, the hygiene hypotheses have put forward as an explanation for this increase [7].

Both genetic and environmental factors contribute to asthma onset and severity. Although, it has been well established that there is an inherited component in asthma, yet aetiological factors of asthma severity remain largely unknown, as there are very few studies on familial and genetic factors as causes underlying severity of asthma [8].

Childhood asthma is a chronic respiratory condition that can restrict a child's life, physically, emotionally, socially and spiritually, which has an impact on the child's quality of life [9]. However, it is difficult to quantify the increased childhood asthma symptoms which yield a burden of morbidity in the form of limitation of physical exercise, missed school days and increased medication cost [10].

Identifying the distinctive characteristics of children with severe asthma may be useful not only for improving scientific knowledge of severe asthma-related risk factors, but also as the basis for developing tailored approaches to asthma management [11]. Although many factors could probably play a role in determining asthma severity, yet they are poorly defined. Therefore, the purpose of this work is to study the link between environmental and personal factors related to childhood asthma severity.

METHODS

Study design

This is hospital based observational cross-sectional study.

Study sample

The study was conducted on 180 known asthmatic children who were residing in the suburbs of Cairo city.

Selection of Subjects

Children were recruited during attending the paediatric outpatient clinic at Al-Zahraa University hospital for the regular follow up visits. Although they were adherent to proper asthma medications, all of them had a history of being symptomatic and uncontrolled within the previous six months of the study onset. Data was collected between June 2014 and December 2015.

Exclusion criteria

Children under seven years of age, uncooperative children, those who were unable to perform spirometry as well as those with other chronic respiratory diseases, were excluded from the study.

Data collection

All children were subjected to the following:

1. Full history taking by using an interview questionnaire with parents. The questionnaire consisted of closed-ended questions covered the following items: 1- Personal characteristics as age, gender, age at first attack, 2- History of co- morbid allergic diseases (nasal, skin or eye), history of upper respiratory tract infections (URTI), food allergy, 3- The time pattern of asthmatic attacks (either continuous, episodic or seasonal), and the daily time of attacks (diurnal or nocturnal), 4-Family history of atopy or allergic diseases like asthma, nasal allergy and dermal or conjunctiva allergy, 5- Indoor environment related to housing conditions was assessed by asking about the presence of unclean carpets, excess dampness and mould in the structure of the building and the presence of cockroaches and rodents. As well as, the exposure to passive smoking, gas stove, aerosol chemicals and contact with pets, 6- Outdoor environment was assessed by asking about the exposure to environmental tobacco smoke (ETS), pollen and the presence of unauthorised factories in the residential area. 7-Asthma outcomes were assessed by asking about limitation of physical activities, school performance and missed school days in the last six months.
2. Spirometry was done using (MEDISOFT–HYPERAIR compact + flow meter pulmonary function

testing-Belgium). The following parameters were recorded; forced vital capacity (FVC%), forced expiratory volume in the first second (FEV_1%), FEV_1\FVC ratio and forced expiratory flow rate 25-75% ($FEF_{25-75\%}$). Spirometric-indices were calculated using the best out of three technically satisfactory performances in accordance to the recommendations of the American Thoracic Society (ATS) [12].

Classification of Subjects

Children were diagnosed on the basis of typical symptoms and signs, in addition to bronchodilator reversibility test at time of diagnosis as they had an increase in FEV_1 > 200 ml, or >12% of baseline value 15 minutes after inhalation of 400µg Salbutamol given via a metered-dose inhaler. They were divided into three groups according to the FEV_1% [13].

- Mild asthma group: 50 asthmatic children (FEV_1% ≥ 80)
- Moderate asthma group: 92 asthmatic children (60 ≤ FEV_1% < 80)
- Severe asthma group: 38 asthmatic children (FEV_1% < 60)

Ethical consideration

All participants voluntarily participated after explanation of the objective and tools used in the study to children and their caregivers. They were reassured about the confidentiality of data. A verbal informed consent was obtained from all parents or guardians. Also, participants were informed that they had the right to withdraw from the study at any time without giving any reasons and without affecting their rights of medical care. The study was conducted after approval of the ethical review committee of the Faculty of Medicine for girls Al-Azhar University.

Statistical Analysis

Descriptive analysis was done for each item. Results are expressed as a mean and standard deviation for quantitative continuous variables, and as percentages for qualitative (categorical and nominal) variables. Comparisons between the studied groups were made using Chi-square (χ^2) test regarding qualitative variables and ANOVA test regarding quantitative variables. A two sided p ≤ 0.05 was considered significant. Data were analysed with SPSS-PC version 17.0 (SPSS Inc., Chicago, IL). The confidence level was 95% and confidence interval was 5%.

RESULTS

The mean age of the studied children was (9.2 ± 1.9 years), ranging between 7-17 years, with 48.9% males and 51.1% females. Severely asthmatic children were of younger age (p < 0.05). Children with moderate and severe asthma developed the first asthmatic attack at a younger age than those with mild asthma (table1).

Children with moderate and severe asthma had more clinical, perennial, diurnal and nocturnal symptoms (table 2).

Children with severe or moderate asthma showed a higher percentage of allergic co-morbidities. Overall, allergic rhinitis was the most common allergic co-morbidity associated with asthma; also eczema was higher among children with severe asthma than moderate asthma. Severely asthmatic children reported a higher percentage of family history of atopy especially if more than one family member were atopic. They also showed a higher percentage of allergies to fish, egg and milk with frequent upper respiratory tract infection (URTI) (table 3).

More than half of the severely asthmatic children (57.9%) live in poor housing conditions compared to the moderate or mild asthmatics (30.4% and, 16% respectively) (p =0.001). They reported more exposure to passive smoking (78.9%, p=0.004), gas stove (21.1%, p=0.02), aerosol chemicals (68.4%, p=0.002) and contact with domestic pets (42.1%, p=0.58) (table 4).

About one third (31.6%) of children with severe asthma have unauthorised factories in their residential area with non-significant p-value (p= 0.64). However, the highest levels of exposure to ETS and pollens are not reported among severely asthmatic children with a non-significant difference in between groups (table 5).

Children with severe asthma had insignificant higher limitations of physical activities (73.7%, p=0.19) and more missed school days (81.5%, p=0.07), whereas they had a significant poor school performance (92.1%, p=0.04) compared to mild and moderate asthmatic children (table 6).

DISCUSSION

Risk factors for childhood asthma development have been studied extensively worldwide; however, the contribution of environmental exposure and personal characteristics to asthma severity is poorly evaluated. Although, environmental exposures to indoor and outdoor inhalant allergens are well-known triggers of asthma attacks that may increase the risk of asthma severity and decrease levels of its control, yet their role in asthma severity is still not fully studied.

Accordingly, this study demonstrated that living in poor housing conditions with exposure to passive smoking and aerosol chemicals was significantly higher among severely asthmatic children than those with mild or

TABLE 1. Personal characteristics and spirometric indices of the studied groups.

ITEMS	TOTAL (n = 180)	GROUPS			p value
		MILD (n = 50)	MODERATE (n = 92)	SEVERE (n =38)	
Gender - Male - Female	88 (48.9) 92 (51.1)	30 (60.0) 20 (40.0)	42 (45.7) 50 (54.3)	16 (42.1) 22 (57.9)	0.16
Age /year (Mean ± SD)	9.7 ± 2.5	9.2 ± 1.9	10.2 ± 2.6	8.9 ± 2.5	0.007*
Age at first attack/ Months (Mean ± SD)	25.3 ± 21.3	26.9 ± 21.2	24.8 ± 22.2	24.7 ± 19.6	0.81
FEV_1 % (Mean ± SD)	84.9 ± 3.1	84.8 ± 3.1	72.1 ± 5.2	51.4 ± 7.5	0.000*
FVC% (Mean ± SD)	80.3 ± 9.5	80.3 ± 9.5	77.8 ± 6.0	69.2 ± 9.0	0.000*
FEV_1/FVC (Mean ± SD)	77.0 ± 6.1	77.0 ± 6.1	76.3 ± 6.2	68.2 ± 11.3	0.000*
$FEF_{25-75\%}$ (Mean ± SD)	54.1 ± 14.1	54.1 ± 14.1	56.8 ± 18.8	44.67 ± 18.8	0.002*

** Significant p value*

TABLE 2. Presenting symptoms and time trend of asthmatic attacks of the studied groups.

ITEMS	TOTAL (n = 180)	GROUPS			p value
		MILD (n = 50)	MODERATE (n = 92)	SEVERE (n =38)	
Cough	152 (84.4)	32 (64.0)	84 (91.3)	36 (94.7)	0.000*
Dyspnoea	146 (81.1)	42 (84.0)	72 (78.3)	32 (84.2)	0.60
Wheezes	140 (77.8)	30 (60.0)	76 (82.6)	34 (89.5)	0.001*
Diurnal symptoms	60 (33.3)	2 (4.0)	38 (41.3)	20 (52.6)	0.000*
Nocturnal symptoms	116 (64.4)	18 (36.0)	62 (67.4)	36 (94.7)	0.000*
Seasonal symptoms	122 (67.8)	38 (76.0)	64 (69.6)	20 (52.6)	0.17
Perennial symptoms	54 (30.0)	4 (8.0)	26 (28.3)	24 (63.2)	0.000*

** Significant p value*

moderate asthma ($p < 0.05$). This might be attributed to the fact that children spend most of their time inside homes where many allergens existed. This finding is in agreement with Simons et al. [14] who documented that inner-city homes have higher levels of airborne pollutants that predispose to greater asthma morbidity. Also, asthmatic children of parents who smoke cigarettes suffer from more frequent asthma attacks and more severe symptoms [15]. In the same context Zedan et al. [4] documented that passive smoking and unfavourable housing conditions were reported by 47.8% and 81.3% of asthmatic children respectively. Previously published studies have determined that indoor allergen exposures are important risk factors for asthma development and morbidity in urban children [16]. The WHO has demonstrated that around one billion people, mostly women and children, are regularly exposed to levels of indoor air pollution that are up to 100 times higher than those considered acceptable [17,18]. This study found that 21.1% of severely asthmatic children have contact with gas stoves ($p=0.03$), indicating that localised indoor air pollution, particulate matter as well as gases released during the use of gas stoves may play an important role in asthma severity.

Moreover, this study showed an insignificant higher level of contact with domestic pets (42.1%, p=0.58) among the severely asthmatic children. Due to which these results were inconclusive to confirm the relationship between contact with domestic pet and severity of childhood asthma.

Regarding the exposure to an outdoor environment, this study showed that around one third (31.6%) of severely asthmatic children reported a higher but non-significant ($p= 0.64$) prevalence of unauthorised factories in their residential areas. This could be attributed to the fact that in greater Cairo industrial zones are located close to or in the dense populated areas (specifically unplanned areas). Also with chemical and food factories representing 43% and 33% respectively of industrial facilities that are located inside or close to residential areas resulting in an increase in the level of pollution [19]. Although, this result was not

TABLE 3. History of co-morbid atopic diseases, family history of atopy, food allergy and upper respiratory tract infections among the studied groups

ITEMS	TOTAL (n = 180)	GROUPS			p value
		MILD (n = 50)	MODERATE (n = 92)	SEVERE (n =38)	
Other allergic co-morbidities	**102 (56.7)**	**22 (44.0)**	**54 (58.7)**	**26 (68.4)**	**0.06**
Eczema	32 (17.8)	0 (0.0)	22 (23.9)	10 (26.3)	0.001*
Allergic rhinitis	96 (53.3)	22 (44.0)	48 (52.2)	26 (68.4)	0.07
Allergic conjunctivitis	10 (5.6)	4 (8.0)	4 (4.3)	2 (5.3)	0.66
Family history of atopy	**156 (86.7)**	**40 (80.0)**	**80 (87.0)**	**36 (94.7)**	**0.13**
One family member atopic	116 (64.4)	32 (64.0)	60 (65.2)	24 (63.2)	0.17
More than one family member atopic	42 (23.3)	8 (16.0)	22(23.9)	12 (31.6)	
Food allergy	**116 (64.4)**	**26(52.0)**	**64 (68.4)**	**26 (64.4)**	**0.09**
Banana	56 (31.1)	12(24.0)	32 (34.8)	12 (31.6)	0. 41
Strawberry	44 (24.4)	10 (40.0)	26 (28.3)	8 (21.1)	0.47
Milk	16 (8.9)	4 (8.0)	6 (6.5)	6 (15.8)	0.23
Fish	12 (6.7)	0 (0.0)	6 (6.5)	6 (15.8)	0.01*
Egg	14 (7.8)	6 (12.0)	2 (2.2)	6 (15.8)	0.01*
Chocolate	12 (6.7)	4 (8.0)	6 (6.5)	2 (5.6)	0.87
URTI	148 (82.2)	42 (84.0)	74 (80.4)	32 (84. 4)	0. 81

**Significant p value*
URTI: upper respiratory tract infections

TABLE 4. Indoor environmental factors among the studied groups as reported by parents

ITEMS	TOTAL (n = 180)	GROUPS			p value
		MILD (n = 50)	MODERATE (n = 92)	SEVERE (n =38)	
Poor housing conditions	58 (32.2)	8 (16.0)	28 (30.4)	22 (57.9)	0.001*
Passive smoking	126 (70.0)	26 (52.0)	70 (76.1)	30 (78.9)	0.004*
Gas stove	18 (10.0)	2 (4.0)	8 (8.7)	8 (21.1)	0.026*
Aerosol chemicals	78 (43.3)	20 (40.0)	32 (34.8)	26 (68.4)	0.002*
Contact with domestic pets	64 (35.6)	18 (36.0)	30 (32.0)	16 (42.1)	0.58
Cats	54 (30.0)	18 (36.0)	24 (26.1)	12 (31.6)	0.58
Dogs	14 (7.8)	2 (4.0)	8 (8.6)	4 (10.6)	0.69

**Significant p value*

significant and did not specify the type of industry; yet it highlighted the association between asthma severity and industrial factories in proximity.

Although the results of this study highlighted an evidence of association between indoor and outdoor environmental pollution and asthma severity; yet, it is difficult to discriminate between the effects of each one separately, as they are interrelated. Moreover, several studies reported that 50% of inner-city asthmatic children exposed to higher levels of ETS with more frequent nocturnal symptoms and more than 60% of them have mothers or caregivers who smoke [20-23]. Additionally, other studies demonstrated that environmental interventions at home reduced asthma morbidity [24, 25].

Childhood asthma, rhino-conjunctivitis and eczema have become important public health problems worldwide [26]. Therefore, identification of allergic co-morbid diseases is essential to understand asthma burden. This study revealed that severely asthmatic children had a significantly higher level of eczema (26.3 %, p= 0.001).

TABLE 5. Outdoor environmental factors among the studied groups as reported by parents.

ITEMS	TOTAL (n = 180)	GROUPS			p value
		MILD (n = 50)	MODERATE (n = 92)	SEVERE (n =38)	
Unauthorised factories in residential area	48 (26.7)	14 (28.0)	22 (23.9)	12 (31.6)	0.64
ETS	48 (26.7)	18 (36.0)	18 (19.6)	12 (31.6)	0.07
Pollens	32 (17.8)	10 (20.0)	20 (21.7)	2 (5.3)	0. 07

**Significant p value*
ETS: environmental tobacco smoke

TABLE 6. Asthma outcome among the studied groups.

ITEMS	TOTAL (n = 180)	GROUPS			p value
		MILD (n = 50)	MODERATE (n = 92)	SEVERE (n =38)	
Limitation of physical activities	102 (56.6)	22 (44.0)	52 (56.5)	28 (73.7)	0.19
Missed school days / Month	124 (68.9)	30 (60.0)	63 (68.5)	31 (81.5)	0.07
Poor school performance	142 (78.9)	35 (70.0)	72 (78.3)	35 (92.1)	0.04*

**Significant p value*

This could be attributed to that eczema has been considered as an 'entry point' for subsequent allergic diseases [27]. Moreover, the similarity of genetic and epidemiological basis of both asthma and eczema has raised a strong possibility of developing asthma among children suffering from other allergic co-morbidities [2, 28, 29].

Additionally, a higher, but an insignificant, percentage of allergic rhinitis was reported among severely asthmatic children. In spite of the inconclusive results of this study regarding the association between severity of asthma and the presence of allergic rhinitis; other studies reported that, the presence of allergic rhinitis among asthmatic patients increased the frequency, duration, severity of attacks, rates of hospitalisation, cost of asthma management as well as poor asthma control [30-32]. Also, Adams et al. [33] reported that treatment of allergic rhinitis reduced emergency visits for asthma. This could be explained by the fact that all allergic diseases had the same pathogenesis, inflammatory mediators and genetic bases [14].

The interplay between T-helper 1 and T-helper 2 lymphocytes in the augmentation or attenuation of the allergic immune response (hygiene hypothesis) is still controversial without sufficient data to draw a specific conclusion. The results of the present study showed a non-significant higher prevalence of URTI (84.4%, p=0.8) among severely asthmatic children. Accordingly, these results do not support the relationship between URTI and asthma severity. However, other studies reported that respiratory viral infections during infancy had been associated with the inception of asthma [34, 35]. While, Stein et al. [36] concluded that some viral respiratory infections early in life protect against the development of asthma.

Atopy is an example of the host-environment interactions, also allergic diseases were usually found to cluster in the same family; moreover family history of atopy was found to be the most prominent risk factor for all allergic disorders in children [37]. This study showed that, the highest (94.7%), prevalence of family history of atopy was among the severely asthmatic children (but insignificant statistically), especially if more than one family member were atopic (31.6%). In the same context Sibbald et al. [38] reported that when both parents had asthma, 80% of their children developed asthma, compared to 40% when one parent had asthma and 10% when no parent had asthma.

While, the rising global burden of asthma, rhinitis and eczema has been well documented, there is no equivalent published data on food allergies [39]. Food allergy is considered a significant paediatric health issue that is likely to increase globally in the coming decade. It had emerged as an unanticipated 'second wave' of the allergy epidemic that dramatically increased the burden of allergic diseases in infants and preschool children. One of ten infants in developed countries has a proven IgE-mediated food allergy [40,41]. This study revealed that severely asthmatic children reported a significantly higher allergy to fish and egg and a non-significant higher allergy to milk. These findings are consistent with earlier studies that highlighted an association between food allergies and the increased risk of asthma [2, 42]. This link between asthma and food

allergy could be attributed to the fact that sensitisation to food allergens itself have a causal role in the development of sensitisation to inhalant allergens and asthma [43]

Worldwide, childhood asthma is the most common chronic disease leading to missed school days, limitation of physical activities with greater impact on family and child life. Accordingly, this study revealed that severely asthmatic children have a significant poorer school performance, an insignificant higher limitation of physical activity and missed school days than those with moderate or mild asthma. In the same context Behl et al. [29] reported that asthma is the commonest chronic disease associated with disability and school absenteeism. Additionally, Bassili et al. [44] documented that, up to 1 of 4 asthmatic children in Egypt were unable to attend school regularly because of poor asthma control.

Regarding, personal characteristics of the studied children, those with severe asthma were significantly of younger age and suffered more cough, wheezes and higher diurnal, nocturnal and perennial symptoms.

STUDY LIMITATIONS

This study has some limitations that deserve to be mentioned; firstly, it's considered a snapshot (a cross-sectional study) so the strength of relationship could not be established. Secondly, assessment of indoor and outdoor environment relied on parents' report, which was likely to underestimate the true exposure and thus influenced the results. Finally, the sample was not a representative sample of Egyptian children as it was a hospital-based study conducted on a small sample size, especially for children with severe asthma and the children were residing in certain localities (Cairo suburbs).

CONCLUSION

According to the results of this study, personal factors that are linked to severity of childhood asthma include: younger age and presence of eczema. This study highlights the role of food (fish and egg) allergy as a significant factor related to asthma severity. Also, environmental factors that are linked to severity of childhood asthma include: poor housing conditions, exposure to passive smoking, gas stove and aerosol chemicals. Accordingly, paediatricians and child health care givers should be aware of all these factors and must consider the potential modifiable factors in order to fix it together with setting asthma medications. Concurrently implementation of effective intervention measures to prevent exposure to these environmental pollutants is needed. Finally, further research is needed on a wider scale to adequately identify the underlying factors leading to asthma severity in childhood.

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