Original Research Article

Environmental risk factors for childhood asthma in a Semi-urban area of Western Tamilnadu

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Abstract

Introduction: Environmental determinants are integral part of etiology, severity and management of asthma. But the association between various indoor and outdoor triggers with pediatric asthma has been inconsistent, complex and variable across the globe. This study was aimed at identifying the environmental risk factors associated with childhood asthma in our region. **Methods:** This was a hospital-based cross-sectional study done at Perundurai Medical college hospital, Tamilnadu. After getting Institutional Ethical Committee approval, children in the age group of 2 to 15 years attending the pediatric outpatient department were enrolled in the study. Parents were interviewed with ISAAC questionnaire and history of exposure to various indoor and outdoor triggers was recorded in addition to the basic demographic details and anthropometric indices. Data was analyzed using Chi-square tests and logistic regression analysis. **Results:** Among 500 subjects, 298 (59.6%) were asthmatics and 202 (40.4%) were non-asthmatics. Age group of 6-10 years (OR 1.94, 95% CI 1.20- 3.13), male gender (OR 2.26, 95% CI 1.47-3.48), overweight/obesity (OR 3.70, 95% CI 1.17-11.66), mould (OR 2.43, 95% CI 1.37- 4.32), seasonal variation (OR 2.39, 95% CI 1.51-3.79) and outdoor air pollution (OR 6.17, 95% CI 4.00- 9.53) were independently associated with childhood asthma. Passive smoking, type of cooking fuel, absence of smoke outlet, exposure to animals and proximity of house to arterial road were not significantly associated with asthma. **Conclusion:** Environmental triggers play a significant role in pediatric asthma. Appropriate interventions to mitigate these modifiable risk factors would decrease the burden of the disease substantially.

Keywords: Asthma, Children, Risk factors, Environment, Air pollution, Indoor

Introduction

Asthma is the chronic inflammatory disease of the airways, which demonstrates significant heterogeneity in etiology, clinical manifestations and natural history [1,2]. Globally, 334 million people suffer from asthma and the burden of asthma is greatest for children aged 10-14 and the elderly aged 75-79 [3]. The prevalence of asthma and allergies in general has substantially increased over the last two decades, particularly among children [4] and there is considerable variability in prevalence across countries [5-7]. Studies of migrant populations have demonstrated the influence of the duration of stay in the new living environment and significant changes in the risk of asthma after migration [8]. These observations suggest that environmental factors may be largely responsible for childhood asthma in combination with the genetic and atopic propensity of the child. The indoor triggers include aeroallergens associated with cats, dogs, birds, dust mites, rodents, cockroaches and moulds, environmental tobacco smoke (ETS) and use of biomass fuel (BMF) for cooking and heating [9]. Air pollutants comprising particulate matter (PM), toxic gases, traffic-related air pollution (TRAP) and pollens constitute the predominant outdoor triggers.

Except for moulds, researches on the role of other environmental triggers in inducing new onset pediatric asthma have yielded inconsistent results [10,11]. Only few studies have investigated environmental exposures as risk factors for childhood asthma in south India [12-14]. The identification of modifiable risk factors is essential for devising appropriate preventive strategies

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and parental education and hence this study was planned.

Aim

To study the association between environmental triggers and asthma in children aged 2-15 years attending the pediatric outpatient department of a tertiary care hospital in Erode district, Tamilnadu.

Methodology

This was a hospital-based Cross-sectional study done at Perundurai Medical college hospital, Erode district, Tamilnadu. The Pediatric department runs a chest clinic and functions as a Referral Centre for asthma. Children from farm-based villages, semi-urban townships and industrial zones with different indoor and outdoor environmental settings attend our paediatric outpatient department and this study was done to gain insights regarding the association of various environmental triggers with childhood asthma. After getting Institutional Ethical Committee approval, the study was done over a period of 4 months from June 2016 to September 2016. Children in the age group of 2 to 15 years attending pediatric OPD were enrolled in the study. Children with systemic illnesses like congestive cardiac failure, chronic renal failure, chronic lung diseases like bronchiectasis, severe anemia, children with severe neurological impairment such as spastic quadriplegic cerebral palsy and immuno-compromised children were excluded. A questionnaire was prepared with excerpts from ISAAC questionnaire for identifying children with asthma [15]. Written consent was obtained from the parents and assent taken from children more than 7 years of age. Students trained in local dialect collected data on basic demographic details, anthropometry, family history, socioeconomic status, exposure to various indoor and outdoor triggers, symptoms related to asthma and treatment details by interviewing the parents.

Medical records were verified to ascertain the diagnosis of asthma. Categorization on nutritional status was done using WHO 2006 MGRS charts for children less than 5 years [16] and revised IAP growth charts for children more than 5 years [17]. Socioeconomic status was classified according to modified Kuppusamy scale [18].

Statistical analysis- Prevalence of demographic characteristics and environmental risk factors among asthmatics and non-asthmatics were calculated using proportions. To test the differences between proportions, Chi- square tests of significance were carried out. Logistic regression analysis (Uni-variate and multi-variate) was applied for identifying the independent risk factors. Statistical analysis was done using SPSS version 16.0 and p-value < 0.05 was considered statistically significant.

Results

Out of 510 children enrolled in the study, 8 subjects were excluded based on diagnosis of congestive cardiac failure

Table No.1: Background Characteristics of study participants.

Background Characteristics	No. (%)
Age in years	
2-5	217 (43.4)
6-10	171 (34.2)
11-15	112 (22.4)
Sex	
Male	299 (59.8)
Female	201 (40.2)
Socio economic status	
Upper class	35 (7.0)
Middle class	107 (21.4)
Lower class	358 (71.6)
Nutritional status	
Normal	276 (55.2)
Under nutrition	199 (39.8)
Overweight/obese	25 (5%)

(n=2), thalassemia (n=2), spastic CP (n=1), acquired immunodeficiency (n=2) and bronchiectasis (n=1). Parents did not give consent for two children (n=2) and thus 500 participants (40.2% girls) were included in the study. Among the study population, 298 children (59.6%) were asthmatics and 202 children (40.4%) were non-asthmatics. The majority (43.4%) of the children belonged to pre-school group 2-5 years and more than two-thirds (71.6%) of the children in the study group belonged to lower socioeconomic status. Table 1 shows the background characteristics of the study population.

Table 2 illustrates the association of background variables with asthma. Children aged 6-10 years (OR 1.69, 95% CI, 1.12-2.56) were at a significantly higher risk for asthma compared to 2-5 year olds, but similar association was not seen with 11-15 years age group. Male gender, history of asthma among first degree relatives, middle and lower socioeconomic status were also significantly associated with childhood asthma. The association of asthma with increased BMI (OR 2.94, 95% CI, 1.07- 8.07) was statistically significant in comparison with children with normal nutritional status.

Table-2: Association of Background factors with asthma.

Background Characteristics	Prevalence among asthmatics	Prevalence among non-asthmatics	Odds Ratio (95% CI)	p-value
	No.(%)	No. (%)		
Age in years				
2-5	116 (53.5)	101 (46.5)	1	
6-10	113 (66.1)	58 (33.9)	1.69 (1.12 - 2.56)	0.01*
11-15	69 (61.6)	43 (38.4)	1.39 (0.87 - 2.22)	0.16
Sex				
Female	104 (51.7)	97 (48.3)	1	
Male	194 (64.9)	105 (35.1)	1.72 (1.19-2.48)	0.003*
Socio economic status				
Upper class	14 (40.0)	21 (60.0)	1	
Middle class	69 (64.5)	38 (35.5)	2.72 (1.24 - 5.96)	0.01*
Lower class	215 (60.1)	143 (39.9)	2.25 (1.11 - 4.58)	0.02*
Nutritional status				
Normal	159 (57.6)	117 (42.4)	1	
Underweight	119 (59.8)	80 (40.2)	1.09 (0.75- 1.58)	0.22
Over weight/obese	20 (80.0)	5 (20.0)	2.94 (1.07- 8.07)	0.03*
Maternal Education				
Higher education	54 (57.4)	40 (42.6)	1	
Up to High school	204 (58.6)	144 (41.4)	1.04 (0.66 - 1.66)	0.83
Illiterate	40 (69.0)	18 (31.0)	1.64 (0.83 - 3.28)	0.15
Family h/o Asthma	81 (70.4)	34 (29.6)	1.84 (1.17-2.88)	0.007*

Among various indoor triggers, presence of wall dampness or mould (OR 2.07, 95% CI, 1.25-3.44) was significantly associated with childhood asthma (Table 3). Children exposed to cockroach and mice antigens, those living in houses with asbestos or thatched roof and usage of LPG as domestic fuel were at increased risk of developing asthma, but the association was not statistically significant. Passive smoking, absence of kitchen smoke outlet at home and stuffed toys were not associated with asthma in our study.

Table-3: Association of indoor triggers with paediatric asthma.

Environmental risk factors (Indoor triggers)	Prevalence among asthmatics No.(%)	Prevalence among non-asthmatics No. (%)	Odds Ratio (95% CI)	p-value
LPG as fuel for cooking	286 (60.5)	187 (39.5)	1.91 (0.87-4.17)	0.09
Absence of Kitchen chimney/exhaust fan	264 (59.7)	178 (40.3)	0.95 (0.54-1.66)	0.87
Rat or Mice infestation	132 (61.4)	83 (38.6)	1.14 (0.79-1.63)	0.48
Presence of cockroaches in houses	130 (62.8)	77 (37.2)	1.26 (0.87-1.80)	0.22
Passive smoking	81 (58.7)	57 (41.3)	0.95 (0.64-1.41)	0.79
Paint/floor refurnishing activities in home	68 (59.6)	46 (40.4)	1.00 (0.65-1.53)	0.99
Wall dampness or presence of mould in wall	65 (73.0)	25 (27)	2.07 (1.25-3.44)	0.004*
Stuffed or furry toys	51 (53.7)	44 (46.3)	0.74 (0.47-1.16)	0.19
Other irritants – room perfumes/Cleaning agents	41 (61.2)	26 (38.8)	1.08 (0.63-1.83)	0.77
Electronic appliances i.e. air conditioners	14 (53.8)	12 (46.2)	0.78 (0.35-1.72)	0.54
Roof of the House				
- Tiles/Concrete	218 (57.4)	162 (42.6)	1	
- Asbestos	28 (71.8)	11 (28.2)	1.89 (0.91-3.91)	0.08
- Thatched	52 (64.2)	29 (35.8)	1.33 (0.81-2.19)	0.25

Among outdoor triggers, seasonal variation (OR 2.99, 95% CI, 2.02-4.44) and outdoor air pollution (OR 5.41, 95% CI, 3.63-8.06) were significantly associated with increased risk of asthma (Table 4). Also, children living in houses in proximity to an arterial road with heavy vehicular traffic, houses surrounded by vegetation and flowering plants and children exposed to building construction dust showed marginally increased risk of asthma, but the association was not statistically significant. The presence of livestock and pet animals was not associated with childhood asthma in our study.

Table-4: Association of outdoor triggers with paediatric asthma.

Environmental risk factors (Outdoor triggers)	Prevalence among asthmatics No. (%)	Prevalence among non-asthmatics No. (%)	Odds Ratio (95% CI)	p-value
Seasonal variation	236 (67.6)	113 (32.4)	2.99 (2.02-4.44)	<0.001*
Outdoor air pollution	189 (79.4)	45 (19.1)	5.41 (3.63-8.06)	<0.001*
Proximity to heavy vehicular traffic	143 (61.4)	90 (38.6)	1.15 (0.80-1.64)	0.45
Vegetation/flowering plants around house	82 (64.1)	46 (35.9)	1.28 (0.85-1.95)	0.23
Livestock / pet animals	65 (58.6)	46 (41.4)	0.95 (0.61-1.45)	0.80
Construction activities near home/school	71 (65.7)	37 (34.3)	1.39 (0.89-2.17)	0.14

Multivariate logistic regression analysis revealed age group 6-10 years (as compared to 2-5 years), male gender, overweight/obesity, middle and lower socioeconomic status, presence of mould, seasonal variation and outdoor air pollution as independent risk factors for childhood asthma (Table 5).

Table No.-5: Association of various factors with childhood asthma– Logistic Regression.

Background characteristics	Unadjusted OR	Adjusted OR	95% CI for Adjusted OR	p-value
Age in years				
2-5	1	1		
6-10	1.69	1.94	1.20 - 3.13	0.006*
11-15	1.39	1.45	0.84 - 2.52	0.18
Sex				
Female	1	1		
Male	1.72	2.26	1.47 - 3.48	<0.001*
Socio economic status				
Upper class	1	1		
Middle class	2.72	2.85	1.25 - 6.48	0.01*
Lower class	2.25	3.82	1.55 - 9.36	0.003*
Nutritional status				
Normal weight	1	1		
Underweight	1.09	1.03	0.67 - 1.59	0.87
Over weight/obese	2.94	3.70	1.17 - 11.66	0.03*
Family H/o Asthma	1.84	1.55	0.93 - 2.59	0.09
INDOOR TRIGGERS				
Wall dampness/ mould	2.06	2.43	1.37- 4.32	0.002*
Roof of the House				
-Tiles/Concrete	1	1		
-asbestos	1.89	2.20	0.95 - 5.09	0.06
-thatched	1.33	1.54	0.87 - 2.73	0.13
OUTDOOR TRIGGERS				
Outdoor air pollution	5.41	6.17	4.00 - 9.53	< 0.001*
Seasonal variation	2.99	2.39	1.51 – 3.79	< 0.001*

Discussion

Among the etiological factors of asthma, the role of environmental determinants has been entangled between "hygiene hypothesis" and "immuno-tolerance hypothesis" [19]. Some triggers like pet danders exhibit a complex relationship, with early childhood exposure offering protective effect and late childhood exposure precipitating asthma [20].

In our study, age group of 6-10 years was found to be independently associated with asthma as compared to the preschool age group. Another South Indian study has reported such independent association of 6-9 years age group with bronchial asthma among school going children [21]. Male gender was also found to be an independent risk factor for childhood asthma, in similar with other studies [13,22]. This male predominance is due to the relatively narrow airways of boys which persist till adolescence. Children belonging to middle and lower socio-economic classes had significantly increased risk of asthma. This may be attributed to chronic stress, endotoxin exposure, inadequate ventilation of living places and poor compliance with preventive medications associated with low-income households. A longitudinal study in Australia has observed a protective effect against asthma among children whose families had moved out of poverty [23].

By acting as a mechanical inhibitor to the development of normal lung function and augmentation of inflammatory cytokines, obesity and overweight have been postulated as a contributor of observed worldwide asthma epidemic [19]. A meta-analysis of prospective studies has reported a 50% increase in incidence of asthma among overweight/obese adults [24]. In our

study, overweight and obese children were at 3.7 times higher risk of developing asthma and increased BMI was an independent predictor of childhood asthma. Family history of asthma was not an independent predictor of childhood asthma in our study which was in contrast to a recent Indian study [21]. Inclusion of pre-school age group in our study could have resulted in this difference.

Among the environmental risk factors, presence of wall dampness or mould was an independent risk factor for asthma. The association of moisture damage and mould growth in the main living quarters with the development of asthma in early childhood has been documented in a Finnish population-based case-control study [25]. In our study, seasonal variation was an independent risk factor for childhood asthma similar to a recent study from Korea [26]. Seasonal variation of symptoms in asthmatic children can be attributed to bronchospasm induced by respiratory viral epidemics, declining mean temperature, cold dry air, airborne allergens like pollens and smog acting as triggers.

Outdoor air pollution (exposure to high atmospheric particulate matter levels and toxic gases) was independently associated with increased risk of asthma in children. Guarnieri and Balmes [27], in their review series have elaborated the role of outdoor air pollutants in the exaggeration of pre-existing asthma and also in the induction of new onset asthma in children and adults. There was no significant risk of asthma in children whose houses were situated within 500 feet (150 m) of road with heavy vehicular traffic, which was in contrary to a south Californian cohort study [28]. This could be due to the reporting bias of the parents in our study regarding the exact distance of the house from the arterial road.

In our study, passive smoking was not associated with increased risk of asthma similar to a study from rural Puducherry [14]. This is in concurrence with a systematic review which postulated that environmental tobacco smoke (ETS) can be considered as a co-factor provoking wheezing attacks, rather than a cause of the underlying asthmatic tendency [29].

Type of fuel used for cooking and absence of kitchen chimneys were also not significantly associated with childhood asthma in our study. Kumar et al [30] have reported a lower prevalence of asthma in children with smoke outlets in their houses, though there was no association with the type of fuel used. We could not find any significant association regarding exposure to mice, cockroach, livestock and pet animals with risk of childhood asthma, which was similar to several studies [22,31]. In contrary, a study from Beijing have reported increased risk of asthma for those having both a dog and a cat as pets or for finding both cockroaches and rats inside their houses [32].

We acknowledge certain limitations of our study. Our study was based on history of exposure to indoor and outdoor triggers and not on allergen-specific serum IgE or skin prick tests. Biomarkers do not always correlate well with clinical disease [19] and are also expensive. Being a questionnaire based study, the results may be influenced by the memory bias or reporting bias of the parents regarding the presence or absence of environmental risk factors.

Conclusion

Environmental determinants play a significant role in inducing childhood asthma. In developing countries, identification of specific risk factors for the particular child is a challenging task for the treating physician. General non-pharmacological measures like reduction in exposure to outdoor air pollution, protective care during seasonal changes and creating child-friendly homes with prevention of mould formation may help in decreasing the asthma related morbidity. Efforts to check the rise in childhood overweight and obesity are necessary to prevent asthma and other associated complications.

Abbreviations

ISAAC- The International Study of Asthma and Allergies in Childhood
MGRS- Multicenter Growth Reference Study
BMI- Body Mass Index
LPG- Liquefied Petroleum Gas

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