

PEDIATRIC ASTHMA

Burden of asthma among children in a developing megacity: childhood asthma study, Pakistan

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Abstract

Objectives: Global burden of childhood asthma has increased in the past few decades, particularly in low-income countries. In Pakistan, there is a lack of community-based epidemiological studies estimating the burden of asthma among children. This study determined the prevalence and predictors of asthma among children 3–17 years of age in Karachi, Pakistan. **Methods:** A two-stage community-based representative cross-sectional survey was conducted in Karachi from March 2012 to April 2013 comprising 1046 children aged 3–17 years. Of 7500 clusters, 80 were randomly selected, and of these, 15 children per cluster were enrolled randomly. A translated and pre-tested version of International Study of Asthma and Allergies in Children questionnaire was administered. **Results:** The overall prevalence of asthma among study participants was 10.2% (95% CI: 8.4–12.0). Asthma was more likely to occur among boys (adj. OR: 2.5, 95% CI: 1.6–4.0), children in the younger age group (3–7 years) (adj. OR: 2.9, 95% CI: 1.7–4.8), those living in households with ill-ventilated kitchens (adj. OR: 1.8, 95% CI: 1.1–3.1), having family history of asthma (adj. OR: 2.3, 95% CI: 1.3–3.9) and those of the Sindhi ethnicity (adj. OR: 2.2, 95% CI: 1.1–4.4). **Conclusion:** This study is the first robust evidence regarding asthma among children in Pakistan, reporting a high burden in this group. Family history, male gender, Sindhi ethnicity and ill-ventilated kitchen were identified as important predictors of asthma. Targeted preventive measures and intervention studies are required to better understand and reduce the burden of asthma among children in Pakistan.

Keywords

Asthma, children, ISAAC (International Study of Asthma and Allergies in Children) questionnaire, Pakistan, prevalence and predictors,

History

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Introduction

Approximately 300 million people of all ages worldwide currently have asthma, with estimates suggesting that asthma prevalence increases globally by 50% every decade [1]. Asthma is estimated to be responsible for 1 of every 250 deaths worldwide, with 85% of these deaths occurring in low and middle-income countries [1]. The prevalence of asthma has increased in low and middle-income countries over the past few decades, being one of the most common chronic disorders in children [2]. International Study of Asthma and Allergies in Children (ISAAC) surveyed large number of children (around 1.2 million) at 233 centers from 98 countries across the globe, and their findings show that prevalence of asthma is 11.7% in 6–7 year old children and 14.1% in 13–14 year old children [3]. However, a study

from India reported lower prevalence of asthma symptoms for 6–7 and 13–14 year old children, i.e. 6% [4]. Recent studies report the prevalence of preschool (<5 years) children in low-income countries to be around 10–15% [5].

Asthma has a broad spectrum of potential determinants ranging from genetics to life style and environmental factors. Indoor environment is of particular interest because children spend more than 80% of their time indoors, globally [6]. Exposure to environmental tobacco smoke, gas cooking, dust mite allergen and insufficient ventilation are contributory factors for the onset of asthma [6]. Solid fuels such as wood, dung or charcoal are extensively used in low and middle-income countries for cooking and heating purposes. These lead to high levels of indoor air pollution and an increase in the incidence of respiratory infections, including pneumonia, tuberculosis, chronic obstructive pulmonary disease and bronchial asthma [7]. Family history of atopy and smoking, large family size, low socioeconomic status, decreased lung function in infancy, low birth weight, obesity and male gender have also been found to be associated with asthma [8–10]. A study conducted in China revealed that diet in addition to the environmental

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factors can also create a difference in the prevalence of asthma [11]. Furthermore, genetic susceptibility to allergic diseases is also linked with exposure to various environmental factors [12,13].

According to the ISAAC global study, prevalence of asthma among children who were 13–14 years in Pakistan was 8% in 1995 [14], which was based on a representative sample of school children in Karachi. However, there is paucity of literature on childhood asthma in Pakistan, and only few studies are available with limited generalizability. One such study conducted in 2007 estimated the prevalence of physician-diagnosed asthma to be 15% in school going children (3–16 years of age) in Karachi [15]. Another study from Hyderabad identified urban living, parental history of asthma or allergic rhinitis and history of early weaning as important risk factors for asthma [16]. Since the burden of asthma is increasing in low-income countries like Pakistan [2], and its prevalence in children and the associated risk factors are still unknown, there was a need for community-based studies assessing the recent magnitude of asthma in children. Therefore, this study was designed to determine the prevalence and predictors of asthma among children who were 3–17 years of age in urban areas of Karachi as well as to determine pattern of asthma prevalence among different age groups of children.

Materials and methods

This cross-sectional survey was conducted among children who were 3–17 years of age ($n = 1046$) living in Karachi, Pakistan. Karachi, the capital of the province of Sindh, a mega city and the largest urban center of Pakistan, is estimated to have a population of over 15 million [17]. The city comprises a mix of various ethno-linguistic groups found in the country, although Urdu is the most spoken and commonly understood language [18]. According to the type of residence, Karachi can be divided into planned or unplanned (slums or squatter settlements) areas (called katchi abadis). There are an estimated 702 squatter settlements, or ‘katchi abadis’, in the city harboring 40–61% of the population [18,19]. The city is divided into five districts namely, Karachi East, Karachi West, Karachi Central, Karachi South and District Malir and together these five districts form the Karachi Division. In addition, there are six military cantonments in the city, which are administered by the Pakistan Army [17].

Households were selected through multi-stage cluster sampling. Sampling frame of the Pakistan Bureau of Statistics was used [20], which divides the city into 7500 enumeration blocks or clusters and the lists of these enumeration blocks were updated during 2003 by the Population Census Organization [21]. In the first stage, 80 clusters of 7500 were randomly selected, and then within each cluster, line listing of 200–250 households was done. Of these lines listed households, 15 households per cluster were selected, and one child from each household was enrolled randomly in the study (Figure 1).

For households with more than two eligible children, the ‘Kish method’ [22] was applied to select the study participants. This is a random sampling method for selecting one individual from each household [22] where every eligible

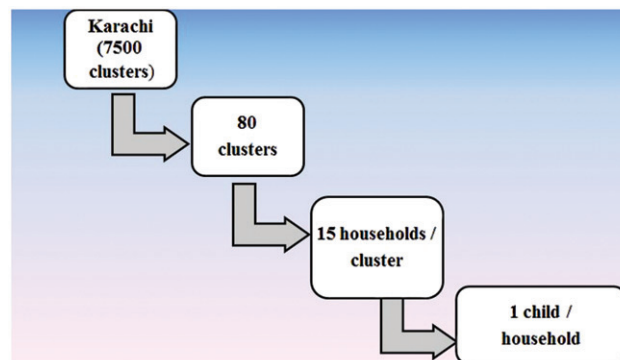


Figure 1. Flow diagram showing sampling strategy adopted to enroll 1046 children aged 3–17 years of age in urban areas of Karachi.

child is ranked on the basis of age, boys being ranked first, followed by girls. The Kish selection table is used to select one individual with the help of household identification number and total number of eligible members in the household.

In case of any refusal, the immediate next household was approached and included in the study. The study participants were recruited in three groups classified on the basis of age, i.e. 3–7 years, 8–14 years and 15–17 years. In order to have equal representation in the three groups, effort was made to enroll equal number of children from each group in the cluster. One child from any of the three age groups was considered for the study from the selected household. Those households where both of the parents, guardian or the child was not present at home at the time of the interview, were excluded.

Sample size was calculated using Open-Epi version 3.01 (Atlanta, GA) [23]. Using 95% confidence interval and absolute precision of 3%, the sample size for prevalence was calculated to be 568, based on estimated prevalence of 15.8% among children (3–16 years) [15]. For determining the predictors of asthma, the sample size was calculated by using odds ratio of 1.8 for presence of smoker in household [16], using 95% confidence interval and 80% power, the sample size was calculated to be 370. For determining pattern of asthma prevalence among different age groups, anticipated proportions of 12%, 22% and 14% were used for different age groups, [15] using 95% confidence interval and absolute precision of 5%, the sample size was calculated to be 163 for 3–7 years age group; 264 for 8–14 years; and 185 for 15–17 years age group. The aggregate for each age group came up to the total of 612, which was the maximum sample size. Design effect of 1.7 was applied to get the final sample size of 1040.

The ISAAC questionnaire was used for data collection after translating into Urdu language. Back translation of the questionnaire was done and it was pilot tested in 2% of the study population before use (other than the sampled population). The structured questionnaire also addressed questions on socio-demographic characteristics, family history of asthma, household smoking history, kitchen characteristics, allergies and symptoms of asthma. Aims and objectives of this study were explained to the parents and children before inclusion. The questionnaire was administered

by a team of trained data collectors. Each of the eight items of the ISAAC questionnaire assesses in detail the history of wheeze ever, number of attacks of wheeze in past 12 months, wheeze-related sleep or speech disturbances, wheezing after exercise, history of asthma and bronchitis at any time or history of dry cough [24]. Each of the eight items of the questionnaire is assigned the score from 0 to 2 with maximum score of 14 for all the eight items. The study coordinator supervised the field teams and filled questionnaires were re-checked and verified in the field, while office editing was also done to maintain data quality. Anthropometric measurements included standing height (in cm) measured without shoes using a height board, and weight (in kg) measured while dressed in light clothing and without shoes, using a bathroom scale.

Definitions

Asthma: a score of 5 or more for 5–6 years age group and score of 6 or more for those above six years was used as a cut-off for classifying asthma using ISAAC questionnaire [24].

Wheeze: defined as whistling sound arising from the chest and not from the nose or throat.

Type of kitchen: ill-ventilated kitchen was defined as having no ventilation in the kitchen except for the door, while ventilated kitchen was defined as having either window, an exhaust, having window and exhaust both or having kitchen in the open environment [25].

Type of residence: the city was divided into planned and slum areas according to the official categorization [19]. Planned areas included housing structure of a permanent nature, where sufficient living place, access to safe water and adequate sanitation system were present, while slum areas were defined as densely populated area of substandard housing, characterized by poverty, unsanitary and inferior living conditions and social disorganization.

Statistical analysis

Data were entered in Epi data software 3.1 (The EpiData Association, Odense M, Denmark). Quality of entered forms was randomly checked, error rates were calculated and forms were re-entered where required. Data were analyzed on IBM SPSS, version 19 (SPSS, Inc., Chicago, IL). Multi-co linearity was assessed between independent variables using Eta, Phi and Cramer tests as applicable. To enhance interpretability, we recoded the household income variable into binary category, i.e. less than or equal to 10000 Pakistani Rupees (PKR) and greater than 10000 PKR. Frequencies and percentages were reported for categorical variables and mean and standard deviation for continuous variables were calculated.

The outcome variables included asthma, wheeze and any type of allergy, while the covariates were sex, age groups, birth weight, type of residence, ethnicity, birth order, duration of living at current residence, monthly household income, number of household members, mother's and father's educational status, parental smoking status, family history of asthma, type of kitchen, allergy with dust mite and time spent indoors. The variables that came out significant in the

univariate model (p value < 0.25) and those which had biological plausibility were entered in the final model. Multiple logistic regression analysis was done to generate adjusted odds ratios in two age groups: 3–7 years and 8–14 years, third age group of 15–17 years was not included due to smaller sample. P value of < 0.05 was considered significant. Chi square test was applied to see the difference in prevalence of asthma with respect to age.

Ethical consideration

Informed consent was taken from parents and an assent form was signed by child if older than seven years. Approval was taken from the Ethical Review Committee of the Aga Khan University (application reference: 2199-CHS-ERC-12). Confidentiality of data was strictly maintained. Those households where children were found to have symptoms of asthma were counseled about the possible treatment and preventive methods. Those who needed referral were referred to a public sector tertiary care hospital near their house.

Results

A total 1046 children were recruited in the study, with the response rate of 95%. The median age of the study participants was eight years (IQR: 5–12 years). The study participants had almost equal representation of boys and girls among the three age groups. Urdu speaking ethnicity was the most common one in all age groups: 3–7 years (42.5%), 8–14 years (45.0%) and 15–17 years (48.4%). In terms of the type of residence, most of the children were living in planned areas (around 66.8% of 3–7 years of age, 68.6% of 8–14 years of age and 65.8% of 15–17 years of age). About equal proportion of the study participants' parents smoked cigarettes (34.4% of 3–7 years of age, 34.6% of 8–14 years of age and 31.7% of 15–17 years of age). Up to 16% of the houses had ill-ventilated kitchen in the age groups of 3–7 and 15–17 years, while the proportion was less in the age group of 8–14 years of age (12.3%). Around 13% of all the children had a positive family history of asthma (Table 1).

The overall prevalence of asthma among study participants was 10.2% (95% CI: 8.4–12.0), while among 3–7 year old children, it was 14.7%, followed by 6.8% in 15–17 and 5.8% in 8–14 year old children ($p < 0.05$). Our study identified 13.5% (95% CI: 7.9–19.1) and 4.6% (95% CI: 0.2–9.0) asthmatic children in 6–7 and 13–14 year age groups, respectively. The overall prevalence of ever wheeze was 23%, while among all three age groups, the highest proportion of ever wheeze was reported as 27.6% among 15–17 year old children. The prevalence of allergy was 20.2% (Table 2).

The prevalence of asthma decreases with the increasing age. Amongst asthmatic children aged 3–7 years, the highest proportion was found among those aged three years, i.e. 17.1%, and it decreases as the age increases up till eight years of age. In the age group between 8–14 years, there was a steady decline observed, where the proportion decreases and then a rising trend was observed after 10 years of age. In the age group of 15–17 years, as the age increases, a trend of increase asthma was observed from 3.2% to 11.4% (Figure 2).

Table 1. Characteristics of children 3–17 years of age in Karachi, Pakistan, 2013 ($n = 1046$).

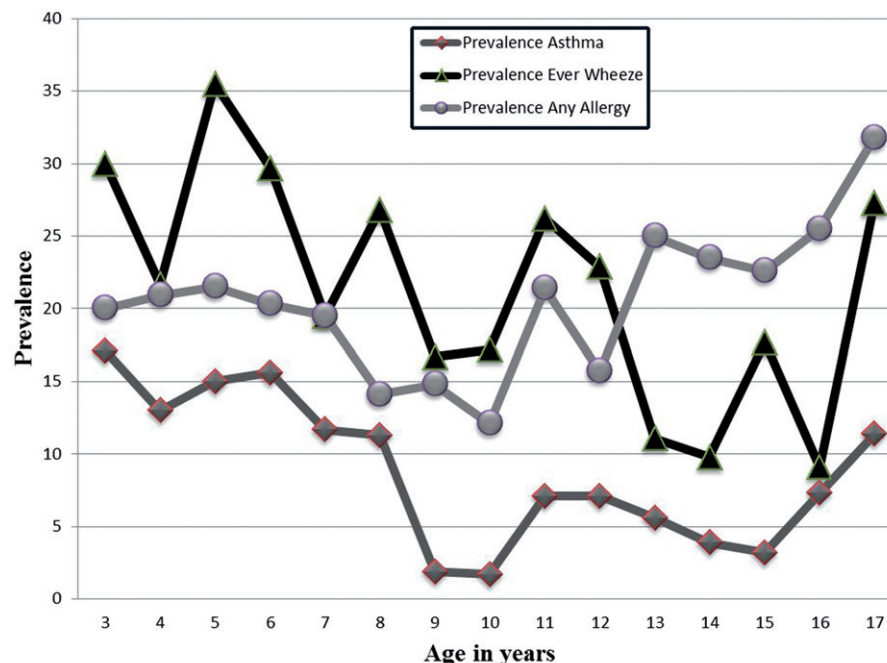
Characteristics	Age group 3–7 years ($n = 503$) (48.1%) ^a n (%)	Age group 8–14 years ($n = 382$) (36.5%) n (%)	Age group 15–17 years ($n = 161$) (15.4%) n (%)
Sex			
Boys	254 (50.5)	204 (53.4)	74 (46.0)
Girls	249 (49.5)	178 (46.6)	87 (54.0)
Ethnicity			
Urdu	214 (42.5)	172 (45.0)	78 (48.4)
Punjabi	138 (27.4)	94 (24.6)	40 (24.8)
Sindhi	40 (8.0)	29 (7.6)	11 (6.8)
Others ^b	111 (22.1)	87 (22.8)	32 (19.9)
Type of residence			
Planned	336 (66.8)	262 (68.6)	106 (65.8)
Slum	167 (33.2)	120 (31.4)	55 (34.2)
Birth order			
First and second order	351 (69.8)	221 (57.9)	94 (58.4)
Greater than second	152 (30.2)	161 (42.1)	67 (41.6)
Birth weight ^c			
Underweight (<2500 g)	75 (16.0)	35 (10.5)	12 (8.6)
Normal (2500–4500 g)	372 (80.1)	281 (84.6)	122 (87.1)
Overweight (>4500 g)	18 (3.9)	16 (4.8)	6 (4.3)
Residence years in current home			
Up to five years	47 (9.3)	26 (6.8)	8 (5)
Greater than five years	456 (90.7)	356 (93.2)	153 (95)
No. of household members			
Up to five members	159 (31.6)	83 (21.7)	42 (26.1)
More than five members	344 (68.4)	299 (78.3)	119 (73.9)
Mother's educational status ^d			
Uneducated	135 (26.8)	123 (32.2)	49 (30.4)
Educated	368 (73.2)	259 (67.8)	112 (69.6)
Father's educational status ^d			
Uneducated	115 (22.9)	93 (24.3)	46 (28.6)
Educated	388 (77.1)	289 (75.7)	115 (71.4)
Monthly household income ^e			
Less than 1000 PKR ($\leq$ \$ 98.18 USD)	237 (47.1)	152 (39.8)	66 (41.0)
More than 1000 PKR ($>$ \$ 98.18 USD)	266 (52.9)	230 (60.2)	95 (59.0)
Parental smoking history			
Yes	173 (34.4)	132 (34.6)	51 (31.7)
No	330 (65.6)	25 (65.4)	110 (68.3)
Type of kitchen ^f			
Ventilated	420 (83.5)	335 (87.7)	135 (83.9)
Ill-ventilated	83 (16.5)	47 (12.3)	26 (16.1)
Family history of asthma			
Yes	65 (12.9)	50 (13.1)	21 (13.0)
No	438 (87.1)	332 (86.9)	140 (87.0)
Time spent indoor (hours)			
Up to 12	64 (12.7)	64 (16.8)	26 (16.1)
Greater than 12	439 (87.3)	318 (83.2)	135 (83.9)
Weight (kg) Median (IQR)	15.0 (13–17)	27.0 (23–35)	46.0 (4–53)
Height (cm) Mean (SD)	102.9 (12.1)	136.7 (13.9)	157.3 (13.2)

^aMedian (IQR) age of study participants ($n = 1046$) was 8 (5–12).^bIncluded Baluchi, Brahui, Hazara, Gujrati, Memon, Rajput, Persian, Kathyawari, Kashmiri Gilgity, Hindko, Chakra, Gujrati, Marwari, Balti, Bengali and Rajhistani.^c $n = 937$ (missing values).^dIlliterate individuals were categorized as uneducated, while individuals having education of at least primary, and also from Madarsa and informal education were categorized as educated.^e1USD equals 107.5 Pakistani rupees (6th November 2013).^fIll-ventilated kitchen was defined as having no ventilation in the kitchen except for the door, while ventilated kitchen was defined as having either window, an exhaust, having window and exhaust both or having kitchen in the open environment.Table 2. Prevalence of asthma and wheeze among different age groups of children aged 3–17 years in Karachi, Pakistan, 2013 ($n = 1046$).

Variable	Children 3–17 years ($n = 1046$)	3–7 years ($n = 503$)	8–14 years ($n = 382$)	15–17 years ($n = 161$)	p Value
Asthma % (95% CI)	10.2 (8.4–12.0)	14.7 (11.6–17.8)	5.8 (3.5–8.1)	6.8 (2.9–10.7)	$<0.001^a$
Ever wheeze % (95% CI)	23.0 (20.4–25.5)	19.4 (15.9–22.9)	17.4 (13.6–21.2)	27.6 (20.7–34.5)	0.003 ^a
Current wheeze % (95% CI)	10.1 (8.3–11.9)	14.7 (11.6–17.8)	5.5 (3.2–7.8)	6.8 (2.9–10.7)	$<0.001^a$
Any allergy % (95% CI)	20.2 (17.8–22.6)	20.5 (17.0–24.0)	17.3 (13.5–21.1)	26.1 (19.3–32.8)	0.06

^aSignificant at $p < 0.05$.

Figure 2. Prevalence of asthma and other allergy symptoms in children 3–17 years of age, Karachi, Pakistan, 2013 ($n = 1046$).



In multivariate analysis, we found that asthma was more likely to occur among boys (adj. OR: 2.5, 95% CI: 1.6–4.0), age group of 3–7 years (adj. OR: 2.9, 95% CI: 1.7–4.8), ill-ventilated kitchen (adj. OR: 1.8, 95% CI: 1.1–3.1), family history of asthma (adj. OR: 2.3, 95% CI: 1.3–3.9) and Sindhi ethnicity (adj. OR: 2.2, 95% CI: 1.1–4.4) (Table 3).

In a separate model for 3–7 years of age group, we found family history of asthma (adj. OR: 2.4, 95% CI: 1.3–4.5), boys (adj. OR: 2.1, 95% CI: 1.2–3.6) and allergy to dust mite (adj. OR: 2.3, 95% CI: 1.0–5.0) as important risk factors for asthma (Table 4). The most important risk factors associated with childhood asthma among 8–14 years age group were found to be monthly household income of less than 10 000 PKR (adj. OR: 3.3, 95% CI: 1.3–8.6), boys (adj. OR: 2.8, 95% CI: 1.0–7.7) and Sindhi ethnicity (adj. OR: 5.3, 95% CI: 1.4–20.5) (Table 5).

Discussion

This is the first community-based survey to assess burden of asthma among children and adolescents in Pakistan. The survey used robust methodology comprising of two stage cluster sampling and an internationally validated tool (ISAAC) to assess the prevalence of asthma. We found the overall prevalence of asthma among children who were 3–17 years of age to be 10.2% (95% CI: 8.4–12.0). Among the three age groups, the highest proportion of asthma was observed among the youngest group of 3–7 years (14.7%, 95% CI: 11.6–17.8), while the age group of 8–14 years were found to have the least proportion of asthmatics (5.8%, 95% CI: 3.5–8.1). These findings are consistent with the natural course of asthma and also reported by previous studies [26]. Other possible explanations in variation of asthma prevalence across different age groups could include a possible cohort effect or

some environmental factors that have changed over the period of time. However, further investigation through follow-up studies is required to investigate this phenomenon.

The overall prevalence of 10.2% for asthma determined through our study is high compared to regional countries which report prevalence of 6% and 7.3% in India and Bangladesh, respectively [4,27]. Indian study was part of ISAAC study conducted in a representative sample of school children of 6–7 years ($n = 31\,697$) and 13–14 years ($n = 37\,171$) [4]. While, Bangladesh study was also a nationwide survey having a representative sample of 1571 children of 5–14 years of age [27]. However, the estimate from our study is close to the estimates of ISAAC study conducted in Pakistan in 1995 on a sample of school children who were 13–14 years of age in Karachi [14] and a multicenter survey conducted in three cities of China [11]. The parent ISAAC study in Pakistan [14] only recruited 13–14 year old children in the study and reported 8% prevalence of asthma in this age group, while our study identified 4.6% asthmatic children in 13–14 year age group. The sample size in 6–7 year age group and 13–14 year age group in our study population was 141 and 87 participants, respectively. So, we think that it may not be accurate to compare the prevalence with this small sample in this age bracket. Furthermore, the study population in the ISAAC study in Pakistan comprised of school children, while we took a community-based generalizable sample from the population. The higher prevalence among school children could be explained by the “hygiene hypothesis”, where better hygiene and lower rate of respiratory infections may be associated with higher proportion of asthmatics among school children. Moreover, for the specific age groups, i.e. 6–7 and 13–14 years old children, we do not have the adequate sample size, that is why the sub group analysis of these specific age groups could not be done for

Table 3. Univariate and multivariate analysis of factors associated with asthma among children who were 3–17 years in Karachi, Pakistan, 2013 ($n = 1046$)^a.

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Sex		
Girls	1	1
Boys	2.3 (1.5–3.6)	2.5 (1.6–4.0)
Age, years		
8–14	1	1
15–17	1.2 (0.6–2.5)	1.3 (0.6–2.8)
3–7	2.8 (1.7–4.6)	2.9 (1.7–4.8)
Birth weight ^b		
Normal (>2500 grams)	1	1
Underweight(<2500 grams)	1.5 (0.7–3.1)	
Monthly household income		
More than 10 000 PKR (≤ \$ 98.18 USD)	1	1
Less than 10 000 PKR (< \$ 98.18 USD)	1.5 (1.0–2.2)	
Type of residence		
Planned	1	1
Slum	1.4 (0.9–2.2)	
Parental smoking status		
No	1	1
Yes	1.1 (0.7–1.6)	
Kitchen type		
Ventilated	1	1
Ill-ventilated	1.6 (1.0–2.7)	1.8 (1.1–3.1)
Allergy with dust mite		
No	1	1
Yes	2.3 (1.2–4.3)	
Family history of asthma		
No	1	1
Yes	2.3 (1.4–3.7)	2.3 (1.3–3.9)
Residence years in current home		
Up to five years	1	1
More than five years	0.6 (0.3–1.2)	
Ethnicity		
Urdu	1	1
Punjabi	1.4 (0.9–2.4)	1.4 (0.8–2.3)
Sindhi	2.7 (1.4–5.1)	2.2 (1.1–4.4)
Others	1.0 (0.6–1.8)	0.9 (0.5–1.6)
Mother's education		
Educated	1	1
Uneducated	1.5 (1.0–2.3)	
Father's education		
Educated	1	1
Uneducated	1.0 (0.7–1.7)	
No. of household members		
Up to five members	1	1
More than five members	0.8 (0.5–1.3)	
Time spent indoors (hours)		
Up to 12	1	1
More than 12	0.8 (0.4–1.3)	

^aAll variables are mutually adjusted for each other and also for parental smoking status, no. of smokers at home, birth weight, monthly household income, duration of residence years in current home, no. of individuals living at home and education status of mother and father.

^b $n = 937$ (missing values).

this study. Recent studies from Pakistan report prevalence of 15.8% [15] and 42.1% [28] among school children in various urban areas. The difference in estimates could be due to use of different operational definitions and tools for assessing asthma. In addition, the previous studies were school-based studies, while our study was a community-based survey. The natural course of asthma shows a higher incidence among boys in pre-puberty age group (i.e. before 15 years).

Table 4. Multiple logistic regression analysis of factors associated with asthma among children aged 3–7 years in Karachi, Pakistan, 2013 ($n = 503$)^a.

Variable	Adjusted OR (95% CI)	<i>p</i> Value
Age (years)	–0.102	0.281
Sex		
Girls	1	0.007
Boys	2.1 (1.2–3.6)	
Allergy to dust mite		
No	1	0.041
Yes	2.3 (1.0–5.0)	
Family history of asthma		
No	1	0.007
Yes	2.4 (1.3–4.5)	

^aAll variables are mutually adjusted for each other and also for parental smoking status, no. of smokers at home, type of residence, birth weight, monthly household income, residence years in current home, no. of individuals living at home and education status of mother and father.

Table 5. Multiple logistic regression analysis of factors associated with asthma among children aged 8–14 years in Karachi, Pakistan, 2013 ($n = 382$)^a.

Variable	Adjusted OR (95% CI)	<i>p</i> Value
Age (years)	–0.057	0.612
Sex		
Girls	1	0.04
Boys	2.8 (1.0–7.7)	
Ethnicity		
Urdu	1	
Punjabi	2.8 (0.9–9.2)	0.083
Sindhi	5.3 (1.4–20.5)	0.015
Others	1.2 (0.3–4.8)	0.795
Monthly household income		
More than 10 000 PKR (≤ \$ 98.18 USD)	1	0.014
Less than 10 000 PKR (> \$ 98.18 USD)	3.3 (1.3–8.6)	

^aAll variables are mutually adjusted for each other and also for parental smoking status, no. of smokers at home, types of residence, birth weight, duration of residence years in current home, no. of individuals living at home and education status of mother and father.

However, females have a natural tendency to have increased asthma prevalence in adolescence and adult life [29]. These study findings are consistent with the findings of our study where we found boys (adj. OR: 2.5, 95% CI: 1.6–4.0) to be at a higher risk for asthma [29,30]. The association between asthma and family history of asthma (adj. OR: 2.3, 95% CI: 1.3–3.9) is also consistent with studies conducted in Pakistan and other countries [6,16,28].

Global evidence reports that indoor environmental factors, including poorly ventilated cooking conditions, can increase the risk of respiratory symptoms in children, but there is insufficient evidence to conclude that there is any association of indoor pollution with asthma development [31]. We found a significant risk of childhood asthma with ill-ventilated kitchen (adj. OR: 1.8, 95% CI: 1.1–3.1). However, this finding needs to be confirmed through

measurement of indoor air pollutants and information regarding personal exposure. Our study also reported an increased risk of asthma among children of the Sindhi ethnicity (adj. OR: 2.2, 95% CI: 1.1–4.4). The effect of ethnicity on childhood asthma could be due to certain socio-economic and behavioral differences among these groups as reported by other studies [32,33]. Alternatively it is possible that most of the Sindhi speaking children were from rural background having previous exposure to indoor air pollution due to use of biomass fuel for cooking. History of dust mite allergy was also identified as an important risk factor for asthma in our study, especially among the youngest age group (adj. OR: 2.3, 95% CI: 1.0–5.0). Among few studies on this subject, a recent review also reported that exposure to dust mite allergens is associated with childhood asthma [29].

The prevalence of smoking among fathers of our study participants was 22.4%, while it was only 0.6% for mothers. A recently conducted nationwide study also reported similar findings, i.e. around 26.6% and 0.4% of males and females in Pakistan are current tobacco smokers, respectively [34]. Although there are some variations in prevalence of parental smoking of our study participants [34.4% (3–7 years of age), 34.6% (8–14 years of age) and 31.7% (15–17 years of age)], but we think that these are not significant differences and are consistent with the national estimates [34]. Our study also identified low-income status of the household as a significant risk factor for asthma among 8–14 year old children (adj. OR: 3.3, 95% CI: 1.3–8.6), a finding which has been reported previously [8,28,35,36]. Our study could not find association of childhood asthma with certain established risk factors like parental smoking, parental education and low birth weight [16,29,37]. One possible reason for not having family history of smoking significantly associated with asthma could be the open air environment in the homes and smoking outside the homes, which prevented the children from exposure to second hand smoke. Residence in unplanned or slum areas was also not found to be a predictor of asthma, which could be due to the fact that the home environment in these settings is different, and children most of the time are not present at home and rather prefer to play outside [38].

The socio-demographic characteristic of the three age groups indicated that the older age group (15–17 years old) had lowest proportion of low birth weight (8.6%) compared to the other two age groups [16.0% (3–7 years of age) and 10.5% (8–14 years of age)]. This low proportion of low birth weight in older age group may be due to recall bias as parents of older children may not have been able to recall the exact birth weight as compared to parents of younger children. These estimates are consistent with the national prevalence of low birth weight in urban population, which is reported as 21.0% in the recent Pakistan Demographic and Health Survey 2012–2013 [39]. Moreover, it was interesting to see the highest proportion of uneducated fathers (28.6%) in older age group (15–17 years old) as compared with other two age groups [22.9% (3–7 years of age) and 24.3% (8–14 years of age)]. This finding may be secondary to increase in the literacy rate over the period of

past decade, i.e. 58.0% of adult male in 2001–2002 versus 70.0% in 2010–2011 [40].

Certain consideration regarding our observation and measurement need be taken into account. Asthma was diagnosed through a questionnaire and not validated by clinical diagnosis or spirometry. Various international and national studies have utilized questionnaires based on symptoms of asthma where “wheeze” was used as a key symptom [2,3]. Wheeze occurring any time over a 12-month has a good specificity and sensitivity for bronchial hyper responsiveness and asthma. Few studies have also used physician diagnosed asthma as a parameter of asthma prevalence which may give underestimation of the burden [41,42]. Although clinical history in combination with a reversible airway obstruction measured by a pulmonary function test is the gold standard for diagnosing asthma [43], implementing such a standard is impractical considering the scale of the sample of large community-based surveys and would be extremely costly and time consuming. Therefore, we believe the prevalence of asthma obtained with the use of ISAAC questionnaire has given us reliable estimates. Secondly the ISAAC questionnaire was developed for children who were six years old or above, but we used it on children who were three years and above. Various studies have gone beyond this age bracket of 6–7 and 13–14 years of age for assessing the burden of asthma globally [8,15,27]. Although it is difficult to measure the burden in age less than five years, we ensured that the questionnaire was administered by trained data collectors in the field and that parents understood the questions and gave the required information accurately. Younger age group are certainly more vulnerable and prone for wheezing symptoms as allergy march suggests, therefore, we tried to assess the burden of asthma among this age group. We did not ask about the possibility of respiratory infections as trigger of wheezing in younger children. These lower respiratory infections early in the life can trigger the development of wheezing in subsequent years, however, we were not able to capture this information. We were also not able to cover few of the selected clusters (4 of 80) of the city due to adverse law and order situation, but we believe that this would not have affected our findings drastically. The households that refused to take part in our study (5%) were similar to our study participants in terms of socio-demographic characteristics, i.e. age, gender, etc., therefore, we believe that this low non-response rate would not have altered our study findings significantly.

In our study, the self-reported history of dust mite allergy was not found to be a significant predictor of asthma in the multivariate analysis. Although we trained our data collectors to accurately convey the meaning of this variable to participants in local language, however, the validity of this variable may be low in our setting. Our cross sectional study was unable to provide any trends of asthma development among children in Pakistan. However, we do think that this study reflects the true burden of asthma among children and our findings are comparable with the estimates from other developing countries. As no epidemiological study was available previously in Pakistan, data from this study will be relevant to use for assessing trends in future.

Conclusion

This study is the first robust evidence of burden of asthma among children in Pakistan. Family history of asthma, male gender, Sindhi ethnicity and the type of kitchen were found to be important risk factors of asthma. Targeted preventive measures and further intervention studies are required to understand and reduce the burden of asthma among children in Pakistan.

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Declaration of interest

The authors declare no conflicts of interest. No funding was sought or received for this study.

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