RISK FACTORS FOR ASTHMA IN IRAQI CHILDREN

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ABSTRACT

Background: Although a large number of studies of asthma had been conducted, the etiology of childhood asthma is not yet established. Both life style factors and environmental exposure during early life may play important roles. Objective: To evaluate the risk factors for asthma in Iraqi primary school children. Patients and Methods: The sample consisted of 2875 children, who were between 11 and 14 years of age at the time of enrollment in the Regional Study of Asthma and Allergies in Childhood (RSAAC) and were subsequently followed up at their schools. Results: The prevalence of asthma when assessed by interview was 7.2% [95% confidence interval (CI) 6.3% - 8.3%], while it was 8.9% [95% CI 7.9 % - 10.0%] when assessed by clinical examination. There was no significant difference between the prevalence of asthma in males and females. Exposure to wood or oil smoke (Odds-ratio (OR)=2.40, 95% CI 1.84–3.17; P<0.001); cats and dogs (OR=2.95, 95% CI 2.15–4.04; P<0.001); herbicides and /or pesticides (OR=1.68, 95% CI 1.16–2.43; P=0.005); farm animals, farm crops or dust (exposure to animals OR= 2.97, 95% CI 2.02–4.37; P<0.001; exposure to farm crops (OR=2.17, 95% CI 1.33–3.55; P=0.002); and breastfeeding (OR=8.5, 95% CI 6.10-11.84; P<0.001) were significantly associated with asthma. Family history of asthma (OR=4.11, 95% CI 3.16-5.34; P<0.001) and atopy (OR=2.33, 95% CI 1.79-3.04; P<0.001) were associated with an increased prevalence of asthma. In addition, family history of smoking was associated with asthma (OR=1.52, 95% CI 1.17-1.97; P=0.001). Presence of skin problems (OR=2.40, 95% CI 1.63-3.55; P<0.001), gastro intestinal problems (OR=5.64, 95% CI 2.23-14.25; P<0.001) and food allergy (OR=6.08, 95% CI 2.96-12.52; P<0.001) were significantly associated with asthma in childhood. Maternal education (p<0.001) and social status (p=0.001) may be a risk markers for asthma in childhood. Conclusion: These results suggest that both environmental exposure and lifestyle factors are important risk factors for childhood asthma in Iraqi children. Both indoor and outdoor environmental exposure may play a crucial role in the etiology of childhood asthma.

KEYWORDS: Asthma; Risk factor; Children; Iraq; Environmental exposure; Prevalence.

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INTRODUCTION

Asthma is a complex multifactorial disease in which allergic factors and non-allergic triggers interact, resulting in bronchial obstruction and inflammation (Busse et al., 2003). Asthma is the leading chronic disease of children in industrial countries; however, the disease is also common in children in developing countries (Busse et al., 2003).

Although a large number of studies focussing on asthma have previously been conducted, the aetiology of childhood asthma is yet to be firmly established (Salam et al., 2004). Both life style factors and environmental exposure during early life may play important roles in asthma occurrence (Johnson et al., 2002). Allergenic sensitization is important in the development of asthma and although links between inhalant allergens and asthma have been known for many years, they have recently been reemphasized. Indoor allergens are associated with asthma prevalence, severity and exacerbations, whereas outdoor allergens are associated with exacerbation (Adkinson et al., 2000). However, timing of such environmental exposure during early development may also be important in allergic sensitization and later asthma development (Melen et al., 2001). Early exposure to endotoxin from farm environments has been associated with reduced childhood asthma risk (Braun-Fahrlander, 2001), however, endotoxin exposure later in life may increase asthma occurrence especially in agricultural settings (Schwartz, 2001).

Asthma exacerbation is the major cause of morbidity and mortality in asthmatic children (Johnston, 1998). Evidence suggests viral infections, rather than bacterial infections play a major role in asthma exacerbation (Johnston, 1998; Weiss, 1998). However, the impact of respiratory infections declines with age in children; with increasing age, asthma episodes are more likely to be triggered by factors such as exercise or allergy problems (Sarafino, 1998).

Exposure to various constituents including tobacco smoke, wood smoke, air-born allergens, dust mites, mould, and other indoor pollutants is known or suspected to trigger wheezing or exacerbate asthma in children (Weiss, 1998). The level of exposure to these compounds differs in regional Iraq from the situation in developed societies, as children spend more time outdoors with increasing age. Despite the increased exposure to asthma triggers, there are few population-based data examining whether exposure to environmental factors may be associated with asthma in Iraqi children. The purpose of this investigation is to use population-based data from a regional study of asthma and allergies in

childhood to assess the risk factors for asthma among primary school children in Iraq.

METHODS

Participants

Participants for this cross-sectional study were selected from the Community-Based Health Promotion Research (CBHPR) study that was conducted by Tikrit University College of Medicine [TUCOM], Iraq. The CBHPR are population based studies that were performed in Salahul-Deen Governorate as part of a research project conducted by a faculty member of TUCOM: included in this program is the Regional Study of Asthma and Allergies in Childhood (RSAAC). Briefly, the RSAAC is a population based study in which 2875 children were recruited from public classrooms from grade 5 and 6 in Samara.

Samara (348,700 inhabitants) is a city located 120 km north of Baghdad, the capital of Iraq. The employment in the city ranges from farmers and casual workers to university lecturers. The city can be considered representative of the Iraqi urban population and the primary school children of the town are largely representative of Iraqi primary school children. There are 25 primary schools in the city with a total enrolment of 10,820 children (5397 boys).

All 25 schools (11 for boys and 14 for girls) were included in the study to determine factors associated with asthma among primary school children living in different socioeconomic conditions in Samara city. Most of the schools visited were overcrowded. After explaining the nature of the study to the administrator in the education department, the school administrators were asked to allow the study team to examine the children in their school.

All 5th and 6th class primary school children were recruited (2875; 1624 boys); all were preadolescent. These classes (the highest of the primary classes) were selected because children of this age are able to perform the exercise challenge test and peak flow metric measure better than younger children and the questionnaire information obtained from them are more accurate than information from lower classes.

The exclusion criteria for the study were: being disabled; having severe anemia; having heart disease; being steroid dependant; having thyrotoxicosis or having congenital heart diseases. The parents of each participating student provided written informed consent. Physicians performed the interview, completed the questionnaire and conducted the clinical examination. During the follow up period, the children underwent a clinical examination to ensure they fulfilled the inclusion criteria, undertook Peak Expiratory Flow Rate [PEFR] studies and were interviewed if they had been absent during the school visit. Furthermore, parents were interviewed during this follow up visit. The final sample consisted of 2875 children, who were between 11 and 14 years old when they were enrolled in the RSAAC and completed the follow up.
Tikrit University College of Medicine Board reviewed and approved the study.

Data collection

In accordance with the International Study of Asthma and Allergies in Childhood methodology, we developed an Iraqi Arabic version of the questionnaire for use in the RSSAC programme. Initially all primary school children in grades 5 and 6 were asked to complete the questionnaire, then their mothers completed the questionnaire. Subsequently the children underwent a clinical examination.

The teacher and the mother of each subject provided detailed information about demographics, family history of asthma, feeding practices in infancy, house hold environment and farm related exposure by direct interview through a physician. The child was also interviewed. The questionnaire comprised of demographic information, and information about environmental exposure, life style, clinical symptoms and signs of asthma. A modification of the standardized questionnaire of the International Study of Asthma and Allergies in Childhood was prepared (The International Study of Asthma and Allergies in Childhood Steering Committee 1998). The questionnaire was translated into Arabic by a person who is bilingual in Arabic and English, then translated back into English by another bilingual person. The translated questionnaire was pilot tested in a small group of women and their 11-14 year old school children. The interview was repeated if there were any conflicting statements between the mother and her child.

Exposure assessment

For environmental exposure, including exposure to cats, dogs, farm animals, farms crops and dust exposure, herbicide, and pesticide, we recorded whether the child was exposed or never exposed. In Iraq, cats are the only pets while farm animals include cows, sheep, and chickens. Dogs and chickens may live in the area around the house, but do not enter the house. Questions about exposure to wood, oil smoke, soot or exhaust provided a surrogate measure of particulate air pollutant exposure at home. Similarly, questions about exposure to farm crops or dust provided information about exposure to farm land. The cooling of homes by water evaporators was assessed as ever or never.

Assessment of confounders and effect modifiers

Family history of atopy, smoking and asthma were assessed as ever/never. Family history of asthma or allergy were defined as a first-degree relative with a diagnosis of asthma or allergy, presence of skin problems, gastro intestinal (GIT) problems (defined as nausea, vomiting, heart burn, diarrhea, or constipation). Food and drug allergy were assessed as ever/never. Monthly family income at study entry was grouped into two categories of low (less than 2,000 US dollars) and high. Maternal education at study entry was grouped into four categories: illiterate, primary school, secondary school or college and above. Social status was grouped into two categories, low (primary school graduate and below) and high. Crowding index was grouped into three categories 1, 2 or 3, and more than three children in a house.

Outcome assessment

The physical examination was conducted by a specialist physician and the diagnosis of asthma was established

according to the National Heart, Blood and Lung Institutes/ World Health Organization [NHLBI/WHO] workshop on the Global Strategy for Asthma (Bethesda 2002).

Patient evaluation included: Baseline assessment to evaluate the patient's clinical condition, including personal characteristics and clinical history. Asthma history collected was: type and pattern of symptoms, precipitating and aggravating factors, profile of a typical attack, impact of the disease on the child and family, development of the disease, family history, general medical history, socioeconomic situation, physical environment, crowding index, and type of feeding as infant. The physical examination included the upper and lower respiratory tracts and the skin. Physical findings that increased the probability of asthma were hyperinflation, wheezing during forced exhalation, increased nasal secretion, mucosal swelling, nasal polyps, and allergic skin conditions including atopic dermatitis/eczema. The physical examination also included listening to breath sounds for possible ronchi, wheeze or rales and examination of nasal passages for evidence of allergic rhinitis such as nasal polyps or a deviated nasal septum. A peak flow metre was used to measure Forced Expiratory Volume exhaled during the first second (FEV1). A FEV1 percentage of the vital capacity of less than 80% suggests airway obstruction.

It is dangerous to conduct a challenge test which involves the administration of histamine or methacholine unless adequate equipment is available to treat anaphylaxis. As such equipment was not available the exercise challenge test was performed, with the children being asked to run around for 10 minutes, followed by further physical examination for evidence of respiratory symptoms. A fall in the Peak Expiratory Flow Rate (PEFR) of more than 20% following exercise was considered a sign of asthma.

Statistical analysis

Environmental and life-style characteristics of subjects with and without asthma were compared using Chi–square tests and unadjusted odds-ratios (OR) together with 95% confidence interval (95% CI). Race, ethnicity and residence were not further investigated because the sample was from one ethnic group and all were urban residents. P values of less than 0.05 were regarded as statistically significant. Analysis was conducted using SPSS statistical software package (SPSS Inc., Chicago, Illinois).

RESULTS

A total of 2875 children were included in the study (1624 males). The prevalence of asthma in primary school children [11-14 year age] was 7.2% [95% CI 6.3%-8.3%] when assessed by interview, while it was 8.9% [95% CI 7.9%-10%] when assessed by clinical examination (Table 1). Participants belonged to the same ethnic group and the age range and male to female ratio were similar for participants with asthma compared to asthma free participants.

Exposure to wood or oil smoke was significantly associated with asthma prevalence (OR=2.40, 95% CI 1.84–3.17; P<0.001) in primary school children as was exposure to cats and dogs (OR=2.95, 95% CI 2.15-4.04; P<0.001) and herbicides and/or pesticides (OR=1.68, 95% CI 1.16–2.43; P=0.005) (Table 2). Exposure to farm animals (OR= 2.97, 95% CI 2.02–4.36; P<0.001), or farm crops or dust (OR=2.17, 95% CI 1.33-3.55; P=0.002) was also associated with an increased prevalence of asthma. Thus environmental exposure was a potential risk factor for the development of asthma in 11 -14 year old Iraqi children (Table 2).

A family history of asthma (OR=4.11, 95% CI 3.16-5.34; P<0.001), atopy (OR=2.33, 95% CI 1.79-3.04; P<0.001) and smoking (OR=1.52, 95% CI 1.17-1.97; P=0.001) was associated with increased prevalence of asthma. Presence of skin problems, GIT problems and food allergy were significantly associated with asthma in childhood, however, the association was higher for food allergy (OR=6.08, 95% CI 2.96-12.52; P<0.001) and for GIT problems (OR=5.64, 95%CI 2.23-14.25; P<0.001) than for skin problems (OR=2.40, 95% CI 1.63-3.55; P<0.001). There was no significant association between allergy to drugs and having asthma (OR=0.5, 95% CI 0.19-1.32; P=0.156) (Table 3).

Breast-feeding was found to be a significant risk factor for asthma (OR=8.5, 95% CI 6.1-11.84; P<0.001). Family income, using an evaporator as an air cooling method, having a family history of smoking, and gestational age at birth did not confound the association between any of the exposure variables and asthma outcome. However, maternal education (P<0.001), social status (P=0.001) and crowding index (P<0.001) appeared to increase the prevalence of asthma in childhood (Table 4).

Table 1: Prevalence of asthma in Iraqi primary school children 11 to 14 years of age.

	Interview	Examination	p-value
Participants with asthma			
Male [%]	109 [52.4]	140 [54.7]	0.04
Female [%]	99 [47.6]	116 [45.3]	0.22
Total [%]	208 [100]	256 [100]	
p-value	0.21	0.54	
Participants without asthma	2667	2619	
Total number interviewed and examined	2875	2875	
Prevalence of asthma	7.2%	8.9%	0.02
95% confidence interval	6.3 – 8.3	7.9 – 10.0	

Table 2: Bivariate associations between asthma and exposure to environmental factors. Results were based on the analysis of 2875 Iraqi school children.

Environmental variable	Number of participants with asthma [%]	Number of participants without asthma [%]	Unadjusted Odds-ratio [95% CI]*	p-value
Wood/oil smoke				
Yes	172 [67.2]	1202 [45.9]	2.40 [1.84-3.17]	<0.001
No	84 [32.8]	1417 [54.1]	1	
Exposure to cats and dogs				
Yes	204 [79.8]	1495 [57.1]	2.95 [2.15-4.04]	<0.001
No	52 [20.2]	1124 [42.9]	1	
Herbicide/pesticide exposure				
Yes	221 [86.3]	2069 [79]	1.68 [1.16– 2.43]	=0.005
No	35 [13.7]	550 [21]	1	
Farm animal exposure				
Yes	225 [87.9]	1859 [71]	2.97 [2.02-4.36]	<0.001
No	31 [11.1]	760 [29]	1	
Farm crops or dust exposure				
Yes	238 [92.9]	2250 [85.9]	2.17 [1.33-3.55]	=0.002
No	18 [7.1]	369 [14.1]	1	

* 95 CI = 95%-confidence interval

Table 3: Association between prevalence of asthma and medical history. Results were based on the analysis of 2875 Iraqi school children.

Medical history	Number of participants with asthma [%]	Number of participants without asthma [%]	Unadjusted Odds-ratio [95% CI]*	p-value
Family history of atopy				
Yes	160 [62.5]	1092 [41.7]	2.33 [1.79-3.04]	<0.001
No	96 [37.5]	1527 [58.3]	1	
Family history of smoking				
Yes	107 [41.8]	1367 [52.2]	1.52 [1.17-1.97]	=0.001
No	149 [58.2]	1252 [47.8]	1	
Family history of asthma				
Yes	136 [53.1]	559 [21.3]	4.11 [3.16-5.34]	<0.001
No	120 [46.9]	2060 [78.7]	1	
Presence of skin problems				
Yes	35 [13.7]	162 [6.2]	2.40 [1.63-3.55]	<0.001
No	221 [86.3]	2457 [93.8]	1	
Presence of GIT problems**				
Yes	7 [2.7]	13 [0.5]	5.64 [2.23-14.25]	<0.001
No	249 [97.3]	2606 [99.5]	1	
Food allergy				
Yes	12 [4.7]	21 [0.8]	6.08 [2.96-12.52]	<0.001
No	244 [95.3]	2598 [99.2]	1	
Drug allergy				
Yes	5 [1.9]	26 [1.0]	0.5 [0.19-1.32]	=0.156
No	251 [98.1]	2593 [99]	1	

* 95 CI = 95%-confidence interval; **GIT = gastro intestinal problems

DISCUSSION

In this population based study we found that exposure to wood, oil smoke, cats, dogs, herbicides or pesticides, and animal and farm environments were associated with an increased risk of asthma among children in Samara city, Iraq. The findings suggest that the aetiology of childhood asthma is complex and may include both early life environmental exposure and early allergic sensitization. Combustion of wood liberates nitrogen dioxide, carbon monoxide, sulfur dioxide and particulate matter, all of which have been associated with increased respiratory illness (Larson and Koenig, 1994).

Exposure to oil smoke has been shown to significantly increase the risk of asthma (Chen et al., 2002), while particles from wood combustion significantly reduced lung function in elementary school children (Koenig et al., 1993). The results of this study are consistent with previous observations showing that early transient wheezing and/or increased airway reactivity in children and exposure to products of combustion may be important in the patho-physiology of asthma (Salam et al., 2004; Belanger et al., 2003; Sotir et al., 2003). The observed associations between exposure to cats and dogs and childhood asthma are consistent with previous studies (Salam et al., 2004; Lau et al., 2000; Nafstad et al., 2001; Ronmark et al., 2002; McConnell et al., 2002; Zheng et al., 2002), but contrast with other studies which

found pets were protective (Hesselmar et al., 1999; Remes et al., 2001). A review of 32 articles suggested a non-significant increase in asthma risk of 11% was associated with the presence of pets in the first two years of life (Apelberg, Aoki and Jaakkola, 2001). However, it is difficult to explore the association between exposure to pets and childhood asthma, even in prospective studies, because of issues of temporality and possible confounders associated with keeping pets (Salam et al., 2004). Further prospective studies are required to examine the association between childhood asthma and age, duration of exposure to pets, and measured levels of allergens and endotoxins (Salam et al., 2004).

A positive association has been reported between asthma among adults and the use of herbicides and pesticides (Bener et al., 1999; Hoppin et al., 2002), although data on pesticide exposure and childhood asthma are limited (Salam et al., 2004). In the present study, exposure to either pesticides or herbicides was associated with an increased risk of asthma in children. These results are consistent with reports from other geographical areas (Salam et al., 2004; Karmaus, Kuehr and Kruse, 2001).

It has been suggested that children's hand-to-mouth behaviour, closeness to playground, low ratio of skin surface to body mass, reduced ability to detoxify toxic substances, and increased sensitivity of cholinergic receptors to pesticides make them more vulnerable to the toxic effects of pesticides, especially during their early lives (Ernst, 2002). Furthermore, the developing respiratory, immune and nervous systems in children are more vulnerable to the effect of pesticides and herbicides (Salam et al., 2004).

Several studies have suggested a reduced risk of asthma with exposure to a farming environment in early life (Von Ehrenstein, 2000). It has been suggested that exposure to a farming environment causes higher levels of exposure to bacterial endotoxins, eventually leading to the production of several cytokines that shift the balance towards the TH1- over TH2- mediated immunity, thereby reducing asthma risk (Braun-Fahrlander, 2001). In the present study, such an inverse association with farm exposure was not evident, as there was a significantly increased risk of asthma in children with farm-related exposure. In contrast, previous studies have reported that growing up in a farming environment is associated with an increased risk of asthma and that endotoxin exposure may increase asthma risk (Salam et al., 2004). The discrepancy between studies may be due to differences in farming practice, crops, lifestyle and other "rural" factors that differ between this Iraqi environment and that in Europe and other regions from which previous reports originated. A further difference in Iraq may be the proximity of stables to the home and time spent in stables (Braun-Fahrlander, 2001); in this population stables were mostly attached to the family home and sometimes located within the house.

The protective effect of breastfeeding on the development of asthma has raised substantial interest, but the scientific evidence relating to the effect of breastfeeding is controversial (Friedman and Zeiger, 2005). The epidemiological studies have provided controversial results showing negative association consistent with a protective effect, whereas some studies have reported either no association or a positive association between the duration of breast-feeding and the risk of asthma (Chulada et al., 2003; Nafstad and Jaakola, 2003; Oddy et al., 2004). The present study indicated that breast-feeding is a risk factor for asthma. Both methodological issues and the complexity of the phenomenon may be responsible for these contrasting results (Fredriksson, Jaakola and Jaakola, 2007).

Differences in several factors, including; the age at which various diseases were experienced, hereditary factors as well as environmental factors may influence the association between breast-feeding and the development of asthma, thus explaining the conflicting results reported to date. The finding of the present study may differ from that reported for developed countries because of variations in the duration of breast-feeding; generally about two years in Iraq. In addition, there is the potential for incorporation of local environmental pollutants into breast milk.

The duration of breast-feeding varies substantially in the reported studies, which becomes critical when fitting the variable if the relation is non-linear as previously suggested (Fredriksson, Jaakola and Jaakola, 2007). The duration of follow up and the age of onset of asthma are also important, as if breast-feeding could delay the onset of asthma, the prevalence of current asthma would be lower among breast-fed than non-breastfed young children, but similar in later life (Busse et al., 2003). There is evidence that hereditary asthma or atopic disease (Fredriksson, Jaakola and Jaakola, 2007) and exposure to environmental factors (Nafstad and Jaakola, 2003) can modify the relation between the duration of breast-feeding and the risk of asthma. The controversial results referred to above may relate to the non-linear relation between the duration of breastfeeding and the risk of asthma (Fredriksson, Jaakola and Jaakola, 2007).

The finding in this study of a significant association between food allergy and asthma in children is consistent with that reported by others (Simpson, Glutting and Yousef, 2007). Similarly, the association between a family history of atopy and asthma and developing asthma, with the association higher for asthma than for atopy was consistent with findings in other geographical areas (Bjerg et al., 2007; Palvo et al., 2008). These study findings strengthen earlier reports suggesting that genetics might play an important role in the development of asthma in childhood (Jaakola, Nfstad and Magnus, 2001), with parental asthma being the strongest determinant of asthma. The current study also adds to the literature suggesting that exposure to environmental tobacco smoke increases the risk of childhood asthma (Jaakola, Nfstad and Magnus, 2001).

To our knowledge, this is the first large population based study to examine associations among environmental exposures and risk factors for asthma in 11 to 14 year old Iraqi children. The study has several strengths as well as some limitations. The study was nested in a large population based, well characterized cross-section of children from 25 different schools with a wide range of environmental exposures. Asthma status was defined using physical examination, PEFR and an exercise

challenge test to avoid inaccurate recall. The environmental exposure assessment was broad and based on questionnaire data. However, it is possible that mothers of children with and without asthma may recall their child's exposures differently. In addition, the study was cross-sectional in design with the associated limitations. Furthermore, the study design included only dichotomous variables: whether the child was ever exposed or never exposed. An additional limitation of the study was that only bivariate statistical analyses were conducted; hence adjustment for confounding was not performed.

Table 4: Association between prevalence of asthma and demographic characteristics and breastfeeding. Results were based on the analysis of 2875 Iraqi school children.

Variable	Number of participants with asthma [%]	Number of participants without asthma [%]	Unadjusted Odds-ratio [95% CI]*	p-value
Crowding index				
1 child	40 [15.6]	367 [14]	1	
2-3 children	151 [59]	1645 [62.8]	1.73 [1.33 – 2.23]	<0.001
>3 children	65 [25.4]	607 [23.3]	1.13 [0.84 – 1.52]	=0.010
Breast feeding				
Yes	197 [81.1]	851 [33.5]	8.50 [6.1 - 11.84]	<0.001
No	46[18.9]	1689 [66.5]	1	
Economic status				
High	111 [43.4]	1027 [39.2]	1.13 [0.87 - 1.47]	=0.876
Low	145 [56.6]	1592 [60.8]	1	
Social status				
High	53 [20.7]	841 [32.1]	1.81 [1.32 – 2.48]	<0.001
Low	203 [79.3]	1778 [67.9]	1	
Cooling type				
Air cooler	203 [79.3]	2179 [83.1]	0.77 [0.56 - 1.06]	=0.140
None	53 [20.7]	440 [16.9]	1	
Maternal education				
Illiterate	51 [19.9]	563 [21.5]	1	
Primary	128 [50.0]	799 [30.5]	2.28 [1.76 - 2.95]	<0.001
Secondary	73 [28.5]	1189 [45.4]	2.10 [1.58 - 2.78]	<0.001
College or higher	4 [1.6]	68 [2.6]	1.68 [0.61 - 4.64]	0.01

* 95 CI = 95%-confidence interval

CONCLUSION

The results of this study suggest that environmental exposure and lifestyle factors are important in the development of asthma in Iraqi children aged 11 to 14 years. Both indoor and outdoor environmental exposures may play a role in the aetiology of childhood asthma, including exposure to herbicides, pesticides, wood/oil smoke, animals and the farm environment. The combined effect of atopy, tobacco smoke and breast-feeding may modify the relationship between various risk factors and asthma. Early life may provide a critical window for interventions, such as family health education, to reduce the burden of childhood asthma.

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