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Original Research Article

ASSOCIATION OF INDOOR AIR POLLUTION AND OTHER RISK FACTORS WITH ACUTE RESPIRATORY INFECTIONS AMONG CHILDREN IN SHEKA ZONE, SOUTH WEST ETHIOPIA

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Abstract: Acute respiratory infections are one of the major problems of childhood in developing countries. The objective of the study was to obtain the prevalence of ARI and its risk factors among under-five children in Sheka Zone. A community based cross sectional study was conducted from October 15-26, 2016. A child is consider as having experience of ARI if the mother reported that the child had a cough in the last two weeks preceding the survey date along with short and rapid breathing. The weight and length of children were measured in every sampled home visit. Additional questions about socio-demographic status, environmental characteristics, and nutrition practice were asked. Data were entered into the computer and the *Z*-score nutritional variables were calculated by the Epi Info 3.5.4 package program. Further descriptive and inferential analysis carried out using IBM SPSS statistics 20. Binary logistic regression analysis has been used to show the effect of predictor variables on the incidence of acute respiratory infection. From the sampled children, the two weeks prevalence of ARI among under-five children was about 23.8% in Sheka Zone. The factors that influenced the incidence of ARI were lack of mother education, low duration of breast feeding, using unsafe fuel for cooking, absence of enough ventilation, child with mother in cooking, being malnutrition and Had Diarrhea recently. There were no associations between the stove type for cooking and kitchen place with ARI incidence. Our study revealed that Socio-demographic, indoor air pollution, health and nutritional related variables have important effect on incidence of ARI among under-five children in Sheka Zone south west Ethiopia.

Key words: Acute respiratory infection, Cross-Sectional survey, Logistic regression

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Introduction: Childhood is believed to be one of the most interesting, enjoyable and happiest period in one's life. As we all are human beings we cannot escape from diseases. Many kinds of diseases affect a child, starting from the time of birth. Under-five children are prone to get respiratory tract infections [1].

Acute Respiratory Infections (ARIs) are a group of diseases that includes pneumonia, influenza, and respiratory syncytial virus, and result in 4.25 million deaths worldwide every year. Pneumonia is the most serious outcome of ARI in young children which makes the body prevents from getting oxygen and can result in death [2].The early symptoms of ARI usually appear in the nose and upper lungs. Other symptoms include cough, runny nose and sore throat. If the disease advances, there may be high fever and chills and other serious symptoms are difficulty breathing, dizziness, low blood oxygen level and loss of consciousness [1, 2].

The National Health and Medical Research Council defines indoor air pollution as air within a building occupied for at least one hour by people of varying states of health. This can include the office, classroom, hospital and home. Indoor air quality can be defined as the totality of attributes of indoor air that affect a person's health and well-being. A major concern with respect to indoor air quality is the use of gas cookers and unfuled gas heaters. These two sources can often contribute a large percentage of the pollutants found in domestic dwellings [3].

The burning of cooking fuel is not necessarily the only source of indoor air pollution, although it is considered the major source. Other sources include pollutants generated from unclean fuel sources used for indoor space heating and lighting [4]. In Ethiopia more than half of the population in Ethiopia (52.3%) uses kerosene for lighting, while among the rural population nearly two-thirds (64.4%) use it for the same purpose [5].

Acute lower respiratory infection has been identified as the major 'forgotten killer of children' by UNICEF and WHO. Social and environmental factors such as socio demographic status, housing condition, family size, overcrowding and indoor air pollution have been reported to influence the incidence of ARI [6].

Ethiopian children suffer four to eight episodes of ARI on average every year, with the highest occurrence in urban areas in overcrowded living conditions. In rural Ethiopia, 20% of the deaths of children aged under-five years and more than 30% of the infant deaths under one year are due to ARIs. A better knowledge of ARIs will enable us to detect children with an ARI more quickly and give appropriate treatment, or refer them if the disease is severe [7]. A recent study conducted in Ethiopia by Integrated Community Case Management Survey in Amhara, SNNP, and Tigray Regions show that 19% of the children had had ARI in the preceding two weeks. Additionally this study shows that under-five children from SNNP region are more susceptible for ARI with high prevalence 22% as compared to Amhara (19%) and Tigray (17%) regions [8].

ARI cannot be tackled without understanding its causes; there is also inconsistency across studies regarding the determinants factor behind occurrence of ARI in under-five children therefore that is why this study is crucial to assess the prevalence of ARI and identify underling factors of ARI among children in Sheka zone. Therefore, the main aim of this study was to assess association of indoor air pollution and other risk factors with the prevalence of suffering from acute respiratory infection (ARI) morbidity among under-five children in Sheka Zone, South West Ethiopia.

Material and Methods: The study design was community based cross-sectional, which employed an exposure assessment approach, collecting detailed primary data on several child and household-level exposure characteristics through the administration of a questionnaire in 579 households.

The sample size was calculated using a formula for estimation of a single proportion according to the following assumptions: 22%prevalence of under-five children with acute respiratory infection [8], with 95% confidence interval and 5% marginal of error (d). As a multistage sampling technique was employed to identify study subjects, the default value of deff, the sample design effect, should be set at 2.0 unless there is supporting empirical data from previous or related surveys that suggest a different value [9].Also 10% was added for non-responses. Thus, the final sample size was 579.

The study was conducted in the Sheka zone, one of the 13 zones in SNNPR. The capital of the Zone, Masha, is located 951Kms to North West of Awassa, the capital of SNNPR and 676 kms to South west of Addis Ababa. Sheka is bordered on the south by Bench Maji, on the west by the Gambela Region, on the north by the Oromia Region, and on the east by Keffa. Administratively, the Zone is structured into three weredas and two town administrations those comprised of 10 urban and 57 rural kebeles. The source populations were all mothers or caretakers in each household with children under-five years and lived in the study area for at least six months earlier to data collection.

In our study stratification method were applied, *urban* as stratum one and *rural* as stratum two. One rule for stratification is that each stratum created should, ideally, be as different as possible. Urban and rural populations are different from each other in many ways (type of employment, source and amount of income, average household size, fertility rates, etc.) while being similar within their respective sub-groups. Therefore, by using simple random sampling method Anderacha and Yeki has been selected from the list of clusters in rural area and Masha city administration is selected from urban study area. From 16 rural Kebles of Anderacha woreda Shebena and Gemadero, from 22 rural kebeles of Yeki woreda Kura and Dapi; and from 3 urban kebeles of Masha town kebeles 02 are selected using lottery methods for complete enumeration.

A method of selecting one household to be the starting point and a procedure for selecting succeeding households after that was applied. One possibility is to choose some central point in a town, such as the market or the central square; choose a random direction from that point (e.g., by throwing a pencil in the air and seeing which way it lands); count the number of households between the central point and the edge of town in that direction; select one of these houses at random to be the starting point of the survey. The remaining households in the sample were selected to give a wide-spread coverage of the enumeration area.

The data has been collected using structured questionnaire by administering face to face interviewing of mothers/caretakers who has under-five children. In addition to English, the questionnaires were being translated into two major languages; Amharigna and Shekigna. Height and weight measurements were carried out on children under age five in all selected households. Weight measurements has been obtained using lightweight, designed and manufactured under the guidance of UNICEF. Height measurements were carried out using a measuring board. Children younger than 24 months were measured for height while lying down (recumbent), and older children, while standing.

Data were collected during November 15-26, 2015. Fifteen data collectors, who were native speakers and had similar experience were employed and trained by the principal investigator and a Pediatrician for six days extensively in interviewing techniques, data recording, and child health screening. Before the start of fieldwork, the questionnaires were pretested in all two major languages to make sure that the questions were clear and could be understood by the respondents.

After obtaining informed consent from the head of the household and the caretaker, interview was made to the child's primary caretaker. For each child under age five, the caretaker was asked if the child had been ill with a cough in the two weeks preceding the survey interview. For children who had been ill with cough, the caretaker was additionally asked if the child, when ill with cough, breathe faster than usual with short and rapid breath. The research defined ARI in children according to the WHO clinical case definition [10].

Fig. 1. Height and weight measurement at Masha town, Kebele 02

Dependent variables: In this study, the dependent variable was a dichotomy variable that child suffered from ARI, coded as 1 if the child suffered from ARI in the preceding two weeks prior to the survey date and 0 if otherwise. Thus the response variable for our study is described as

$$= \begin{cases} 1 & \text{if a child is suffered from ARI} \\ 0 & \text{if a child is not suffered from ARI} \end{cases}$$

Independent variables

Three major categories of factors were assessed as independent variables;

i. Socio-demographic Characteristics; mother's education, employment status and age of the mother; sex, age, birth order of the child and number of under-five children.

ii. Health and nutritional related characteristics; had diarrhea recently, wasting, stunting, underweight, and duration of breast feeding are an important health and nutritional characteristics.

iii. Environmental and behavioral measures of household; Fuel type, stove type, enough ventilation and place of residence. In addition, behavioral measures like whether child is carried by the mother/caretaker while she is cooking near fire, child stays in smoke, location of the child relative to cooking place, cooking place in same room as where children sleeping was included

Binary Logistic Regression

Regression methods are essential to any data analysis which attempts to describe the relationship between a response variable and any number of predictor variables. Thus logistic regression is used in a wide range of applications leading to binary dependent data analysis [11]. The estimated coefficients tell us the increased or decreased chance of a child having ARI given a set of level of the determinant factors while controlling for the effects of other variables in the model.

The logistic regression model for explaining data is given by,

$$P_i = P(y_i = 1|x_i) = \frac{e^{x_i\beta}}{1+e^{x_i\beta}} = \frac{\exp(\beta_0+\beta_1x_{11}+\beta_2x_{12}+\cdots+\beta_px_{1p})}{1+\exp(\beta_0+\beta_1x_{11}+\beta_2x_{12}+\cdots+\beta_px_{1p})}, i = 1, 2, \ldots, n \qquad [3.3]$$

Where, $P(y_i = 1|x_i)$ is the probability of i^{th} child having ARIs given child's characteristics x_i, and $\beta \epsilon R^p, \beta = (\beta_0, \beta_1, \ldots, \beta_p)^T$ is a vector of unknown logistic regression coefficients with dimension of $(p+1)x1$.

Data analysis: First the questionnaire responses were entered into EPI6 software and the Z-score nutritional variables were calculated by the EPi-Nut program) to convert nutritional data into Z – scores of the indices; H/A, W/H and W/A taking age and sex into consideration using NCHS reference population standard of WHO then data exported to SPSS program for further descriptive and inferential analysis.

Results and Discussion: The response rate for the sampled households was 96.7% (560). From the sampled children, the two weeks prevalence of ARI among under-five children was about 23.8% in Sheka Zone, South west Ethiopia.

From 560 sampled children around 53.9% and 46.1% were female and male, respectively. About 17.5% of under-five children were born to mothers who were resided in urban area and had higher prevalence of ARI (25.5%) as compared to under-five children who were born to mothers who lived in rural area (23.4%). Indeed the highest proportion of the children with ARI was observed for children whose mothers have no education (29.9%) as opposed to the lowest prevalence of the ARI among under-five children which was recorded for children whose mothers have higher educational level (7.9%). Among Health, Environmental and Nutritional related factors Fuel used for cooing, Duration of breast feeding, enough ventilation, Child status when mother cooking, Household source of light, Kitchen place, Underweight, Wasting, Stunting and had diarrhea recently were found to have significant association with two weeks incidence of ARI at the 5% significance level.

Table 1. Distribution of Health, Environmental and Nutritional related Factors Analyzed with Incidence of ARI among under-five children in Sheka Zone, south west Ethiopia

Variables Categories	N	Child's ARI Status		D.F	Chi-Square	P-value
		No	Yes			
Sex of the child						
Female	302 (53.9%)	74.5%	25.5%	1	1.104	.320
Male	258(46.1%)	78.3%	21.7%			
Place of residence						
Rural	462(82.5%)	76.6%	23.4%	1	0.203	.695
Urban	98(17.5%)	74.5%	25.5%			
Maternal education						
No education	284 (50.7%)	70.1%	29.9%	2	15.722	.000*
Primary	213(38.0%)	87.8%	20.7%			
Secondary and above	63(11.2%)	90.6%	7.9%			
Stove type for cooking						
Traditional	497(88.8%)	76.7	23.3	2	2.921	.232
Developed	52(9.3%)	76.9	23.1			
Smokeless	11(2.0%)	54.5	45.5			
Kitchen place						
With bed room	292(52.1%)	67.5	32.5	1	25.99	.000*
Separate kitchen	268(47.9%)	85.8	14.2			
Enough ventilation						
No	290(51.8%)	66.2	33.8	1	33.5	.000*
Yes	270(48.2%)	87.0	13.0			
Child status when mother cooking						
No	74(13.20%)	98.6	1.4	1	23.62	.000*
Yes	486(68.8%)	72.8	27.2			
Fuel used for cooking						
Charcoal/wood	484(84.4%)	81.4%	29.4%	2	54.71	.000*
Electricity	17(3.0%)	70.6%	18.5%			
Other	59(10.5%)	52.5%	47.5%			
Duration of breast feeding						
Never breast feeding	5(0.9%)	20.0%	80.0%	2	12.95	0.00*
Ever feeding, not currently	328(58.6)	73.5%	26.5%			
Still breast feeding	227 (40.5%)	81.1%	18.9%			

Wasting						
No Yes	494(88.2%) 66(11.8%)	79.6% 51.2%	20.4% 48.5%	1	25.28	.000*
Stunting						
No Yes	358(63.9%) 202(36.1%)	88.8% 65.3%	17.6% 34.7%	1	20.74	.000*
Under weight						
No Yes	349(62.3%) 211(37.7%)	85.1% 61.6%	14.9% 38.4%	1	40.06	.000*
Had Diarrhea						
No Yes	436(77.9%) 124(22.1%)	80.5% 61.3%	19.5% 38.7%	1	30.025	.000*

*Significant at 5%

Multiple Binary Logistic Regression Analysis: Multiple logistic regressions were fitted based on the chi-square test result of bi-variable analysis. Based on results displayed in Table 1 those predictor variables that are associated with ARI status at 5% level significance were selected for multiple logistic regression analysis. Accordingly Child age in month, Mother education level, Duration of breast feeding, Source of fuel for cooking, Ventilation, Child with mother in cooking, Wasting, Underweight and Had Diarrhea recently was found to be significant predictors for ARI among under-five children (Table 2).

Table 2 also show that, the log of the odds of child being suffered in ARI was negatively related to current age of the child. Indicating that the older the child less likely having ARI.

The logistic model showed that the likelihood of having ARI was significantly associated with several indoor air pollution factors like source of fuel for cooking, ventilation and child with mother in cooking. Under-five child from household use unsafe fuel as a fuel for cooking is 7.5 times more likely have ARI than child from household use safe fuel for cooking.

From health and nutritional related factors of a child underweight, wasting and recently Diarrhea had significantly associated with ARI status of under-five children (P<0.001). Under-five children who were wasting were 46% more likely to experience ARI than who were not wasted. Under-five children who were underweight was 3 times more likely have ARI than who were not underweight. Indeed Under-five child who had Diarrhea recently were 3.22 times more likely have ARI than who had not Diarrhea recently.

Table 2. Maximum likelihood Estimation of multiple binary logistic regression of predicting incidence of ARI among under-five children, Sheka zone, South West Ethiopia, Oct/Nov 2015

Variable (level)	B	S.E.	Wald	Df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Child age in month								
<6(ref)								
6-11	-1.341	.781	2.950	1	.086	.262	.057	1.208
12-23	-.402	.644	.389	1	.533	.669	.189	2.365
24-35	-2.556	.671	14.513	1	.000*	.078	.021	.289
36-47	-2.330	.672	12.014	1	.001*	.097	.026	.363
48-59	-2.965	.754	15.473	1	.000*	.052	.012	.226
Mother education level								

No education (ref)								
Primary	-.474	.292	2.638	1	.104	.623	.351	1.103
Secondary	-1.565	.626	6.237	1	.013*	.209	.061	.714
Duration of breast feeding								
Never feeding								
Ever feeding	-2.370	1.699	1.945	1	.163	.093	.003	2.613
Still feeding	-3.753	1.731	4.701	1	.030*	.023	.001	.697
Source of fuel for cooking								
Wood/charcoal (ref)								
Electricity	-2.011	.781	6.632	1	.010*	.134	.029	.618
Others	-1.305	.794	2.700	1	.100	.271	.057	1.286
Ventilation								
No (ref)								
Yes	-1.638	.548	8.944	1	.003*	.194	.066	569
child with mother in cooking								
No (ref)								
Yes	4.064	1.054	14.868	1	.000*	58.2	7.378	459.66
Wasting								
No (ref)								
Yes	.794	.377	4.430	1	.035*	1.46	.056	4.630
Stunting								
No (ref)								
Yes	.730	.305	5.731	1	.117	.074	1.141	3.769
Underweight								
No (ref)								
Yes	1.101	.293	14.111	1		3.00	1.693	5.343
Had Diarrhea recently								
No (ref)								
Yes	1.171	.310	14.288	1	.000*	3.22	1.757	5.916
Constant	-0.497	0.172	8.475	1	.002*	2.43		

*Significant at 5%

Discussion of the result: ARI prevalence of the study area (23.8%) was found consistent with the finding reported in the ICCMS prevalence of ARI among three regions Ethiopia (Amhara (19%), Tigray (17%) and SNNP (22%) [8].

The analysis also showed that under-five children whose mothers had no educational experience are 4.8 times more likely have ARI than child whose mother had secondary and above educational experience. This present findings is in agreement with a study done in Bangladesh showed that a child born to mothers with no or more primary education had significantly 20% higher odds of suffering from ARI compared to children born to mothers with secondary or higher education [12,13].

The model revealed that likelihood of having ARI among Under-five child from household use unsafe fuel for cooking is 7.5 times more likely have ARI than child from household use safe fuel for cooking. This present finding is supported by study done in India [14]. This may due to households use unclean fuels like wood/charcoal which release smoke containing harmful particles that adversely affect the functioning of lungs [15].

Similarly child from household have home with enough ventilation is 80.6% less likely suffer in ARI as compared to those children from household does not have enough ventilation. The analysis also shows that child status when mother is cooking have a significant association with two weeks incidence of ARI. This result is agree with study done in slum urban of Addis Ababa show that mother's behavior towards cooking places in a relation to the child's location, ventilation and type of fuel used for cooking was associated with ARI. The presence of ventilation made a difference in the odds of ARI [16].

The findings of this study also show that under-five child who had Diarrhea recently were 3.22 times more likely have ARI than under-five child who had not Diarrhea recently. This result is supported by a study done in Indian and Nepali children [17]. This might be Diarrhea morbidity lower the Child immunity and status of under-five children.

Indeed the data in this study show that under-five children who were wasting were 61.5% more likely to experience ARI than under -five children who were not wasted. This finding is in line with study done in Tanzania [18].This may due to wasting in turn impairs the function of immune system and can lead to increase the severity, duration of and susceptibility to acute respiratory infection.

Conclusion: This study revealed that Socio-demographic, environmental, health and nutritional related variables have important effect on incidence of ARI among under-five children in Sheka zone south west Ethiopia. The factors that influenced the incidence of ARI were lack of mother education, low duration of breast feeding, using unsafe fuel for cooking, absence of enough ventilation, child with mother in cooking, being malnutrition and Had Diarrhea recently. There were no associations between the stove type for cooking and kitchen place with ARI incidence.

Accordingly there is an evident need to reduce indoor air pollution and nutritional related risks like household source of fuel for cooking, enough ventilation and childhood malnutrition, as well as socio-demographic risks like maternal education, in order to reduce both the number and severity of cases of acute respiratory illnesses. The current study thus helps provide a better understanding of the events linked to these diseases at the local level and the basis for establishing specific programs for their control.

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