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ORIGINAL RESEARCH

Environmental Air Pollutants as Risk Factors for Asthma Among Children Seen in Pediatric Clinics in UKMMC, Kuala Lumpur

Idayu Badilla Idris, MBBS, MPH, PhD, Hasanain Faisal Ghazi, MBChB, MCommHlth, PhD, Khor Hui Zhie, Khairul Aliff Khairuman, Siti Kasuma Yahya, Farah Azureen Abd Zaim, Chok Wai Nam, Hazwan Zuhairi Abdul Rasid, Zaleha Md Isa, BSc, PhD

Kuala Lumpur and Selangor, Malaysia

Abstract

The prevalence of asthma is increasing, especially among children in Malaysia, with environmental factors as one of the main preventable contributors. The aim of this study was to determine the association between environmental air pollutants and the occurrence of asthma among children seen in pediatric clinics in Universiti Kebangsaan Malaysia Medical Center (UKMMC), Kuala Lumpur. An unmatched case control study among children who attended the pediatric clinic was carried out from May to August 2015. A total of 223 children who were diagnosed with asthma (105 cases) and who did not have asthma (118 controls) were included in this study. Their parents or caregivers were interviewed using questionnaires modified from the International Study of Asthma and Allergies in Childhood. Data obtained were analyzed using SPSS software version 20. There was a higher risk of asthma in those who had carpet at home (OR = 2.15 CI [1.25-3.68]), those who lived within 200 m of heavy traffic (OR = 1.72 CI [1.01-2.93]), and those who were exposed to lorry fumes (OR = 2.61. CI [1.38-4.93]). Environmental air pollutants increased the risk of asthma among children in Malaysia. Exposure to congested roads, lorry fumes, and indoor carpet were associated with asthma among children in this study. Parents or caretakers of children with asthma should be given adequate education on the prevention of asthmatic attack among these children.

KEY WORDS asthma, children, environmental air pollutants, Malaysia, risk factors

INTRODUCTION

As the world progresses, air pollution has become a major problem that has to be faced, especially in developing countries. The immaturity of the respiratory system in children results in them being at high risk of developing respiratory problems as a result of exposure to air pollution.[1] One of the most common chronic diseases in the world is asthma, and it is now becoming more common in children.[2] Asthma is defined as inflammation of airway that leads to airway hyper-responsiveness and presence of episodic or chronic wheeze or cough. According to previous research in Malaysia, the prevalence of asthma has increased especially in children, from 5.8% among 6- to 7-year-old children to 8.9% among 13- to 14-year-old children.[3] A local study among primary school children in

The authors have no conflicts of interest to declare.
From the Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia Medical Centre, Jalan Yaacob Latiff, Bandar Tun Razak, Kuala Lumpur, Malaysia (IBI, KHZ, KAK, SKY, FAAZ, CWN, HZAR, ZMI); and the Community Medicine Unit, International Medical School, Management and Science University, Shah Alam, Selangor, Malaysia (HFG). Address correspondence to Z.M.I. (zms@ppukm.ukm.edu.my).

Kuala Lumpur discovered 13.8% of children were asthmatic.[4]

In some studies, the socioeconomic status of the child's family was associated with asthmatic symptoms. This includes parental education and income. Evidence indicated that poor children and children from lower income families were more likely to be hospitalized for asthma, to have greater asthmatic symptoms, and to have more severe asthma episodes compared with children with asthma from higher income families.[5] Low income can result in large families living in small and uncomfortable housing. A crowded house is a significant risk to health. Children living in crowded households can consequently experience worse health outcomes. Crowding is associated with several infectious diseases including lung and skin infections, meningococcal disease, and rheumatic fever.[6]

Indoor air pollution can contribute to asthmatic symptoms in children. Respiratory irritants such as pesticides can cause damage to bronchial mucosa and increase airway sensitivity to allergens or other stimuli, thus increasing the risk of developing asthma or of exacerbating existing asthma.[7] Young children may highly be exposed to pesticides because of their greater skin surface area—to—body mass ratio and can have increased sensitivity to some pesticides.[8] Previous studies in Lebanon found that chronic respiratory disease was reported in 407 (12.4%) of 3291 children who were exposed to pesticides.[9]

Among patients with asthma, sensitivity to indoor allergens is more prevalent than sensitivity to outdoor allergens. Exposure to indoor environmental agents, including allergens and pollutants, can cause asthma or exacerbate asthmatic symptoms.[10] Besides, exposure to common indoor allergens, such as dust mites, cockroaches, and cat dander, has been found to increase the risk of asthma in susceptible individuals.[11] Previous studies found that the development of sensitization to animal allergens and allergic diseases in the general population can be caused by indirect exposure, not direct exposure such as pet ownership.[12] In 2004, a survey done by the Seoul Development Institute found that 17.2% of households in Seoul had pets, 16.6% had dogs, and 0.8% had cats.[13] However, the sensitization rate for dogs was 8.6% and for cats it was 9.1%,[14] suggesting that low-dose exposure through indirect contact with cat allergen increases the risk of sensitization.

Mosquito-borne disease is common in tropical and subtropical countries, including Malaysia. Thus, many families use mosquito coils to repel and kill mosquitoes. Studies have found that the fumes generated by coils containing allethrin can act as an asthma trigger.[15] However, a local study found that the prevalence of asthma among children in families using mosquito coils was 6.5% and that this was not statistically significant.[16]

Another risk factor that triggers asthma is household members who smoke. Exposure to cigarette smoke increases incident asthma among children. Because children have smaller airways, faster rates of breathing, and immature immune systems, they are more prone to any adverse health effects compared with adults.[17]

Because Malaysia is rapidly urbanizing, many people living in urban areas are now faced with traffic or road congestion, surrounded by factories and reduced recreational park and greeneries, and thus have higher chances of exposure to indoor and outdoor air pollution. Children are at increased risk because they often play outside with friends. Recent studies have found that there was a significantly higher indoor exposure to PM 2.5 for children living near busy roads than near less busy roads, with a subsequently higher risk of respiratory illnesses.[18]

After many previous studies associating environmental air pollutants with asthma in children, the aim of this study was to investigate symptoms of asthma among children seen at the Universiti Kebangsaan Malaysia Medical Centre (UKMMC) in relation to environmental air pollutants.

METHODS

This nonmatched case control study was conducted in the pediatric clinic at UKMMC, which is situated at Bandar Tun Razak, Cheras and is governed by Universiti Kebangsaan Malaysia. UKMMC, 1 of 4 university hospitals in Malaysia, is a teaching hospital and provides tertiary health care services in Kuala Lumpur province. The pediatric clinic provides mostly tertiary care to referral cases from other primary health care centers.

The study population for the case group included children 3-13 years old who were diagnosed with asthma, whereas the control group consisted of children 3-13 years old who did not have asthma. Patients who were having severe asthmatic attack and parents who did not understand Bahasa Melayu or English were excluded from this study. This study was conducted on patients in the pediatric clinic of UKMMC from June to August 2015.

The sample size was calculated using Kish formula,[19] $n = \frac{Z^2(p)(1-p)}{D^2}$. The prevalence of asthma among primary school children in Kuala Lumpur was taken as 13.8%.[20] By taking $P = 0.138$,

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confidence level of 95% (Z = 1.96) and absolute precision of 8% (D = 0.05), the sample size was calculated by using Kish formula[19]: $n = \frac{Z^2(p)(1-p)}{D^2}$, in which 183 respondents were needed. It can also be determined by referring to the table in Lwanga and Lemeshow.[21] Because this is an unmatched case control study, we collected the data during the time designated without fixing any number of cases and controls. However, because of the limited number of asthmatic patients in the pediatric clinic at Hospital Canselor Tuanku Muhriz in UKMMC, we had only 105 children for cases and 118 children for controls.

The data were collected from June to August 2015. The sampling method used for this study was stratified sampling. The patients seen in the pediatric clinic within the age range of 3-13 years old were divided into asthmatic and nonasthmatic groups or strata. Within each group, a probability sampling then was used. Our samples consisted of 60 boys and 45 girls from the asthmatic group and 68 boys and 50 girls from the nonasthmatic group.

The questionnaire we used was modified from the International Study of Asthma and Allergies in Childhood and was distributed to the mother, father, or other caregiver of the selected patient. Information about this study was explained to them, and they were given the freedom of choice to either participate in the study or refuse with or without reason. They were also informed about the confidentiality of their personal details in this research. Those who agreed to participate in the study were given informed consent forms before filling the questionnaire.

They were allowed to ask questions if they did not understand the questions asked. The given questionnaire was collected on the same day it was distributed. Enough time was allocated to the respondents to complete their questionnaire. The questionnaire comprised section A, which include demographic characteristic data; section B, which include child health; and section C, which include environmental factors.

The data collected were analyzed using IBM SPSS Statistics version 20 (IBM Corp., Armonk, NY). The data were presented using descriptive statistics and bivariable and multivariable analysis. Odds ratio for each risk factor was calculated. χ^2 test was used to determine the relationship between environmental risk factors and asthma among children. A confidence interval of 95% and *P* value $< .05$ were taken as significant values.

Ethical approval was obtained from the Research and Ethics Committee, Faculty of Medicine, UKMMC. Furthermore, approval from the pediatric clinic at UKMMC was also obtained. All respondents signed a consent form as a proof that they agreed to participate in the study.

RESULTS

We recruited a total of 103 cases (57.1% boys and 42.9% girls) and 118 controls (57.6% boys and 42.4% girls), with median age of 6 years old.

Outdoor Air Pollutants. Among cases, 33.3% had frequent exposure to lorry fumes, whereas 16.1% of controls reported such a history (Table 1). The exposure to lorry fumes doubled the prevalence of asthma (OR = 2.5, 95% CI = 1.31-4.77) (Table 2). The prevalence of asthma was significantly associated with the distance of the house to the congested road; 51.4% of respondents with asthma lived near congested roads compared with 38.1% of controls (Table 1). The risk was higher in those living near congested roads (OR = 1.72, 95% CI 1.01-2.93) (Table 2).

Indoor Air Pollutants. In this study, 52.4% of asthmatic cases and 33.9% of controls had carpet at home (Table 1). The presence of carpet at home doubled the risk of asthma in children (OR = 2.06, 95% CI = 1.19-3.58) (Table 2). For the presence of a pet at home, 30.5% of asthmatic cases and 26.3% of controls had pets at home, but the difference was not significant ($\chi^2 = 0.484$, 95% CI = 0.69-2.21) (Table 2).

A total of 32.4% of cases and 41.5% of controls had more than 2 family members sleeping in their bedroom; however, the difference was not significant ($\chi^2 = 1.980$, 95% CI = 0.39-1.17) (Table 2).

Meanwhile, 26.7% of cases and 25.4% of controls were exposed to household aerosols (such as perfume) and pesticides usage (Table 1). The difference was not significant ($\chi^2 = 0.045$, 95% CI = 0.59-1.94) (Table 2). For exposure to smoking household members, a total of 45.7% cases and 33.1% controls were exposed to it; however, the difference was not significant ($\chi^2 = 3.719$, 95% CI of 0.99-2.94) (Table 2). A total of 17.1% cases and 13.6% controls were exposed to household usage of mosquito coil burning, but the difference was not significant ($\chi^2 = 0.550$, 95% CI = 0.64-2.74) (Table 2).

Socioeconomic Factors (Parents' Educational Level and Family Income). A total of 31.4% of children who had asthma had a father with lower educational level compared with 44.9% among children without asthma

Table 1. Distribution of Cases and Controls

Risk Factors	Cases n (%)	Controls n (%)	Total n (%)
Gender			
Male	60 (57.1)	68 (57.6)	128 (57.4)
Female	45 (42.9)	50 (42.4)	95 (42.6)
Age			
3-6 years old	52 (49.5)	65 (55.1)	117 (52.5)
7-13 years old	53 (50.5)	53 (44.9)	106 (47.5)
Smoking Household Member			
Present	48 (45.7)	39 (33.1)	87 (39.0)
Absent	57 (54.3)	79 (66.9)	136 (61.0)
Exposure to Aerosols			
Yes	28 (26.7)	30 (25.4)	58 (26.0)
No	77 (73.3)	88 (74.6)	165 (74.0)
Mosquito Coil Burning			
Yes	18 (17.1)	16 (13.6)	34 (15.3)
No	87 (82.9)	102 (86.4)	189 (84.7)
Presence of Pets			
Present	32 (30.5)	31 (26.3)	63 (28.3)
Absent	73 (69.5)	87 (73.7)	160 (71.7)
Presence of Carpet at Home*			
Present	55 (52.4)	40 (33.9)	95 (42.6)
Absent	50 (47.6)	78 (66.1)	128 (57.4)
Fathers' Educational Level			
Higher	72 (68.6)	65 (55.1)	137 (61.4)
Lower	33 (31.4)	53 (44.9)	86 (38.6)
Mothers' Educational Level			
Higher	66 (62.9)	64 (54.2)	130 (58.3)
Lower	39 (37.1)	54 (45.8)	93 (41.7)
Family Income			
Higher	25 (23.8)	18 (15.3)	43 (19.3)
Lower	80 (76.2)	100 (84.7)	180 (80.7)
Congested Household			
Yes	34 (32.4)	49 (41.5)	83 (37.2)
No	71 (67.6)	69 (58.5)	140 (62.8)
Exposure to Lorry Fumes*			
Frequent	35 (33.3)	19 (16.1)	54 (24.2)
Seldom	70 (66.7)	99 (83.9)	169 (75.8)
Living Near Congested Roads*			
Yes	54 (51.4)	45 (38.1)	99 (44.4)
No	51 (48.6)	73 (61.9)	124 (55.6)

* significant association

Table 2. Factors Associated with Asthma in Children

Risk Factors	Wald	SLR Crude OR	95% CI
Smoking Household Member			
Present	3.719	1.71	0.99-2.94
Absent		1.00	
Exposure to Aerosols			
Yes	0.045	1.07	0.59-1.94
No		1.00	
Mosquito Coil Burning			
Yes	0.550	1.32	0.64-2.74
No		1.00	
Presence of Pets			
Present	0.484	1.23	0.69-2.21
Absent		1.00	
Presence of Carpet at Home*			
Present	7.663	2.15	1.25-3.68
Absent		1.00	
Fathers' Educational Level			
Higher	4.230	0.56	0.33-0.97
Lower		1.00	
Mothers' Educational Level			
Higher	1.693	0.70	0.41-1.20
Lower		1.00	
Family Income			
Higher	2.578	0.58	0.29-1.13
Lower		1.00	
Congested Household			
Yes	1.980	0.67	0.39-1.17
No		1.00	
Exposure to Lorry Fumes*			
Frequent	8.683	2.50	1.31-4.77
Seldom		1.00	
Living Near Congested Roads*			
Yes	3.952	1.72	1.01-2.93
No		1.00	

OR, odds ratio; SLR, simple logistic regression
* significant association

(Table 1) ($\chi^2 = 4.230$, 95% CI = 0.33-0.97). This result contradicts with previous researches. There is no significant association found between mothers' educational level and the prevalence of asthma in children ($\chi^2 = 1.693$, 95% CI = 0.41-1.12). There is also no significant association between family income and the prevalence of asthma ($\chi^2 = 2.578$, 95% CI = 0.29-1.13) (Table 2).

The results of multiple logistic regression indicate that only 2 factors were significantly associated with asthma occurrence in children; they were the presence of carpet at home and exposure to lorry fumes (Table 3). The presence of carpet at home presents approximately 2 times higher risk of asthma in children, whereas exposure to lorry fumes presents about 3 times higher risk.

DISCUSSION

Based on our results, there was a significant association between the presence of carpet at home and the prevalence of asthma in children. This is consistent with our hypothesis, as well as supporting the results of previous research. As reported in previous study, sensitization to house dust mites,

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Table 3. Risk Factors for Asthma in Children (Multiple Logistic Regression)

Risk Factors	Wald	MLR Adj OR	95% CI
Presence of Carpet at Home			
Yes	6.648	2.06	1.19-3.58
No		1.00	
Exposure to Lorry Fumes			
Frequent	7.710	2.50	1.31-4.77
Seldom		1.00	

Adj, adjusted; OR, odds ratio; MLR, multiple logistic regression.

which are found in carpets, is significantly more prevalent in children with asthma in Malaysia.[22]

Similar to our hypothesis, children who lived near congested traffic have higher prevalence of asthma. Children who are frequently exposed to lorry fumes are at risk for asthma. We believed that in Malaysia, urban citizens tend to be more affected by asthma than those living in rural areas because of environmental air pollution. One of the common reasons was waste and fumes from vehicles. Road traffic, especially congested roads, contributes the most to air pollution in urban areas, which supports the statement that living near roads with congested traffic significantly impaired respiratory health.[23]

According to our study, the percentage of children who had asthma was higher in higher family income group than those with lower family income group, but the finding was not statistically significant. Thus, this study found that there is no association between parents' income and prevalence of asthma in children. Other studies have also found no significant association between these 2 variables; rather, they found that the prevalence of asthma is more affected by other factors such as genetic and environmental effects.[24] However, a different study reported that having parents with lower income exposed the children to lower socioeconomic communities and increased the children's risk for asthma.[25]

Our data indicated that there was a significant association between prevalence of asthma in children and their father's educational level but not their mother's educational level. We classified parents' educational level into 2 categories: lower educational level and higher educational level. Our finding somehow contradicts other research, as according to Augusto et al,[26] parents' educational level plays an important role in the prevalence of asthma. Statistically, parents with higher educational level have a better job and a better house environment, thus lowering the risk for their children to get asthma.

Southeast Asian homes tend to be crowded.[27] A crowded home environment exposes susceptible persons to other environmental factors, including air pollutants, tobacco smoke, and enhanced allergic sensitization.[28] However, our results indicate a trend that asthma was less common in those who share a bedroom with >2 persons than those who shared their bedroom with ≤2 persons; however, the difference was not statistically significant. According to Ones et al,[29] household size and sharing a bedroom were not significant risk factors for asthma in their survey, which supports our result.

Surprisingly, there was no significant association between smoking household members and the prevalence of asthma among children. Previous literature reported that children and young adults who were exposed to passive smoking will have 20% higher risk for wheezing or asthma. However, the same study also stated that a few studies found that household passive smoking exposure may not be significantly associated with increasing asthma prevalence.[30]

Studies by Salome et al[31] and Hernandez et al[7] found that the standard insecticides formulation had significant effects on asthma patients. This is contradicted by our study, in which there was no significant association between aerosol insecticides and the prevalence of asthma. It remains uncertain whether pesticide exposure increases the risk of asthma or not.

In our study, a higher percentage of children with asthma had pets compared with children without asthma, although this was not statistically significant. There is a trend that the presence of pet does have some risks. According to Benjamin et al,[32] exposure to pets appears to increase the risk of asthma and wheezing in children. They also stated in their research that parents of asthmatic children are more likely to remove pets from the home, biasing the results of their study.

Mosquito coils are efficient as a mosquito repellent and contain pyrethrins, formaldehyde, and various fine particles.[33] Prolonged exposure to mosquito coils has been found to induce asthma and persistent wheezing in children.[34] However, our study found an independent association of mosquito coil smoke exposure with asthma and persistent wheezing.

STUDY LIMITATIONS

Our study focused on patients seen in UKMMC, which may not represent the country's population because the hospital is located in Cheras area and thus it is possible that only local area patients were recruited as samples.

CONCLUSIONS

This study found that environmental air pollutants increased the risk of asthma among children in Malaysia. The independent risk factors associated with asthma were exposure to lorry fumes and indoor carpet.

RECOMMENDATIONS

Environmental air pollution is undeniably an important threat and also a major factor that contributes to childhood asthma. Hence, intervention is required in terms of health education for parents or caretakers to prevent asthmatic attack among children in Malaysia. Future studies should be carried out to find other environmental air pollutants that may contribute to asthma in children.

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