Severe pneumonia and risk factors among hospitalized children under five in Adama, Ethiopia

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Abstract

Background

Ethiopia stands fifth in pneumonia death rate among children under five worldwide but the severity and determinants of the disease are inconsistently reported, hindering policy and practice. This study aimed to assess the magnitude and determinants of severe pneumonia among hospitalized children under five in Adama town, Ethiopia.

Method

A facility-based cross-sectional study was conducted among under five children admitted at Adama Hospital and Medical College (AHMC), Adama Town, East Shoa Zone of Oromia in Ethiopia. Using adapted, structured questionnaire and systematic random sampling, the patients' parents or caregivers were interviewed to determine the magnitude of the disease and underlying determinants including sociodemographic, environmental, comorbidity, nutrition, and immunization characteristics. The bivariate logistic regression model was used to test the association between variables on SPSS version 21.

Result

The study enrolled 465 hospitalized children under five, with a mean (standard deviation) age of 22.4 (15.5) months, 236 (50.8%) males, and 285 (61.3%) living in urban areas. The magnitude of severe pneumonia among the children was 41.9%. Factors significantly associated with severity of the pneumonia episode were: persistent diarrhea lasting two or more weeks [adjusted odds ratio (AOR) 4.31, 95% CI 2.14–8.66], non-exclusive breastfeeding [AOR 3.23, 95% CI 1.23–8.49], undernutrition [AOR 1.73, 95% CI 1.04–2.90], and smoking of a family member [AOR 8.33, 95% CI 4.10–17.00].

Conclusion

Severe pneumonia among hospitalized children under five was higher in Adama town, and more common among those with persistent diarrhea, non-inclusive breastfeeding, undernutrition, and living closely with smokers that require a coordinated intervention.

Introduction

The term pneumonia describes inflammation of parenchymal structures of the lung, such as the alveoli and the bronchioles. Although most cases of pneumonia are caused by microorganisms (ranging from viruses to bacteria and fungi), noninfectious causes include aspiration (of food or gastric acid, foreign bodies, hydrocarbons, and lipoid substances), hypersensitivity reactions, and drug- or radiation-induced

pneumonitis (1). The cause of pneumonia in an individual patient is often difficult to determine because the direct culture of lung tissue is invasive and rarely performed (2).

The etiologic agents of pneumonia depend on the patient's age. In neonates (0–3 months of age), maternal flora, such as group B streptococcus and gram-negative bacteria, are common causes that are vertically transmitted (3). With the use of molecular diagnostic testing, a bacterial or viral cause of pneumonia can be identified in 40–80% of children with community-acquired pneumonia.

Fever and cough are the hallmarks of pneumonia (4). Other findings, such as tachypnea, increased work of breathing (e.g., nasal flaring in infants), and hypoxia, may precede the cough. The WHO uses tachypnea and retractions to effectively diagnose pneumonia in children younger than 5 years but, tachypnea becomes less sensitive and specific as age increases (in children > 5 years) (4). Most of the clinical signs and symptoms have low sensitivity and specificity except for cough, crackles (rales), retractions, rhonchi, and nasal flaring (in young infants), which are highly specific but not sensitive, meaning that their absence might help rule out the disease (5).

Timely diagnosis of pneumonia is an essential step in the prevention process of the disease. X-ray and laboratory identification of the causative agent is the confirmatory tools to certainly establish the diagnosis of pneumonia. However, these are largely unaffordable in resource-poor settings like Ethiopia. The recommended approach to settle the diagnosis of suspected pneumonia in such regions is, therefore, to rely on the clinical presentation of the disease like cough and fast breathing and/or difficulty of breathing in children older than three months and yet less than 60 months of age (6).

Evidence showed that different factors were associated with the occurrence of pneumonia. Factors could be child, maternal, environmental, access to health care, overcrowding, indoor air pollution, charcoal use for cooking, carrying the child on the back during cooking, cooking within the main house, comorbid diseases such as HIV/AIDS, malaria, exclusive breastfeeding, duration of breastfeeding as well as nutritional status of the child (7–9).

The African region has the highest burden of global child mortality, with 50% of the world's death from pneumonia in this age group. Between 2000 and 2015, global hospital admissions for child pneumonia increased by 2.9 times with a more rapid increase observed in the WHO South-East Asia Region than in the African Region (10). More than 50% of all new pneumonia cases of under-five children are concentrated in the poorest world regions, Sub-Saharan Africa and South Asia (11, 12). In 2015, 49% of global pneumonia deaths occurred in India, Nigeria, Pakistan, the Democratic Republic of the Congo, and Ethiopia collectively (13). It is most prevalent (20%) in sub-Saharan Africa and South Asia, of which Ethiopia is included in countries that accounted for 50% of total deaths (14).

The incidence of pneumonia in children under the age of five years is 0.29 episodes per child year, which equates to 151.8 million cases annually in developing countries, and a further four million cases occur in developed countries. Ethiopia is the fifth (62 deaths in 1000) among 15 countries having the highest death rate of under five years clinical pneumonia in the world (15).

Even though interventions were done in Ethiopia such as vaccination, case management of pneumonia in the community and health facilities, exclusive breastfeeding for the first six months of life, improvement of nutrition and prevention of low birth weight, control of indoor air pollution, and provision of a healthy environment, prevention, and management of HIV infection (14), there is no sufficient evidence about the magnitude of severe pneumonia and the associated risk factors after the above intervention. This study will provide valuable information about the magnitude of severe pneumonia and factors associated with pneumonia among children.

Material And Methods

Study Design and Area

A facility-based cross-sectional study was conducted among under five children admitted at AHMC, Adama Town, East Shoa Zone of Oromia in Ethiopia located about 99 km to the southeast of Addis Ababa. AHMC is the only governmental hospital in Adama town. The hospital is giving service to a catchment population of more than 6 million; from five regions (Oromia, Amhara, Afar, Somali, and Dire-Dawa). AHMC Pediatric department has 51 staff of different professional categories and has a total of 20 beds in pediatric emergency and 42 beds in the ward (16).

Sample size and Sampling procedure

The sample size was calculated by using single population proportion formula at 95% confidence interval with 3% margin of error and prevalence of under-five pneumonia 16.1% from a study conducted in Northwest Ethiopia (6) with final sample size was 465.

$n_1 = (Z\alpha_{/2})^2 * p(q)/ d^2 = 1.96^{2*} 0.16(0.84)/0.03^2 = 577$

Where, n = the minimum sample size, Z = the desired level of confidence interval 95% (1.96). Since the sample was going to be taken from a relatively small population of < 10 000 (total of 2445 cases of under-five admission), then the final sample size was adjusted as below.

Final sample $(n_2) = n_1/1 + n_1/N = 577/1 + 577/2445 = 465$

Participants were selected by systematic random sampling technique. Systematic random sampling was used to select patients using K random numbers of N/n every 2 of medical records. In 2019 there were total of 2445 cases of under-five admission. N is 2445 and final sample size is 467. Then, the K interval will be: $K = N/n_2 = 2445 / 467 = 5$.

Data collection and statistical analysis

Data were collected by three trained degree female nurses working at emergency service area and ward using structured and pre tested questionnaire adapted and modified from similar study. The

questionnaire included different factors like socio demographic, environmental, comorbidity and environmental factors.

The data were checked for completeness, coded and entered into EPI-info and exported to SPSS version 21(17) for analysis. Summary statistics such as percentage was computed and odds ratio calculated with 95% confidence interval. The bivariate logistic regression model was used to test the association between variables. Those variables with statistically significant association at P value of < 0.05 were expressed as potential risk factor for severe pneumonia.

Operational Definition

Crowdedness: The number of persons in the household divided by the rooms in the dwelling exceeded the accepted standards which are as follows: 1 room – 2 persons; 2 rooms – 3 persons; 3 rooms – 5 persons; 4 rooms – 7 persons; 5 or more – 10 persons (additional 2 for each further room) (18).

Diarrhea

characterized by three or more loose or liquid stools per day due to abnormally high fluid content of stool or an abnormal increase in daily stool fluidity, frequency, and volume from what is considered normal for an individual (19).

Undernutrition

Defined as the presence of oedema of both feet or severe wasting (weight-for-height/length <-3SD or mid-upper arm circumference < 115 mm or <-3SD weight-for-age) (20).

Constantly smoking family member

a family member who has smoked more than 100 cigarettes (including hand rolled cigarettes, cigars, cigarillos etc) in their lifetime and has smoked in the last 28 days (21).

Severe Pneumonia

defined as a history of cough or difficult breathing and lower chest wall in-drawing or age-specific fast breathing (≥ 50 and ≥ 40 breaths/minute for 2–11 month-olds and 12–59 month-olds respectively) without any general danger signs (6).

Result

Socio-demographic characteristics of study participants

Total of 465 participants were included with the mean (± standard deviation) age of 22.4(± 15.5) months. Majority of the children were from urban 285(61.3%). About 236 (50.8%) children were males and 229

(49.2%) were females. About 30.7% of children in this study were in the age group of 2–11 months (Table 1).

Table 1
Sociodemographic characteristics of children admitted to AHMC (n = 465)

Variable	Category	Frequency	Percent
Age	Mean (sd)	22.40 (15.52)	
Residence	Urban	285	61.3
	Rural	180	38.7
	Total	465	100.0
Age of the child in months	3-11months	143	30.8
	12-23months	133	28.6
	24-34months	77	16.6
	35–60 months	112	24.1
	Total	465	100.0
Sex of the child	Male	236	50.8
	Female	229	49.2
	Total	465	100.0
Total family size	Three	9	1.9
	Four	59	12.7
	Five	305	65.6
	Greater than five	92	19.8
	Total	465	100.0
HIV Serostatus of the child	Negative	458	98.5
	Positive	7	1.5
	Total	465	100.0

Environmental characteristics of participants

Majority of the study participants cook food in the kitchen 321(69%). Among those who had a kitchen, 99% had kitchen separated from the main house. Majority of the children 328(70.5%) stays outside the cooking room during cooking. In almost all case there was no cattle in the main house. More than two three fourth397(85.4%) of case had a family size of five and above whereas 68(14.6%) had a family size of less than five (Table 2).

Table 2
Environmental characteristics of study participants (n = 465)

Variables	Category	Frequency	Percent
Place of cooking	In the main house	149	32.0
	In the kitchen	316	68.0
	Total	465	100.0
The kitchen is separated	Yes	316	68.0
	No	10	2.2
	Total	326	70.1
The kitchen has window	Yes	306	65.8
	No	19	4.1
	Total	325	69.9
Type of fuel used	Wood	332	71.4
	Electricity	133	28.6
	Total	465	100.0
Location of child during cooking	With the mother	167	35.9
	Outside	298	64.1
	Total	465	100.0
Constantly smoking family member	Yes	67	14.4
	No	398	85.6
	Total	465	100.0
Number of rooms	One	127	27.3%
	Two	306	65.8%
	Three	31	6.7%
	>Four	1	.2%
	Total	465	100.0
Cattle available in the main house	Yes	11	2.4
	No	454	97.6
	Total	465	100.0

Nutrition, Immunization and Past comorbid characteristics of participants

Most of the children 334 (71.8%) were breastfed exclusively while 131(28.2%) were partially breastfed during the first six months. Nearly half 230 (49.5%) of children breastfed for 6–12 month and about one fourth of the children were breastfed for 6–12 months. Almost all of the children 449 (96.6%) were vaccinated. Among those who were vaccinated,316 (67.9%) were completely immunized whereas 149 (32.1%) were partially immunized for their age. About 396(85.2%) children were wellnutrioned, whereas about 69(14.8%) were malnutrioned. Nearly all children were seronegative for RVI (98.5%) and 7 (1.5%) cases seropositive for RVI. About 65(14%) children were known cardiac (CHD). Almost all children 433(93.1%) had history of sun light exposure, out of which 256(59.7%) were exposed by applying ointment and 178(38.3%) without applying ointment. History of diarrhea in the last two weeks was present in 78(16,8%) cases. Nearly half of children had history of URTI235(50.5%) (Table 3).

Table 3
Nutrition, immunization status, comorbid and clinical features

Variable	Category	Frequency	Percentage
Nutritional status of the child	Wellnutrioned	396	85.2
	Malnutrioned	69	14.8
	Total	465	100.0
The child is vaccinated	Yes	449	96.6
	No	16	3.4
	Total	465	100.0
Immunization status	Fully vaccinated	300	64.5
	Partially vaccinated	149	32.0
	Total	449	96.6
Breast feeding status	Exclusive for six months	334	71.8
	Partial breast feeding	131	28.2
	Total	465	100.0
Duration of breast feeding	> 12 months	134	28.8
	6-12months	230	49.5
	< 6 months	101	21.7
	Total	465	100.0
Diarrhea in the last 2 weeks	No	78	16.8
	Yes	387	83.2
	Total	465	100.0
Had history of sun light exposure	Yes	433	93.1
	No	32	6.9
	Total	465	100.0
History of nasal discharge	Yes	235	50.5
	No	230	49.5
	Total	465	100.0
History of ear discharge in the last 2 weeks	yes	22	4.7
	no	443	95.3

Variable	Category	Frequency	Percentage
	Total	465	100.0
Presented with cough	Yes	271	58.3
	No	194	41.7
	Total	465	100.0
Duration of cough	< 2weeks	210	45.2
	> 2weeks	61	13.1
	Total	271	58.3
Presented with fever	Yes	339	72.9
	No	126	27.1
	Total	465	100.0
Duration of fever	< 2weeks	287	61.7
	> 2weeks	54	11.6
	Total	341	73.3
Presented with grunting	Yes	224	48.2
	No	241	51.8
	Total	465	100.0
Presented with fast breathing	Yes	227	48.8
	No	238	51.2
	Total	465	100.0
Cyanosis detected	Yes	16	3.4
	No	449	96.6
	Total	465	100.0
Head nodding	Yes	122	26.2
	No	343	73.8
	Total	465	100.0
Subcostal and intercostal muscle retraction	Yes	213	45.8
	No	252	54.2
	Total	465	100.0

Variable	Category	Frequency	Percentage
Chest indrawing	Yes	210	45.2
	No	255	54.8
	Total	465	100.0
Lung crepitation	Yes	286	61.5
	No	179	38.5
	Total	465	100.0

Magnitude of under-five severe pneumonia

The magnitude of severe pneumonia among under five children admitted to AHMC in 2019 was 41.9% (195 cases of total 465 admission). Among children from urban the magnitude was 41.4% and rural 42.8%. Severe pneumonia was most common (62.2%) among 3-11month aged children whereas it was less common (16.9%) among children aged 24–34 months (Table 4).

Table 4
Magnitude of severe pneumonia among different Variables

Variables	Severe pneumonia		
	Yes (n)	No (n)	Total
Age category			
3-11months	89	54	143
12-23months	56	77	133
24-34months	13	64	77
35–60 months	47	75	122
Total	195	269	464
Residence			
Urban	118	167	285
Rural	77	102	179
Total	195	269	464
Gender			
Male	90	146	236
Female	105	123	228
Total	195	269	464

Factors associated with severe pneumonia in under five children

In bivariate logistic regression analysis independent variables such as constantly smoking family member, age of the child, total family size, nutritional status of the child, duration and status of breast feeding and diarrhea in the last two weeks were significantly associated with severe pneumonia at p-value < 0.05. In multivariable logistic regression analysis, all variables with p-value < 0.05 where simultaneously included in the final model to control for possible cofounders. Children with family member who constantly smoke have 7.5 odds of developing severe pneumonia than others (AOR 7.52; 95%CI (3.70, 15.40); p-value < 001). Odds of developing pneumonia were about three times higher (AOR = 3.63; 95% CI (1.93, 6.83) among children who had diarrhea in the last two weeks. Odds of developing pneumonia were about six times higher (AOR = 5.92; 95% CI (1.08, 32.35) among who live in family size of greater than five (Table 5).

Table 5
Factors associated with severe pneumonia among children

Variables		Pneumonia		COR (95%CI)	AOR (95% CI)
		Yes	No		
Residence	Urban	77(42.8%)	102(58.6%)	.94 (.64, 1.37)	0.79 (.48, 1.30)
	Rural	118(41.4%)	167(58.6%)		
Place of cooking	In the main house	78(54.1%)	71 (45.9%)	1.9 (1.25, 2.76)	1.57 (.77, 3.23)
	In the kitchen	117(36.6%)	198 (63.4%)		
Age category	3-11months	89(62.2%)	54(37.8%)	0.30 (0.18, 0.5)	0.37 (.20, .67)
	12-23months	56(42.1%)	77(57.9%	0.69 (0.41, 1.2)	0.61 (.32, 1.12)
	24-34months	13(16.9%)	64(83.1%)	2.46 (1.20, 5)	1.79 (.80, 4.01)
	35–60 months	47(33.1%)	75(66.9%)		
Location of child during cooking	With the mother	84 (50.3%)	83 (49.7%)	1.70(1.16, 2.49)	1.12 (.54, 2.26)
	Outside	111(37.4%)	186(62.6%)		
Breast feeding status	Partially	118(35.3%)	216 (64.7%)	2.60(1.72, 3.91)	3.23 (1.23, 8.5)
	Exclusive for six months	77 (58.8%)	54 (41.2%)		
Nutritional status	Wellnutrioned	37(53.6%)	32(46.4%)	.58 (.35, .96)	0.31 (.16, .60)
	Malnutrioned	158(40%)	238(60%)		
Diarrhea in the last 2 weeks	No	175(45%)	212(55%)	2.35(1.36, 4.10)	4.0(1.98, 8.13)
	Yes	20 (10.2%)	57 (89.8%)		
Smoker family member	Yes	50(74.6%)	17(26.4%)	5.11(2.84, 9.19)	8.13(3.93,16.8)
	No	145(36%)	152(64%)		

COR: cumulative odd ratio; AOR: adjusted odd ratio; CI: confidence interval

Child Vaccinated	No	185(41.3%)	263(58.7%)	2.40 (.85, 6.63)	2.10 (.61, 7.02)
	Yes	10(62.5%)	6(37.5%)		

COR: cumulative odd ratio; AOR: adjusted odd ratio; CI: confidence interval

Discussion

Overall, the magnitude of severe pneumonia among under-five children admitted to AHMC in the year 2019 revealed by this study is 41.9%. This current finding is higher than the prevalence reported in Munessa district, Arsi zone, Ethiopia (17.7%) (22), systematic review and meta-analysis in Ethiopia 20.68% (I2 97.9%; P ≤ 0.001) (7), Gondar City, Northwest Ethiopia 12% (23), systematic review and meta-analysis in Africa 34% (24), and Sidama zone, Ethiopia (33.3%) (25). The difference seen in the prevalence of pneumonia might be due to different factors including the assessment method used, the type of study design used, and possibly the combination of risk factors. But our study's result is similar to a multicentre cross-sectional study conducted at Mekelle zone, Tigray, Ethiopia (43.7%) (26) and North Shoa, Ethiopia (39.6%) (27).

Several risk factors for pneumonia under-five children were identified by this study, including diarrhea in the last two weeks, constant family member smoking, breastfeeding status, nutritional status of the child, and total family size.

This study evaluated having diarrhea in the last two weeks had four times higher adjusted odds ratio of developing pneumonia than the other group (AOR = 4.31; 95% CI (2.14, 8.66). This finding is statistically significant with p value < 001. This finding is similar to the Unmatched Case-Control Study done in Gondar, Ethiopia (AOR = 6.183; 95% CI: 3.482, 10.977) (28) and Amhara region, Ethiopia (AOR = 3.06, 95%CI: 1.54, 6.11) (29).

The undernourished child has a statistically significant association with pneumonia development among under-five children in our study. It increased two times odds of developing pneumonia than well-nourished children (OR = 1.73; 95% CI (1.04, 2.90; p-value < 001). The study done in Jimma, southwest, Ethiopia (30) showed that moderate acute malnutrition (AOR = 4; 95% CI (2, 10); p-value = 0.002,), Addis Ababa, Ethiopia (31) weight-for-age z-score (WAZ) <−2 SDs (AOR = 2.2; 95% CI: 1.1, 4.8), and in kersa, Ethiopia (32) wasting (AOR = 2.0; 95% CI: 1.2, 3.5) reported as risk factors similar to our study.

This study also showed that children that live with constantly smoking family members were about eight times higher to develop severe pneumonia as compared to another group of children (AOR = 8.33; 95% CI (4.10, 17.00); p-value < 001). This result is similar to a meta-analysis of nine case-control studies that showed that exposure to secondhand smoke increased the risk of pneumonia in children under five years (AOR = 2.15; 95% CI: 1.25, 3.68; p-value = 0.005) (33), and indoor smoke exposure (OR = 2.57; 95% CI = 1.54, 3.60; p-value < 0.001) (34).

According to this study odds of developing severe pneumonia was 3.2 times higher among children who partially breastfeed for less than six months (AOR = 3.23; 95% CI (1.23, 8.49); p-value 0.02). This result is comparable to a study done in the Kersa district which showed children who were not on Exclusive breastfeeding for the first six months of life had 3.3 odds of developing pneumonia (29) and in Brazil (35)

This study showed that place of cooking was associated with a risk of developing severe pneumonia, children living in a house who cooked in the main house had an odd of 1.6 times higher to develop severe pneumonia compared to those who cooked in the kitchen. But this result is not statistically significant. Similar results were found in a study conducted in northwest Ethiopia which showed child carried on their mother's back had odds of five times to develop pneumonia (36) and in in Nepal showed that there was association between location of child while cooking and risk of developing pneumonia(37). The possible explanation for this could be when cooking takes place in the living room, the risk of indoor air pollution is high which in turn increases the vulnerability of children to acquire acute respiratory infections including pneumonia.

This study showed that female children had no difference to develop severe pneumonia compared to male children. However, the result of a study done in Brazil showed that the male sex was less likely to experience pneumonia as compared to the female children (35).

Children who were not fully vaccinated are 2.1 times (AOR 2.10; 95%CI (.61, 7.02) more likely to develop pneumonia compared to those who were fully vaccinated according to this study. A study conducted in India also showed children who were not fully immunized had odds of 2.6 times experiencing pneumonia compared to their counterparts (38).

Conclusion

This study showed that the magnitude of severe pneumonia was high at AHMC. The nutritional status of the child, constantly smoking family members, family size greater than five, and diarrhea in the last two weeks were significantly associated with severe pneumonia. Thus, we recommend improving the nutritional status of the child, and early treatment of diarrheal disease is needed to reduce severe pneumonia. And also, health education and promotion of smoking behavior at the community level.

List Of Abbreviations

ALRI: Acute Lower Respiratory Infection; AHMC: Adama Hospital Medical College; AOR:Adjusted Odds Ratio; ARI:Acute Respiratory Infection; AURI: Acute Upper Respiratory Infection; CHERG:Child Health Emergency Reference Group; CI:Confidence Interval; CSA :Central Statistics Agency; FMOH-E :Federal Minister of Health-Ethiopia; HIV:Human Immunodeficiency Virus; IHRERC:Institutional Health Research Ethics Review Committee; IMNCI:Integrated Management of Neonatal and Childhood Illness; OPD:Out

Patient Department SPSS: Statistical Package for Social Science; UNICEF:United Nations International Children's Emergency Fund; WHO: World Health Organization

Declarations

Ethics approval and consent to participate

Ethical clearance was taken from Adama Hospital medical college Institutional review board (AHMC IRB). The verbal informed consent was obtained from the patient's parent or care-giver. All necessary information were given regarding the objectives of the study to the patient's parent or care-giver and they had the right either to decline or participate in this study. The participants' privacy was confidential and anonymous and the study was conducted under the Declaration of Helsinki.

Consent for publication: Not Applicable

Availability of data and materials: All data generated or analysed during this study are included in this published article

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