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Respiratory Health Status of Children from Two Different Air Pollution Exposure Settings of Sri Lanka: A Cross-sectional Study

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Abstract

Background—Health effects due to air pollution is becoming a major public health problem with growing traffic congestion and establishment of small to medium scale industries with poor emission controls in urban cities of Sri Lanka.

Methods—Respiratory health status of 7–10 year old children in two settings (urban and semi-urban) was assessed using standard questionnaires. Information on socio-demographic characteristics and potential determinants of both outdoor and indoor air pollutants exposure levels were also obtained. The respiratory health status of children in the two settings was compared.

Results—We found that children from the urban setting had a significantly higher prevalence of wheezing within the last 12 months as compared to children from the semi-urban setting (adjusted OR=2.02; 95% CI=1.13–3.59). Indoor cooking with unclean fuels was a risk factor for wheezing independent of the area of residence (Adjusted OR =1.57; 95% CI = 1.01–2.46).

Conclusions—*Poor indoor air quality was a major determinant of wheezing for the overall study group.* Children from urban areas of Sri Lanka have poorer respiratory health status as compared to children from semi-urban areas. Besides poor outdoor air quality, this difference may also be due to other unexplored factors which may differ between urban and rural areas in Sri Lanka.

Keywords

urban air pollution; Sri Lanka; respiratory health; biomass fuel; indoor air pollution

INTRODUCTION

Air pollutants generally do not exist in isolation, but in complex mixtures that create the potential for synergistic effects of air pollution [HEI, 2004]. The responses to air pollutants depend on an individual's sensitivity. Therefore, the average response in a population depends on the population distribution of sensitivities [ATS, 2000; WHO, 2000] The composition of air pollutants may be differ in countries, in regions and in cities while the

health impacts of air pollution depend on the sensitivity and the exposure level of the susceptible population to the pollutants. In view of the above, generalization of findings from epidemiological studies done one country or region to another may not be appropriate [WHO, 2000].

Adverse respiratory health effects of outdoor and indoor air pollution, particularly the asthma and asthma-like symptoms are well established. However, estimates of these associations vary by country, region and city [Anderson et al., 2010; HEI, 2010a]. For example, the prevalence of wheezing was 7.4% among 10 to 12 year-old children in central Taiwan [Liao et al., 2009], 25.6% among 7 to 15 year-old children in a industrial area of India [Kumar et al., 2007], 8.4% among 11 to 15 year- old Chinese children [Zhao et al., 2008] and 12.6% among 13–15 year-old children in Poland [Kasznia-Kocot et al., 2010]. Most epidemiological studies have assessed the association of indoor unclean cooking fuel exposure and respiratory health or outdoor traffic-related air pollution and respiratory health separately [Rehfuess et al., 2009; Weinmayr et al., 2010; Andersson et al., 2011] Further, studies on exposure to biomass fuel use and respiratory health studies have mostly been conducted among preschool children [Dherani et al., 2008; Fuentes-Leonarte et al., 2009]. Studies comparing respiratory health of school age children living in households using unclean cooking fuel in different outdoor air pollution settings are limited. One such study among Nigerian children of 7 to 14 year-old found a wheezing prevalence of 5.4%; and wheezing was associated with traffic disturbance at home and not with wood or coal use at home [Mustapha et al., 2011].

Urbanization and industrialization in Sri Lanka over the past few years has affected the environment to a great extent. Emissions of various air pollutants from an ever increasing vehicle fleet, deteriorating traffic congestion, and establishment of small and medium scale factories with poor emission control technologies in urban settings has contributed immensely to poor air quality [Batagoda et al., 2004]. The annual ambient particulate matter of $<10\mu\text{m}$ aerodynamic diameter (PM_{10}) in Colombo from 1997 to 2007 was between 72–82 $\mu\text{g}/\text{m}^3$ with slight downward trend [Nandasena, et al. 2010]. In addition, over 78% of population in Sri Lanka still relay on biomass fuel for cooking (DHS, 2008), which is known to be the main sources of indoor air pollution in developing countries [Bruce et al., 2002].

The World Health Organization (WHO) estimated the number of deaths attributable to indoor and outdoor air pollution in Sri Lanka as 4,300 and 1,000, respectively [WHO, 2009a]. Only a few epidemiological studies on air pollution and respiratory health of school age children are available in Sri Lanka [Karunasekara et al., 2005; Lankathilaka et al., 2000; Premaratna et al., 2002; Sirithunga et al., 2006]. These studies assessed limited number of respiratory conditions, had small study size and did not examined households characteristics in detail [Nandasena et al., 2010].

We therefore undertook the present study to address the above research gaps. The study was designed to assess respiratory health of school children expose in different outdoor air pollution exposure levels and indoor air exposure levels based on a spectrum of cooking fuel types in an urban and a semi-urban setting in the Western province of Sri Lanka.

METHODS

Study sites

Two study settings with different outdoor air pollution levels were selected. The high outdoor air pollution setting was selected from the Colombo Municipal Council (CMC) area, which is the commercial capital of Sri Lanka extending over 37 km^2 with a resident

population of 750,000 consistent an urban setting. The CMC area is further divided into 47 administrative divisions known as wards.

We used nitrogen dioxide (NO₂) levels measured by passive samplers at 15 locations to interpolate the air quality levels in the CMC area and to identify the most polluted areas (21 out of 47 wards). The NO₂ passive sampler air quality data were obtained from the routine monitoring network of the National Building Research Organization. Of 21 wards, one was purposively selected as the study site based on its characteristics of having households that were predominantly residential with lower number of commercial establishments and the availability of both permanent and semi-permanent households in the same area.

We selected a second study setting from Panadura Medical Officer of Health (MOH) area situated approximately 40 km away from the first study setting. We assumed that this area has low air pollution levels, although the air quality data were not available prior to the selection of study sites. Panadura MOH area consists of 107 Grama Niladari (GN) divisions which are the smallest administrative divisions. Most of the Panadura MOH area is residential and consists of single households amidst lush home gardens with no vehicular traffic congestion or industries as in the CMC area. Other point sources of pollution such as bush burning or controlled fires are uncommon. The Panadura MOH area has basic facilities such as pipe-borne water supply, electricity, efficient public transport and basic health care facilities similar to CMC. Thus the Panadura area may be considered as a “semi-urban setting”. Both study areas have a similar weather pattern.

We identified the most eligible GN divisions for our study setting by selecting that were at least one km away from the major roads to minimise traffic-related air pollution. Twenty six GN divisions fulfilled the study criteria and we randomly selected one GN division as the second study site.

Types of dwellings

Based on construction materials, we classified the dwellings in the CMC area as “permanent” or “semi-permanent”. Permanent households were those that were made of only permanent materials such as walls built of bricks, cement blocks, pressed soil blocks etc.; roof made of tiles, asbestos, concrete etc.; and floor constructed of cement, terrazzo, tiles etc. Semi-permanent households were those that were made of a mixture of permanent and semi-permanent materials or only with semi-permanent materials. Semi-permanent materials of walls could be mud, planks, metal sheets etc.; roofs could be metal sheets, cadjans, straw etc.; and floor could be mud, wood etc. Categorization of dwellings was completed at the time of subject recruitment. We found an equal distribution of permanent and semi-permanent households in the CMC area. Housing units in Panadura MOH area were selected, irrespective of the type of house, if other eligibility criteria were met.

Study subjects

Our desired sample size was 204 children for each group of households. This was calculated based on another study done in a Colombo suburb comparing the respiratory health of children living in an industrial zone and in a non-industrial zone [Premaratna et al., 2002]. Assumptions made in the sample size calculation were based on the probability of a respiratory symptom in the low exposure group as 0.20 and the probability of the same respiratory symptom in the high exposure group as 0.35. A power of 90% and an alpha error of 5% were considered in the computation.

Subject recruitment

We selected households with children aged 7–10 years and administered a screening questionnaire. That included questions to verify the age, permanent residency and location of school. All eligible children for whom we obtained informed written parental consent were recruited to participate in the study until the required sample size (204 children for each group) was reached within the smallest possible geographic area. Inclusion criteria included being permanent residents of the selected study settings (spent more than half of their life in the same ward or GN division and being resident in the same household for more than one year). However, when there was more than one eligible child in a single housing unit, only the oldest child was selected as a predetermined strategy. A child was excluded if the school he/she attended was located in an urban area while residing in the semi-urban area or vice versa.

As described above, we began subject recruitment from a single administrative unit (ward or GN division). Screening of the children was started from the most interior point of the administrative units with house-to-house canvassing towards the exterior border (coastal side). If the expected number of children to recruit was not met, the adjacent administrative unit located to the right was canvassed in the same way. We completed the expected sample size by recruiting children from two wards from CMC and three GN divisions from Panadura MOH area.

Public Health Midwives (PHMs) who are responsible for the domiciliary maternal and child health care of the area assisted in identifying eligible children. Each PHM supported by a group of local volunteers from the community, ensured the administration of screening questionnaire to every potentially eligible child. If the parent were not present at the first visit, we made three additional attempts to the households with the assistant of community volunteers.

The overall participation rate was 98%. The number of children screened, exclusions and refusals are provided in table 1. The main reasons for exclusions were children schooling in a different exposure area (urban children schooling in semi-urban schools or vice versa) and recent migration to urban areas.

Data collection

The survey questionnaire consisted of three components: socio-demographic information and parental health status; determinants of indoor air pollutants; and respiratory health status. Specific information collected included: income levels of the family; parents' education level; smoking status; chronic respiratory disease conditions in parents; housing characteristics including types of cooking fuel and place of cooking; and other determinants of indoor air pollution (incense burning, use of mosquito coil practices, pets inside homes, indoor smoking practices etc.). For family history of asthma, we asked whether the mother or father ever had asthma. If the mother or the guardian was unaware of asthmatic status of spouse, the father or the grandparent was contacted in a subsequent visit. Children's respiratory health status was assessed using the validated International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire for wheezing-related questions and the American Thoracic Society questionnaire (ATS-DLD-78-C) for other respiratory conditions. Both of these questionnaires have been used widely to assess the respiratory health status of children in epidemiological studies [Nishima et al., 2008; Langkulsen et al., 2006; Hansel, et al. 2008]. The ISAAC questionnaire is considered to be more reliable to assess asthma and wheezing-related questions as compared to the ATS-DLD-78-C [Norzila et al., 2000]. The questionnaire was administered to the mothers. If the mother was not living with the child (e.g. mother employed overseas), the questionnaire was administered to the guardian who

usually looked after the child. Height and weight were measured according to the standard WHO protocols [WHO, 1995]. Height was measured with stadiometers and weight was measured with an electronic scale (SECA brand). Ethical clearance was obtained from the Ethics Committee of the Faculty of Medicine, University of Kelaniya and the Institutional Review Board of the University of Alabama at Birmingham, USA.

Analysis

Socio-demographic characteristics of the study population were examined using descriptive statistics. Chi square tests and ANOVA were used to compare children of three different panels (urban semi-permanent, urban permanent and semi-urban). The WHO Anthro-plus software was used to calculate anthropometric indicators of children. Odds ratios (OR) and 95% confidence intervals (CI) were computed for selected respiratory symptoms/conditions using semi-urban population as the reference group. Within the urban setting, respiratory symptoms among Sinhalese and non-Sinhalese ethnic subgroups were compared. Using multivariable logistic regression procedures, we computed OR and the corresponding 95% CIs for wheezing in the last 12 months, for overall study group and for the Sinhalese subgroup. The adjusted OR estimated the OR of wheezing in the last 12 months, compared to those without wheezing in the last 12 months, to a particular risk factor, adjusting for other risk factors in the model. Risk factors known to affect wheezing such as potential environmental factors were included in the final model. Use of unclean indoor cooking fuel was defined as using biomass or kerosene routinely for cooking indoors. Mothers' educational level and monthly income was considered in the final model to represent the socioeconomic status of the family. Exposure to second-hand (SHS) smoke was considered, if any person regularly smoked inside the house on a daily basis. Multivariable models included indicators for indoor cooking fuel (cooking indoors with unclean fuels vs. cooking outdoors/cooking indoors using clean fuel), use of mosquito coils (< 4 times per week vs. use of mosquito coils > 4 days per week), SHS exposure (yes vs. no), pets inside houses (> 50% of time vs. < 50% of time), mothers education (grade 5 or grade 6–10 vs. > grade 10), family income (< 10,000 Sri Lankan Rupees (SLR) or 10,001–20,000 SLR vs. >20,000 SLR), parental asthma (yes vs. no), residence in an urban area (urban vs. semi-urban) and fathers ethnicity (Sinhalese vs. non-Sinhalese). Data analysis was done using the International Business Machine Company's PASW statistical package.

RESULTS

The socio-demographic characteristics of three panels of children were similar in many aspects including mean age, sex, anthropometric measurements, father's education, income levels and parental asthma (additional file 1). Electricity was the source of lighting in the majority of households. Most (90%) households in the semi-urban setting used biomass fuel for cooking, while <10% of urban households used biomass (urban semi-permanent, 9.8%; urban permanent, 7.4%). In the semi-urban setting, cooking was done in a separate room in the house (47%), in a separate building (36.1%) or outdoor cooking (13.4%) (Table 2).

There was no difference in the distribution of children reporting "ever wheezing or whistling in the chest" between the groups. Among the wheezers, there was no difference in the frequency of attacks between the three groups of children. The occurrence of night time cough in the last 12 months, usually having cough and usually having phlegm were significantly higher in children from both groups of the urban setting compared to children from the semi-urban setting (Table 3). Differences in the prevalence of respiratory symptoms/conditions among Sinhalese and Non-Sinhalese children in the urban setting were unremarkable (additional file 2). Comparisons of respiratory symptoms/conditions are provided in table 3 and additional file 3. We asked the question "Has your child had wheezing or whistling in the chest in the past 12 months?" In response to this question,

20.8% children in semipermanent houses, 24%, in permanent houses and 17.6% in semi-urban setting reported wheezing within the last 12 months.

In multivariable analysis, use of biomass or kerosene oil for cooking inside the main building (adjusted OR = 1.57; 95% CI = 1.01–2.46), parental asthma (adjusted OR = 2.72; 95% CI = 1.83–4.65) and being resident in an urban area (adjusted OR = 2.02; 95% CI = 1.13–3.59) were independent risk factors of wheezing within the last 12 months. In analysis restricted to the Sinhalese ethnic subgroup, use of biomass was not a significant risk factor (adjusted OR = 1.53; 95% CI = 0.85–2.74) for wheezing in the last 12 months.

DISCUSSION

We found that the prevalence of most respiratory symptoms/conditions were higher in the urban setting compared to the semi-urban setting. Living in urban setting and parental asthma were risk factors for wheezing during previous 12 months when adjusted to other factor. Use of biomass cooking fuel was not a significant risk factor for wheezing among Sinhalese children when adjusted for other risk factors.

Wheezing is the most important symptom for the identification of asthma in epidemiological studies and it has shown that this symptom has reasonably good specificity and sensitivity for bronchial hyper-responsiveness compared to other symptoms in both children and adults [Patel et al., 2008]. The prevalence of children who had wheezing in the last 12 months in the urban setting (20.8%) in our study was within the upper range of results reported from other studies done in Sri Lanka where the prevalence have ranged from 10.8–23.0% [Karunasekara et al., 2005; Premaratna et al., 2002; Mistry et al., 2004, Samarasinghe, 2007]. A wide range of current prevalence of wheezing among school children has been reported between and within countries over time, varying from 32.2% among 13 to 14 year-old children in the United Kingdom to 1.7% among 10 to 19 year-old in Ethiopia [Patel et al., 2008]. These variations may be attributable to differences in many factors such as air pollution exposure levels, age ranges, method of administration the questionnaire etc. The use of the self-administered ISAAC questionnaire has been found to yield a higher prevalence of wheezing as compared to it being administered by an interviewer [Patel et al., 2008]. In our study, the ISAAC questionnaire was interviewer administered. We did not miss in screening any of the potentially eligible children and the numbers of refusal children in both settings were very few. Thus, selection bias is an unlikely explanation of the high prevalence noted in our study.

The current respiratory health status of children from the semi-urban setting is better than that of children from the urban area, despite the fact that a higher proportion of households used biomass fuel. The exposures to traffic related air pollution is more hazards and severe compare to the biomass exposure for our study population. However, we did not have accurate micro-environment time activity pattern of the study population. It is plausible the children's exposure may be lower to biomass fuel pollutants due to several factors such as time spend commuting to school, time at school, playing outdoor etc. Similar findings were reported among Nigerian school children of 7 to 14 years as current wheezing was associated with traffic disturbances (OR = 2.16; 95%CI = 1.28–3.64), while the association was non-significant for cooking with wood or coal (OR = 2.99; 95% CI = 0.88–10.18) [Mustapha et al., 2011].

The prevalence of “ever wheezing” among children in urban and semi-urban areas in our study was similar. This indicates that the children from the semi-urban setting had higher prevalence of wheezing in their younger age. Wheezing is a major clinical expression of asthma and other common causes such as lower respiratory tract infections, pneumonia etc.

[Chung, 2011]. A large body of literature supports the occurrence of high adverse respiratory health effects among preschool children who mostly stay close to their mothers while cooking and are exposed to biomass smoke [Bruce et al., 2002]. Preschool children spend more time in the kitchens compare to their elder schooling siblings [Saksena et al., 2007]. Further research targeting younger children specially those who are not schooling are needed to explore risk factors for adverse respiratory health status from a Sri Lankan perspective.

“Persistent cough” was reported in 10.0% and 3.4% of children in the urban and in the semi-urban areas, respectively. Our estimate for the urban areas is consistent with estimates from other urban settings in the region. In a highly polluted roadside area and in a highly polluted general area of Bangkok, Thailand, persistent cough, defined as in this study, was reported in 5.1% and 8.2% of children, respectively [Langkulsen et al., 2006]; in four Chinese cities with different levels of air pollution, persistent cough was reported in 5.2% to 14.0% of school children [Zhang et al., 2002].

Following the initial data collection, we monitored the outdoor PM ($PM_{2.5}$ and PM_{10}), NO_2 and SO_2 levels in three locations in each setting simultaneously which were approximately equidistant and located in bordering areas of children’s households. Monitoring locations were selected following the visualization of households in an aerial map by their coordinates. During the first month after the baseline survey, PM was measured for 24 hours twice (one month apart) by high volume gravimetric air samplers while NO_2 and SO_2 were monitored over a one month period by passive samplers.

In the urban area, the 24-hour average values of $PM_{2.5}$ and PM_{10} levels were $50.4 \mu g/m^3$ and $68.1 \mu g/m^3$, respectively; and the monthly average values of NO_2 and SO_2 levels were $47.2 \mu g/m^3$, and $42.7 \mu g/m^3$, respectively. In the semi-urban area, the 24-hour average values of $PM_{2.5}$ and PM_{10} levels were $19.2 \mu g/m^3$ and $34.9 \mu g/m^3$ respectively, and the monthly average values of NO_2 and SO_2 levels were $10.2 \mu g/m^3$ and $10.0 \mu g/m^3$, respectively. The WHO recommends that the 24-hour $PM_{2.5}$ and PM_{10} concentrations should not exceed $25 \mu g/m^3$ and $50 \mu g/m^3$, respectively [WHO, 2005]. Thus, the air quality measurements done after the baseline survey, suggest that the poor respiratory health status of children in the urban area may be explained in part by the poor outdoor air quality and is unlikely to have changed much in the months preceding the survey. Asthma or wheeze prevalence for $10 \mu g/m^3$ change in pollutant concentration has shown a wide variation across studies [HEI, 2010b]. A study in four Chinese cities reported an increase in $50 \mu g/m^3$ of $PM_{2.5-10}$ was associated with increase in wheezing, persistent cough and persistent phlegm by 1.14, 1.34 and 1.57 times, respectively among school children [Zhang et al., 2002]. Current wheezing reported by Turkish school children exposed to average NO_2 levels of $24.8 \mu g/m^3$ was 22.9%, while those who were exposed to average NO_2 levels of $14.9 \mu g/m^3$ was 15.9% [Gul et al., 2011].

In order to estimate the effects of indoor air pollution by structural characteristics of houses, we selected two panels of children living in permanent and semi-permanent houses from the highly polluted urban area. However, we did not find remarkable differences in the most respiratory symptoms/conditions of children living in different types of houses in the urban area. As Sri Lanka is a hot and humid tropical country (temperature of the Western province ranges from 76 – 89 °F around the year), windows and doors are generally kept open. This allows a generous mixing of indoor and outdoor air within households that may have masked differences in respiratory health status due to indoor air pollution that may be attributable to structural characteristics of houses within a high outdoor polluted area. In Taiwan, closing of windows have been advocated when outdoor particle levels are high [Lin

et al., 2009]. If the source of pollutants is from indoors, regular opening of windows will help to dissipate indoor pollutants outdoors.

The prevalence of smoking among fathers of the study population was (urban semi-permanent, 53%; urban permanent, 32%; and 46%, semi-urban) higher than the reported 30.2% for adult Sri Lankan males (> 15 years) in 2005 [WHO, 2009b]. This may be explained by the study population being primarily of the low socio-economic stratum which is known to have a higher prevalence of smoking [Perera et al., 2005]. The majority of households of children in the urban setting had cooked inside the main building (semi-permanent, 91.6%; and permanent houses, 90.7%) while cooking was done indoors in about half of the households of children in the semi-urban area. The Demographic and Health Survey of Sri Lanka of 2007 [DCS, 2009] reported that 84.7% and 68.4% of the urban and rural population, respectively, cooked indoors. Electricity was the main source of lighting in both settings; the use of electricity for lighting in this study was higher than the national figure of 81.5% [DCS, 2009]. In this study, 53% urban semi-permanent and 39% permanent households of children used kerosene as the primary cooking fuel, the rates being much higher than the national rates of 12.8% for urban settings. The urban poor rely on kerosene instead of biomass (wood) as kerosene is readily available at a comparatively cheaper price. This is of particular interest as a considerable proportion of the urban poor are exposed to kerosene fumes where cooking is done in congested indoors. The change from polluting cooking fuels (biomass, kerosene etc.) to clean fuels in Sri Lanka is negligible during the past few years; it is unlikely that it would change in the near future either [Nandasena et al., 2009].

CONCLUSIONS

Poor indoor air quality was a major determinant of wheezing for the overall study group. This study suggests that school children from urban areas of Sri Lanka have poorer respiratory health status as compared to school children from semi-urban areas probably due to the effects of poor outdoor air quality. However, this difference may also be due to the other unexplored factors which may differ between urban and semi-urban populations. Thus no firm conclusions can be drawn. It is imperative that measures be taken to mitigate the effects of air pollution on young children in Sri Lanka and to develop a research framework to identify preventable risk factors as a national priority.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Number of children screened and participated

	Urban: semi permanent	Urban: permanent	Semi-urban
Total number screened	243	237	221
Excluded (due to > 1 child in the house)	24	21	12
Excluded due to other reasons ^a	11	6	2
Number of refusals	4	6	3
Final number	204	204	204

^aRecent migration to selected study settings from other areas, school located at urban area for semi-urban children or vice versa

Table 2

Selected demographics, environmental factors and family history of study subjects

Characteristics	Urban		Semi-urban	p-value ^a
	Semi permanent	Permanent		
Total (n, %)	204(100.0)	204(100.0)	204(100.0)	
Mother's education (n, %)				
Grade 5	35 (17.1)	22 (10.8)	19 (9.3)	
Grades 6–10	111 (54.5)	113 (55.4)	97 (40.2)	
> Grade 10	58 (28.4)	69 (33.8)	88 (50.5)	<0.05
Ethnicity (n, %)				
Sinhalese	99 (48.5)	112 (54.9)	198 (97.1)	0.001
Household members (n, %)				
4	47 (23.0)	52 (25.5)	69(33.8)	<0.05
Source of power for lighting (n, %)				
Electricity	184 (90.2)	204 (100.0)	198 (97.1)	
Kerosene oil	20 (9.8)	0 (0.0)	6 (2.9)	<0.001
Place of cooking (n, %)				
living/sleeping room (un-partitioned)	38 (18.6)	21 (10.3)	5 (2.5)	
living/sleeping room (partitioned)	39 (19.1)	10 (4.9)	2 (1.0)	
Separate room (main building)	110 (53.9)	154 (75.5)	95 (47.0)	
Separate building	13 (6.4)	17 (8.3)	73 (36.1)	
Outdoor	4 (2.0)	2 (1.0)	27 (13.4)	<0.001
Primary cooking fuel (n, %)				
Clean fuels	76 (37.3)	110 (53.9)	19 (9.3)	
Kerosene	108 (52.9)	79 (38.7)	0 (0.0)	
Biomass	20 (9.8)	15 (7.4)	185 (90.7)	<0.001
Mosquito coil use (n, %)				
Frequently used	60 (29.4)	55 (27.0)	38 (18.6)	
Non frequent	144 (70.6)	149 (73.0)	166 (81.4)	<0.05
Pets in inside house				
> 50% of time	7(3.4)	15 (7.4)	26(12.7)	<0.005
Father's smoking status (n, %)				
Not smoking	97 (47.5)	139 (68.2)	111 (54.4)	
Smokes indoors	54 (26.5)	27 (13.2)	43 (21.1)	
Smokes, but not indoor	53 (26.0)	38 (18.6)	50 (24.5)	<0.001

^a p-value based chi-square test

Table 3

Selected respiratory symptoms/conditions of study subjects (odds ratios and 95% confidence interval)

Symptoms/conditions	Semi-urban	Urban: Permanent	Urban: Semi permanent
Ever wheezing			
Yes (n (%))	67 (32.8)	74 (36.3)	88 (43.1)
OR (95% CI)	1(reference)	1.10 (0.85–1.44)	1.31(1.02–1.69)
Wheezing (last 12 months)			
Yes (n (%))	22 (10.8)	36 (17.6)	49 (24.0)
OR (95% CI)	1(reference)	1.77(1.01–3.13)	2.62(1.52–4.51)
Night time cough (last 12 months)			
Yes (n (%))	25 (12.3)	51(25.0)	45 (22.1)
OR (95% CI)	1(reference)	2.39 (1.41–4.03)	2.03(1.19–3.45)
Usually having cough			
Yes (n (%))	33 (16.2)	66 (32.4)	94 (46.1)
OR (95% CI)	1(reference)	2.48 (1.54–3.98)	1.79 (1.20–2.67)
Usually having phlegm			
Yes (n (%))	61(30.0)	80 (39.2)	83 (40.7)
OR (95% CI)	1(reference)	1.51(1.01–2.28)	1.61(1.07–2.42)

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Table 4

Adjusted odds ratio (OR) and corresponding 95% confidence intervals for wheezing in the last 12 months for all subjects and for Sinhalese ethnicity

Risk factor	Total		Sinhalese	
	OR ^a	95% C.I.	OR ^a	95% C.I.
Indoor unclean cooking fuel ^b (ref: other methods ^c)	1.57	1.01–2.46	1.53	0.85–2.74
Use of mosquito coils 4 times/week (ref: non frequent)	0.81	0.48–1.35	0.58	0.29–1.13
Indoor smoking (ref: non-smoking)	1.03	0.61–1.76	1.00	0.49–2.03
Pets inside houses > 50% of time (ref: < 50% of time)	0.93	0.39–2.19	1.22	0.47–3.18
Mothers education (ref: > Grade 10)				
Grade 5	1.77	1.16–5.71	1.48	0.41–5.01
Grades 6–10	1.58	0.89–4.35	1.41	0.41–5.26
Family income (ref: > SLR 20,000) ^d				
SLR10,000	1.07	0.55–2.08	1.41	0.63–3.17
SLR 10,001–20,000	0.96	0.52–1.79	0.99	0.39–2.47
Parental asthma ^e (ref: no parental asthma)	2.72	1.83–4.65	2.16	1.37–4.93
Residence in urban area (ref: semi-urban area)	2.02	1.13–3.59	2.09	1.16–3.80
Fathers ethnicity (ref: Sinhalese)	1.47	0.89–2.42		

^aOR for a risk factor was adjusted for all other variables in the model.

^bIndoor unclean cooking fuel: cooking inside the households with biomass or kerosene.

^cCooking with LPG (Liquid Petroleum Gas) or Electricity or cooking outdoor with unclean fuels.

^d1 USD = 110 Sri Lankan Rupees (SLR)

^eFather, mother or both ever having asthma.