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Respiratory symptoms and associated risk factors among under-five children in Northwest, Ethiopia: community based cross-sectional study

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ABSTRACT

Introduction: Acute respiratory infections are still a major public health problem resulting in morbidity and mortality among under-five children. This study aims to assess the extent of respiratory symptoms and associated risk factors among under-five children in Gondar city, Northwest Ethiopia.

Methods: A community-based cross-sectional study was carried out from February to June 2019. From 792 study participants, data were collected *via* face to face interviews by using a semi-structured pre-tested questionnaire. Data were entered in Epi Info version 7, then exported to Stata 14.00 for analysis. Binary (Bivariable and Multivariable) logistic regression analysis was used to test the association of explanatory and outcome variables. Variables with $p<0.05$ were considered as significantly associated with the outcome variable.

Results: The prevalence of respiratory symptoms among under-five children was 37.5% at [95% (CI: 34.3-41)]. Uterine irritability during pregnancy [AOR = 1.89 at 95% CI: (1.11-3.23)], physical exercise during pregnancy [AOR = 0.60 at 95% CI: (0.41-0.89)], using wood and coal for heating [AOR = 2.42 at 95% CI: (1.65-3.53)], cockroaches infestation [AOR = 1.95 at 95% CI: (1.36 – 2.90)], presence of new carpets [AOR = 2.38 at 95% CI: (1.33-4.29)], damp stain [AOR = 2.45 at 95% CI: (1.02-2.69)], opening windows during cooking [AOR = 0.58 at 95% CI: (0.36 - 0 .93)], living less than 100 m heavy traffic [AOR = 1.94 at 95% CI: (1.16-3.27)], and living less than 100 m (unpaved roads/streets) [AOR= 2.89 at 95% CI: (1.89-4.55)] were significantly associated with respiratory symptoms.

Conclusion: The prevalence of respiratory symptoms among under-five children was relatively high in the study area. Personal and environmental characteristics influencing symptom occurrence were identified. Respiratory symptoms will be minimized by reducing exposure to indoor and outdoor air pollution and enhancing housing quality.

Key words: Air pollution; respiratory symptoms; cross-sectional study; under-five children; Ethiopia.

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Consent for publication: Not applicable.

Introduction

Acute respiratory infections (ARI) are still a major public health problem resulting in morbidity and mortality among under-five children. Worldwide, it is estimated that about 7.6 million children died before celebrating their fifth year of birthday attributed to respiratory tract infections [1,2]. About more than half (*i.e.*, 55%) of deaths due to ARI symptoms are from 15 low and middle-income countries (LMICs) and nine of these countries are located in sub-Saharan African (SSA) region [3]. From an estimated, 5.4 million under-five children that died in 2017 roughly half of those deaths occurred in sub-Saharan Africa and ARIs contributed to the highest number of deaths [4].

Finding from Urban Slums of Gulbarga city found ARI incidence of 27.25% among under-five age group children [5]. A multi-country study conducted over sub-Saharan African countries has also reported the magnitude of acute lower respiratory infection (ALRI) for all the countries was 25.3%, Congo (39.8%), Gabon (38.1%), Lesotho (35.2%), and Tanzania (35.2%) were the countries with the highest prevalence of ALRIs [6].

Indoor air pollution is one of the most important contributors to the global burden of disease, particularly in developing countries including Ethiopia, being children one of the most vulnerable groups [7]. The high incidence of ARI in children less than five years of age is one of the main reasons for pediatric outpatients' visits and hospitalization in developing countries [8]. Besides resulting in substantial morbidity and mortality, ARI also yields in multifaceted adverse consequences. Economic losses as a result of the use of healthcare resources, use of health personnel's time, disruption of the family, long time hospitalization and loss in productivity are some of them [9].

Ethiopia has made ample investments to reduce the burden of morbidity and mortality posed by ARI in the pediatrics segment of the population. Integrated management of common childhood illness and community case management are among the program initiatives scaled up nationally to address ARI in the country [10]. Previous studies have identified different factors linked with respiratory symptoms among children of under-five. Age and gender of the child, nutritional status, wealth index, parental educational status, large family size, exposure to biomass fuel, and parental smoking status, insufficient breastfeeding practice, poor immunization status, attendance to daycare centers, and overcrowding were important predictors of ARI among under-five children [3,8,11,12].

This study aims to determine the extent of respiratory symptoms and associated risk factors among under-five children in Gondar city, Northwest Ethiopia.

Methods

Study design, period, and area

A community-based cross-sectional study was conducted from February 15, 2019, to June 20, 2019, in Gondar city, Northwest Ethiopia. The city is divided into 12 administrative areas (sub-cities) which consist of 21 kebeles (the smallest administrative units in Ethiopia). It has an estimated total population of 324, 000 with about 23,929 under-five children.

Sample size calculation and sampling procedure

The sample size was determined by using a single population proportion formula [13] considering the following assumptions: p = 50% proportion of children with respiratory symptoms (there is no previous study in the study area), 95% confidence interval, 5% margin of error (d) and design effect 2

$$n = \frac{(Z_{\frac{\alpha}{2}})^2 * P(1-P)}{d^2} \quad n = \frac{(1.96)^2 * 0.5(1-0.5)}{(0.05)^2} = 384$$

Since we used multi-stage sampling technique, it demands us to use design effect of 2 and we used 5% non-response rate, thus, final sample size (2×384+ 768×0.05) = 806.

Multi-stage sampling was used as an assumption of being a heterogeneous population in the 12 administrative areas of the cities. Fifty percent of total sub-cities were randomly selected from the 12 administrative areas and all eligible study participants present in the selected sub-cities were included in the study. Study participants were selected through simple random sampling technique.

Data collection tools and procedures

Through a face-to-face interview at the participants' home, data were collected using a pretested semi-structured questionnaire. The questionnaire was developed by reviewing different literatures [12,14-16]. The questionnaires include the outcome variable *i.e*. respiratory symptoms (such as cough, shortness of breath, wheezing, chest tightness, phlegm, and a problem in the chest including blocked, or running nose) and the explanatory variables: such as socio-demographic factors (age of a child, age of mothers, average monthly income, mothers and spouse educational level, *etc*.) and household air pollutants (such as type of fuels for cooking, types of fuel for heating, pesticide application, contact with farm animals (*e.g*. cattle, pigs, goats, sheep or poultry), smoke cigarettes (mothers/guardians),cockroach infestation in a household (HH), painting/staining done in the last 6 months HH, new carpets, drapes or other textiles in the last 6 months and using air fresheners, *etc*.) and house characteristics such as floor construction materials, wall surface water-based paint, ceiling surface, damp stains, visible mold, place of cooking, open doors during cooking, open windows during cooking, and time of spending indoors on an average day.

The questionnaire was first prepared in English and then translated to Amharic (local language) and back to English to maintain consistency of the tool. In the data collection process, six licentiate nurses and one BSc nurse were involved. Data collectors and supervisors have received two-days training.

Operational definitions

The outcome variable of this study was respiratory symptoms. Respiratory symptoms were defined in this study as to whether the children under-five years of age had been suffering from cough, shortness of breath, wheezing, chest tightness, phlegm, and a problem in the chest including blocked, or running nose [17,18]. Under-five children who have experienced at least one of the above-mentioned symptoms for the last 12 months prior to the study were considered as having respiratory symptoms.

Data processing and analysis

Data were first checked manually for completeness and then coded and entered into Epi Info version 7, then exported to Stata 14.00 for data checking, cleaning, and analysis. Descriptive statistics were performed to describe the study population with dependent and independent variables. Model fitness was checked with the assumptions of the Hosmer and Lemeshow goodness of fit test. Bi-variable and multivariable logistics regressions were computed to identify the presence and strength of associations. Variables with a $p<0.2$ [19] in the bivariable binary logistic regression analysis

were included in the multivariable binary logistic regression analysis. Odds ratios with 95% CI were computed and variables having a p less than 0.05 in the multivariable binary logistic regression models were considered significantly associated with the dependent variable.

Results

Socio-demographic characteristics of the study participants

A total of 806 study participants were aimed in this study. Out of these, 792 participants were enrolled with a response rate of 98.26%. The median age of under-five children was 24 months ± 12.24(SD) and about 431 (54.4%) were males. 28.65% of the study participants' mothers were in the age of 18-25 years and 22.98% were above 33 years. The majority (77.02%) of the study participants were Orthodox Christian by their religious affiliation (Table 1).

Household air quality and housing characteristics

Three-fifth (60.48%) of the study participants reported the use of charcoal for cooking food. Only few (2.15%) of fathers and (3.03%) of mothers smoked cigarettes and 47.85% of households were infested by cockroaches. Out of the study participants, 250 (31.57%) have spent their time between 6 to 11 h, 179 (31.57%) >15 h, and 198 (25%) <6 h indoors in home, respectively. Above half (55.56%) of the study participants used wood and coal for heating their house during humid weather condition and 43.06% did not use any fuel for heating (Table 2).

Prevalence of respiratory symptoms among under-five children

The prevalence of respiratory symptoms among under-five children in Gondar city was 37.5% at [95% (CI: 34.3-41)]. The most common respiratory symptoms were runny nose (25.63%), phlegm (10.48%), and wheezing (9.72%). The lowest reported respiratory symptom was chest tightness 3.03% (Figure 1).

Factors associated with respiratory symptoms among under-five children

In multivariable analyses, problems during pregnancy (*e.g.* hyperirritability of uterus), regular physical activity during pregnancy, the heredity of respiratory disease, fuel type usually used for heating, cockroach infestation in home, presence of new carpets, damp stains, opening windows during cooking, living less

Table 1. Socio-demographic characteristics of study participants in Gondar city, Northwest Ethiopia, 2019.

Variables		Frequency (n=792)	%
Sex of child	Female	361	45.6
Age of child	12 months	204	25.76
	13-24 months	213	26.89
	25-36 months	181	22.85
	37-48 months	152	19.19
	49-59 months	42	5.30
	Median age of children 24±12.24 (SD)		
Education level of mothers	Unable to read and write	121	15.55
	Read and write	90	11.57
	Primary	100	12.85
	Secondary	253	32.52
	Graduate from vocational	30	3.86
	Diploma and above	184	23.65
Age of mothers	18-25 years	227	28.66
	26-28 years	206	26.01
	29-32 years	177	22.35
	>33 years	182	22.98
	Median age of mothers 28±5.86 (SD)		
Religion	Orthodox	610	77.02
	Muslim	140	17.68
	Others*	42	5.30
Occupation of mother (n=784)	Housewife	533	67.98
	Farmer	4	0.51
	Student	8	1.02
	Private employee	52	6.63
	Government employee	142	18.11
	Merchant	35	4.46
	Others (specify)	10	1.28
Occupation of father (n=723)	Farmer	18	2.49
	Student	8	1.11
	Private employee	310	42.88
	Government employee	232	32.09
	Merchant	88	12.17
	Others	67	9.27

*Protestants, Jewish.

than 100 m from heavy traffic, and living less than 100 m from unpaved roads/streets were significantly associated with under-five children's respiratory symptoms.

Among children of under-five years, those children whose mother had a problem of uterine overstimulation at the time of their pregnancy were 2.20 at times heightened risk of suffering from respiratory symptoms as compared to their counterparts [AOR=2.20 at 95% CI: (1.25-2.89)]. Children from a mother who had done a regular exercise during their pregnancy period had a 40% lesser likelihood of developing respiratory symptoms than children whose mothers had been sedentary during pregnancy [AOR = 0.60 at 95% CI: (0.41-0.89)]. The adjusted odds of respiratory symptoms were 1.89 times higher among under-five children whose mothers had a hereditary respiratory disease when compared with their counterparts [AOR=1.89 at 95% CI: (1.11-

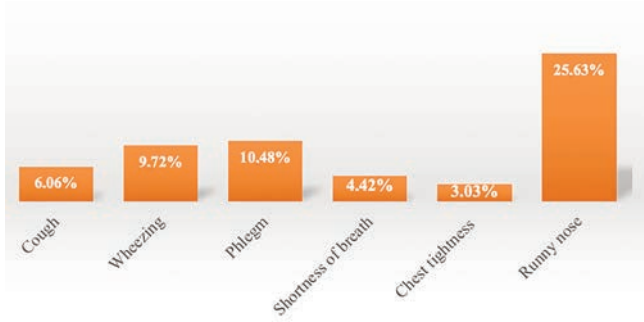

Figure 1. Prevalence of respiratory symptoms among under-five children in Gondar city, Northwest Ethiopia, 2019.

Table 2. Household air quality and housing characteristics of the study participants in Gondar city, Northwest Ethiopia, 2019.

Variables		Frequency (n= 792)	%
Types of fuel usually used for cooking	Charcoal	479	60.48
	Electricity	273	34.47
	Open fires	40	5.05
Types of fuel usually used for heating	None	341	43.06
	Wood, coal	440	55.56
	Electricity	11	1.39
History of contact with farm animals	Yes	47	5.93
Cigarettes smoking (mothers/guardians)	Yes	24	3.03
Cockroach infestation in household	Yes	379	47.85
Painting/staining done in the last 6 months	Yes	110	13.89
Presence of new carpets, in the last 6 months	Yes	110	13.89
Using air fresheners	Yes	48	6.06
Presence of a kitchen exhaust fan	Yes	40	5.05
A pesticide application	Yes	157	19.82
Floor construction materials	Wood and mud	542	68.43
	Brick and concretel	250	31.57
Wall surface water-based paint	Yes	174	21.97
Ceiling surface (n=749)	Wooden	576	76.90
	Painted	131	17.49
	Cement	42	5.61
Damp stains	Yes	63	7.95
Visible mould	Yes	67	8.46
Place of cooking (n=775)	Inside	461	59.48
	Outside	314	40.52
Open doors during cooking (n= 680)	Yes	241	35.44
Open windows during cooking (n=676)	Yes	214	31.66
Length of time spend indoors on an average day	<6 hours	198	25.00
	6 to 11 hours	250	31.57
	11 to 15 hours	165	20.83
	>15 hours	179	22.60
Presence of attached garage within 100 m of household	Yes	46	5.81
Frequency of trucks passing through the nearby street	Never	397	50.13
	Seldom	254	32.07
	Frequently	93	11.74
	Almost the whole day	48	6.06
Living in less than 100 m heavy traffic	Yes	162	20.45
Living in less than 100 m (unpaved roads/streets)	Yes	194	24.49
Exposure to animal allergens in early childhood	Yes	38	4.80
Exposure to animal allergens in the present time	Yes	45	5.68

3.23)]. When compared to children whose parents did not use wood and coal, those who used wood and coal for heating indoors during humid weather conditions were 2.42 times more likely to develop respiratory symptoms [AOR=2.42 at 95% CI: (1.65-3.53)]. Children living in households infested by cockroaches were 1.95 times more likely to suffer from respiratory symptoms when compared with their counterparts [AOR=1.95 at 95% CI: (1.36-2.90)]. Children whose parents used new carpets in HH were 2.38 times more likely to suffer from respiratory symptoms compared with their counterparts [AOR=2.38 at 95% CI: (1.33-4.29)]. Children living in a damp house were 1.66 times more likely to suffer from respiratory symptoms when compared with their counterparts [AOR=1.66 at 95% CI: (1.02-2.69)]. In households where windows were open at the time of cooking, the risk of experiencing respiratory symptoms among under-five children was 42% times less likely as compared to those households which remained closed during cooking time [AOR = 0.58 at 95% CI: (0.36 0.93)]. Children living less than 100 m from heavy traffic areas were 1.94 times more likely to suffer from respiratory symptoms [AOR=1.94 at 95% CI: (1.16-3.27)]. Children living less than 100 m from unpaved roads/streets were 2.89 times more likely to develop respiratory symptoms when compared with their counterparts [AOR=2.89 at 95% CI: (1.89-4.55)] (Table 3).

Discussion

This study found that a number of housing characteristics, indoor air pollution, and outdoor air pollution significantly contributed to an increase in the prevalence of respiratory symptoms among under-five children. In this study, we have found that the overall prevalence of respiratory symptoms among under-five children was 37.5% at [95% (CI: 34.3-41)], of these (runny nose (25.63%), phlegm (10.48%), and wheezing (9.72 were commonly reported respiratory symptoms. This finding [37.5%] was higher compared with previous studies in Ethiopia [20], India [15,21], Nepal [22], and Bangladesh [17]. The possible explanation could be the variation of the study setting, in which some of the studies were institutional-based, whereas our study was community-based, the study period, and the variability in socio-economic, housing, and environmental inequalities.

In regard to the independent factors affecting the respiratory symptoms among children of under-five years, those children whose mother had a problem of uterine overstimulation at the time of their pregnancy were 2.20 times at heightened risk of suffering from respiratory symptoms as compared to their counterparts. This finding may be related to the fact that whenever there is uterine overstimulation, the spiral artery which is responsible for supplying blood to the uterus tends to be ligated/ tied off and this leads the fetus to develop asphyxia due to uteroplacental insufficiency. Birth asphyxia has numerous long term impacts on the baby till childhood including multiple organ damage involving lungs and poor brain stem reflexes like breathing problems which finally pose children at a greater risk of experiencing respiratory symptoms [23].

Regular exercise during pregnancy was another determinant of under-five respiratory symptoms. Accordingly, children from mothers who had done a regular exercise during their pregnancy period had a 40% lesser likelihood of developing respiratory symptoms than children whose mothers had been sedentary during pregnancy. This could probably be explained by well-documented evidence that reports the benefits of exercise during pregnancy for the mother and the fetus with benefits persisting for the child into adulthood. Regular exercise during pregnancy decreases the risk of disease for children including respiratory symptoms in that the babies' hearts most likely had sped up and synchronized with their mothers' during exercise, allowing children to enjoy the same heart benefits, thereby having better-conditioned cardiac muscles which in turn mitigating their risk of respiratory symptoms [24,25]. The adjusted odds of respiratory symptoms were 1.98 times higher among under-five children whose mothers had hereditary respiratory disease. Infection and genetic factors affect the development of the lungs, either directly or indirectly, which can cause respiratory symptoms [26].

When comparing children whose parents did not use wood and coal, those who used wood and coal for heating indoors during humid weather conditions were 2.42 times more likely to develop respiratory symptoms. Evidence has shown that respiratory symptoms are a common problem with wood smoke exposure [27]. Studies suggest that wood smoke particles cause harm to human health through oxidative stress, cell toxicity, defects in cell regeneration, resulting in lung damage, and genotoxicity [28,29]. Children living in households infested by cockroaches were 1.95 times more likely to suffer from respiratory symptoms when compared with their counterparts. Cockroach exposure has been linked to cockroach sensitization and allergic respiratory symptoms [30]. Exposure to cockroaches can increase the risk for frequent wheezing of children with allergic or asthmatic parents in the first year of life even if cockroach infestation is not clear and a relatively low concentration is measured. While the cockroaches in the kitchen are most abundant, their presence in the bedroom and the living room may be more important for the induction of repeated wheeze in infancy [31]. Research in Ethiopia demonstrated that cockroaches are the potential source of multiresistant strains of bacterial pathogens and they are carriers of *Klebsiella pneumonia* [32]. This might enlighten the enhanced associations of respiratory symptoms with a cockroach infestation.

Under-five children whose parents used new carpets at home were 2.38 times more likely to suffer from respiratory symptoms compared with their counterparts. A possible explanation could be that a new carpet can be a source of chemical emissions. In addition to the carpet, the padding and adhesives all emit volatile organic compounds and some people report symptoms such as upper respiratory irritations, skin rash, shortness of breath, cough, and fatigue, which they associate with the new carpet installation, and the distinct odor of new carpet is usually attributed to the chemicals 4-phenyl cyclohexane (4-PC) [33]. Children living in a damp house were 1.66 more likely to suffer from respiratory symptoms. This study confirms previously-reported associations between a damp stain and current respiratory symptoms in children [34,35]. Damp living conditions have adversely affected children's respiratory health. Since both fungi and household dust mites thrive in humid environments, an allergic reaction to one or both of these allergens is suggested as a significant contributing factor in the development of more respiratory symptoms among children living in humid homes [36]. In households where windows were open at the time of cooking, the risk of experiencing respiratory symptoms among under-five children was 42% times less likely as compared to those households which remained closed during cooking time. Similar findings were reported to support this result [37,38]. Although most households reported opening windows during cooking, this study was conducted during winter and spring seasons. The ventilation level will likely decrease over the summer season as windows are often kept closed to minimize energy loss, which can contribute to higher summer indoor air pollutants than those found in this report [39]. Children living less than 100 m from heavy traffic were 1.94 times more likely to suffer from respiratory symptoms. Moving traffic is highly associated with higher emissions of organic carbon, elemental carbon, carbon monoxide, nitric oxide, hydrocarbons, and soot. This might explain the fact

that emission of high proportions of diesel particles and other primary pollutants may enhance the associations of respiratory symptoms among under-five children living within 100 m of heavy traffic [40-43].

In the current study, children living less than 100 m from unpaved roads/streets were 2.89 times more likely to develop respiratory symptoms when compared with children living more than 100 m. Unpaved roads/streets may increase the particulate matter concentration and airborne dust [44], which in turn are responsible for multiplying effects on respiratory symptoms accounted for children living in the proximity of unpaved roads or streets [45].

Limitations of the study

Even though a large sample size and random sampling tech-

Table 3. **Factors associated with children respiratory symptoms in Gondar city, Northwest Ethiopia, 2019.**

Variables		Respiratory symptom Absent	Present	COR 95% CI	AOR 95% CI
Age of child	12 months	135	69	1	1
	13-24 months	134	79	1.15(0.77 - 1.72)	0.82(0.49 - 1.35)
	25-36 months	101	80	1.55(1.03 - 2.34)*	1.47(0.85 – 2.38)
	37-48 months	98	54	1.07(0.69 - 1.68)	0.84(0.49 – 1.44)
	49-59 months	27	15	1.09(0.54 - 2.17)	1.09(0.48 – 2.49)
Marital status	Married	438	246	1	1
	Unmarried	57	51	1.59(1.06 - 2.39)	1.18(0.72 – 2.49)
Hyperirritability of uterus during pregnancy	No	448	235	1	1
	Yes	36	54	2.86(1.8 - 4.48)	2.20(1.25 – 2.89)*
Regular physical activity during pregnancy	No	194	163	1	1
	Yes	293	129	0.52(0.39 - 0.70)	0.60(0.41 – 0.89)*
Stress perception of mother during pregnancy	No	441	249	1	1
	Yes	42	41	1.73(1.09 - 2.73)	1.14(0.62 – 2.08)
Heredity of a respiratory disease	No	447	247	1	1
	Yes	45	50	2.01(1.30 - 3.09)	1.89(1.11- 3.23)*
Fuel is usually used for heating	None	250	91	1	1
	Wood and coal	238	202	2.33(1.72 - 3.16)*	2.42(1.65 – 3.53)**
	Electricity	7	4	1.57(0.45 -5.48)	1.45(0.31 – 6.70)
History of contact with farm animals while being pregnant with this child	No	473	272	1	1
	Yes	22	25	1.97(1.09 - 3.57)	1.43(0.68 – 3.01)
Cockroach infestation in HH	No	284	129	1	1
	Yes	211	168	1.75(1.31 - 2.34)	1.95(1.36 – 2.90)**
Painting/staining been done in the last 6 months HH	No	440	242	1	1
	Yes	55	55	1.82(1.21- 2.73)	0.52(0.17 – 1.61)
New carpets, drapes or other textiles HH	No	451	231	1	1
	Yes	44	66	2.93(1.934- 4.43)	2.38(1.33 - 4.29)*
Pesticide application at HH	No	416	219	1	1
	Yes	79	78	1.88(1.32 - 2.67)	2.64(1.47 – 4.74)
Damp stains	No	463	266	1	1
	Yes	32	31	1.69(1.006- 2.82)	1.66(1.02 – 2.69)*
Open windows during cooking	No	271	191	1	1
	Yes	143	71	0.70(0.50 - 0.99)	0.58(0.36 - 0 .93)*
Poor outdoor air influence during cooking	No	371	207	1	1
	Yes	50	55	1.97(1.29 - 2.99)	1.23(0.56 – 2.72)
Frequency of trucks passing through the nearby street	Never	274	123	1	1
	Seldom	138	116	1.87(1.35 - 2.59)*	1.25(0.79 – 1.96)
	Frequently	57	36	1.40(0.88 - 2.24)	0.67(0.36 – 1.25)
	Whole day	26	22	1.88(1.02 - 3.46)*	0.79(0.34 – 1.79)
Living less than 100 m from heavy traffic	No	422	208	1	1
	Yes	73	89	2.47 (1.74 - 3.51)	1.94 (1.16 - 3.27)*
Living less than 100 m from unpaved roads/streets	No	424	174	1	1
	Yes	71	123	4.22 (3.00- 5.94)	2.89 (1.89 - 4.55)**
Exposure to animal allergens in early childhood	No	481	273	1	1
	Yes	14	24	3.02(1.54 - 5.94)	2.12(0.54 – 8.40)
Exposure to animal allergens in the present time	No	477	270	1	1
	Yes	18	27	2.65 1(1.43- 4.90)	0.74(0.21 – 2.69)

COR, crude odds ratio; AOR, adjusted odds ratio; HH, household; 1, reference group; *p<0.05, **p<0.001.

nique employed in this study help for greater generalizability, the lack of measurements i.e. pulmonary function test was one of the limitations. Furthermore, recall bias and social desirability biases might be high in such types of self-reported cross-sectional studies.

Conclusions

In this study, the overall prevalence of respiratory symptoms among under-five children was relatively high. Personal and environmental characteristics influencing symptom occurrence were identified. Respiratory symptoms will be minimized by reducing exposure to indoor and outdoor air pollution and enhancing housing characteristics.

Acknowledgments

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Abbreviations

ALRIs: acute lower respiratory infections;
AOR: adjusted odds ratio;
ARI: acute respiratory infections;
COR: crude odds ratio;
HH: household;
OR: odd ratio;
SSA: sub-Saharan African.

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