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Original Research

Determinants of Pneumonia among Admitted Under-Five Children at Public Hospitals in East Hararghe, Eastern Ethiopia, 2025

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Abstract

Background: Pneumonia remains a leading cause of under-five deaths globally, claiming 740,180 lives in 2019. In low- and middle-income countries, about 7 million children are hospitalized annually. In Ethiopia, high child pneumonia mortality is linked to malnutrition and household air pollution. This study aims to identify determinants of pneumonia among under-five children admitted to a public hospital in East Hararghe, Eastern Ethiopia.

Methods: The institutional-based unmatched case-control study was conducted in selected Eastern Hararghe Hospital, with target sample size of 255, consisting of 85 cases and 170 controls, maintaining a case-to-control ratio of 1 to 2. Consecutive sampling techniques were used to select samples for cases and controls among children admitted to the same wards. The data were entered into Epi-Info version 7 and exported to SPSS for analysis. Binary and multivariable logistic regression were calculated. Variable that had a p-value < 0.05 was used to declare associated factors.

Results: A total of 249 under-five children were enrolled in the study with a mean age of 21.7 months (SD ±15.4). Most participants 212 (85.14%) resided in rural areas. Multivariable logistic regression identified three significant determinants of pneumonia among admitted under-five children. Children living in urban areas were 2.5 times more likely to develop pneumonia (AOR = 2.57; 95% CI: 1.24, 5.20). Those from households with cigarette-smoking family members (AOR = 2.08; 95% CI: 1.05, 3.13) and those with a recent history of diarrhea (AOR = 1.85; 95% CI: 1.05, 3.13) also had higher odds of pneumonia.

Conclusion: Urban residence, family members who smoked cigarettes, and a recent history of diarrhea in the last two weeks are significant determinants of pneumonia among children under five admitted at public hospitals. Therefore, to reduce pneumonia incidence, targeted prevention should focus on promoting a smoke-free environment and enhancing hygiene and sanitation practices to prevent diarrhea and improve urban sanitation conditions.

Keywords: Case-Control, Ethiopia, Pneumonia, Under-Five Children

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1. Introduction

Pneumonia is a serious acute respiratory infection that primarily affects the lungs by filling the air sacs (alveoli) with pus and fluid, which causes painful breathing and reduces the amount of oxygen reaching the bloodstream. It remains one of the leading causes of morbidity and mortality among young children worldwide. In 2019 alone, pneumonia claimed the lives of approximately 740,180 children, accounting for 14% of all deaths among children under five years old and a staggering 22% of deaths among children aged one to five years [1].

The disease has more than 30 known causes, including bacterial, viral, mycoplasmal, and other less common infectious agents. Bacterial pneumonia, most commonly caused by Streptococcus pneumoniae, affects individuals of all ages but is particularly severe among those with compromised immune systems, malnutrition, chronic illness, or advanced age. Viral pneumonia, often resulting from influenza and other respiratory viruses, accounts for nearly one-third of all pneumonia cases and can predispose patients to secondary bacterial infections, such as those caused by Streptococcus pneumoniae. Mycoplasma pneumoniae, a distinct pathogen, causes atypical pneumonia, especially in school-aged children and young adults. Moreover, fungal and other rare pathogens contribute to pneumonia cases, particularly among immunocompromised individuals [2].

Globally, the burden of pneumonia remains heaviest in low- and middle-income countries (LMICs), where access to healthcare and preventive measures is often limited. Each year, an estimated seven million children under the age of five in LMICs are hospitalized due to pneumonia, many requiring urgent oxygen therapy for survival [3]. The continued failure of many countries to prioritize pneumonia prevention and management threatens progress toward the Global Action Plan for the Prevention and Control of Pneumonia and Diarrhea (GAPPD), which aims to reduce child pneumonia deaths to fewer than three per 1,000 live births by 2025 [4]. Alarmingly, just five countries—Nigeria, India, Pakistan, the Democratic Republic of Congo, and Ethiopia—account for more than half of all childhood pneumonia deaths worldwide [5].

In East Africa, the problem remains widespread. A systematic analysis of thirty-four studies found that the prevalence of pneumonia among under-five children in the region was approximately 34%, reflecting a significant public health challenge. The review also identified several modifiable risk factors associated with childhood pneumonia, including the use of biomass fuel (such as wood) for cooking, lack of vaccination, absence of exclusive breastfeeding, previous upper respiratory tract infections, and parental smoking [6].

Despite this evidence, there remains a scarcity of localized data on the determinants of pneumonia in specific parts of Ethiopia, particularly in the eastern regions. Understanding these determinants is crucial for designing targeted interventions and improving child health outcomes. Therefore, this study aims to investigate the determinants of pneumonia among admitted under-five children in public hospitals in East Hararghe, Eastern Ethiopia, 2025.

2. Method and Materials

2.1. Study Area and Period

This study was conducted to assess the determinants of pneumonia among under-five children admitted to Haramaya, Bedeno, and Garamuleta hospitals, which are located in the East Hararghe Zone of the Oromia Region, Eastern Ethiopia. Data collection took place from March 1 to 21, 2025. The East Hararghe Zone is one of the administrative zones in the Oromia Regional State. Geographically, it is bordered on the southwest by the Bale Zone, on the west by the West Hararghe Zone, on the north by the Dire Dawa City Administration, and on the north and east by the Somali Region. The zone comprises twenty districts (woredas) and three major towns, with a health infrastructure that includes eight hospitals and 121 health centers, serving as the primary sources of healthcare for the local population [7].

According to the 2025 population estimates for the Oromia Region, the Haramaya Woreda has a total population of 433,678, of which 219,989 are male and 213,689 are female. The Bedeno Woreda has an estimated population of 352,816, comprising 177,284 males and 175,532 females, while the Gurawa (Garamuleta) Woreda hosts a population of 351,819, including 177,821 males and 173,998 females [8]. These areas collectively represent a diverse demographic and geographic profile within the East Hararghe Zone, making them suitable sites for studying the determinants of pneumonia among under-five children.

2.2. Study Design

An unmatched case-control study was conducted.

2.3. Population

2.3.1. Source of Population

The source population for the study includes all under-five children living in East Hararghe, Eastern Ethiopia, 2025

2.3.2. Study Population

During the study period, the study population consisted of under-five children diagnosed with

pneumonia for cases and other conditions for controls at selected public hospitals in East Hararghe. Cases were defined as under-five children diagnosed with pneumonia by a physician and admitted to Haramaya, Bedeno, and Garamuleta hospitals for medical care during the study period. Control defined as under-five children other than pneumonia diagnosed by a physician, and admitted to Haramaya, Bedeno, and Garamuleta hospitals for medical care during the study period.

2.4. Inclusion and Exclusion Criteria

2.4.1. Inclusion Criteria

Inclusion criteria included all under-five children who were admitted to selected hospitals and diagnosed with pneumonia and non-pneumonia by a physician for medical care, and were included in the study.

2.4.2. Exclusion Criteria

Children suspected of having pulmonary tuberculosis or having a cough for more than two weeks were excluded from both cases and controls. Children who needed urgent referrals to other hospitals were excluded from the cases. Additionally, Children not residing in East Hararghe for more than six months are also excluded from both cases and controls.

2.5. Sample Size Determination and Sampling Techniques

2.5.1. Sample Size Determination

The sample size for assessing the determinants of pneumonia among admitted under-five children was calculated using the double population proportion formula in Epi Info version 7, with the assumptions of a 95% confidence interval (CI), 80% power, and a 2:1 ratio of controls to cases. The variable carrying a child on the back while cooking was used for sample size estimation, as it was identified as a significant determinant of pneumonia in a previous study, with 43.8% exposure among controls and an odds ratio (OR) of 2.3 [9]. This variable produced the largest sample size among potential determinants in earlier research. Considering 10% non-response rate, the final sample size was 255 participants (85 cases, 170 controls) (Table 1).

Table 1: Sample Size Determination for Study on Determinants of Pneumonia among Under-five Children Admitted at Public Hospital, East Hararghe, Eastern Ethiopia, 2025.

#	Independent variables	Power	Unexposed to the exposed ratio	% Case Exposed	% Control Exposed	AOR	Sample size		
							Cases	Controls	Total
1	Stunting	80%	2:01	23.6	7.9	3.6	68	136	204
2	Exclusive breastfeeding	80%	2:01	56.8	34.48	2.5	64	128	198
3	Hand washing practice	80%	2:01	23.8	8.275	3.469	71	141	212
4	Carrying a child on the back while cooking	80%	2:01	64.1	43.8	2.3	77	154	231

2.5.2. Sampling Techniques and Procedures

From the total public hospitals in East Hararghe, three: Haramaya, Bedeno, and Garamuleta were selected using a lottery method. The total sample size was proportionally allocated to these hospitals based on their annual under-five admissions. Both cases and controls were selected using a consecutive sampling technique among under-five children admitted to the pediatric wards during the study period (March 1–21, 2025). Data were collected from caregivers or mothers using a structured questionnaire administered during the children's hospital stay.

In the previous year, 2,268, 1,248, and 1,104 under-five children were admitted to Haramaya, Bedeno, and Garamuleta hospitals, respectively, equivalent to 189, 104, and 92 monthly admissions. Based on proportional allocation, the study included 42 cases and 84 controls from Haramaya Hospital, 23 cases and 46 controls from Bedeno Hospital, and 20 cases and 40 controls from Garamuleta Hospital. All cases and their corresponding controls were selected consecutively until the required sample size was achieved, maintaining a 1:2 case-to-control ratio.

2.6. Variables of the Study

2.6.1. Dependent Variables

- Presence or absence of pneumonia among admitted children under five years old.

2.6.2. Independent Variables

- **Socio-demographic factors and other related factors:** Age of the child, sex of the child, Place of residence, Father's education, and Marital status
- **Maternal factors:** Mother's age, Mother's education, Mother's Occupation, Antenatal care visits, and Birth order

- **Environmental and home related factors:** Family size, Separate kitchen, the cooking area had a window, carrying a child on the back of the mother, Source of cooking fuels, Parental smoking, Hand washing practice
- **Child-related factors and comorbidity:** Birth Weight, Vaccination Status, Exclusive breastfeeding, Vitamin A supplementation, Upper respiratory tract infections in the last 2 weeks, Diarrhea in the last 2 weeks, Asthma, Measles, HIV, and Malnutrition

2.7. Operational Definitions

Pneumonia: a diagnosis determined by an assigned physician and recorded based on WHO guidelines used as the case during the data collection period [10].

URTI in the last two weeks: A child who had a history of an ear infection, common cold, tonsilitis, and pharyngitis in the last fifteen days before data collection [11].

Diarrhea: characterized by three or more loose or liquid stools per day due to abnormally high fluid content of stool [12].

Cases were defined as all under-five children diagnosed with pneumonia by a physician and admitted to Haramaya, Bedeno, and Garamuleta hospitals for medical care during the study period.

Controls were defined as all under-five children who had diseases other than pneumonia, were diagnosed by a physician, and were admitted to Haramaya, Bedeno, and Garamuleta hospitals for medical care during the study period.

Exclusive breastfeeding: defined as the child receiving only breast milk with no other liquids or solids given, even not water, except oral hydration solution, or drops/syrups of minerals, vitamins, or medicines for the first 6 months of life [13].

Immunization status were categorized as vaccinated for age: A child was defined as fully vaccinated for his/her age, when a child receives all the recommended vaccines, including at birth (polio 0 and BCG), at six weeks (pentavalent 1, OPV 1, PCV 1, Rota 1), at 10 weeks (pentavalent 2, OPV 2, PCV 2, Rota 2), at 14 weeks (pentavalent 3, OPV 3, PCV 3, IPV), at 9 and 15 months: MCV, and recent Vitamin Supplementation [14]. Immunization status was categorized as incomplete for age: A child was defined as not vaccinated for his/her age when he/she missed at least one of the recommended vaccines for his/her age. Immunization status was categorized as not vaccinated for age: A child is defined as not having received a vaccine

at all.

2.8. Data Collection Methods

2.8.1. Data Collection Tool

Data were collected using structured questionnaires and medical record reviews. Primary data were obtained from mothers or caregivers to identify potential determinants of pneumonia. The questionnaire included four sections covering socio-demographic characteristics, maternal and environmental factors, child-related factors, and comorbidities. In addition, medical records of admitted children were reviewed to confirm diagnoses and identify coexisting conditions that could exacerbate the illness. Immunization cards were checked to verify each child's vaccination history, ensuring consistency between caregiver reports and documented records. Finally, anthropometric measurements were taken to assess the nutritional status of the children.

2.8.2. Data Collectors

Three data collectors, a clinical nurse who speaks the Afan Oromo and was trained in IMNCI protocol and working in pediatric units, were recruited. Three BSc Nurses or Public Health Officers supervised and coordinated data collectors during the data collection period.

2.8.3. Data Collection Procedures

A structured questionnaire was developed based on a review of previous studies and was pre-tested before data collection. It was initially prepared in English, translated into Afan Oromo, and then back-translated to English to ensure consistency. The questionnaire was proportionally distributed across the three study hospitals according to the number of under-five admissions in the previous year, and data were collected simultaneously at all sites.

Data collectors conducted face-to-face interviews with mothers or caregivers of both cases and controls. Cases were under-five children admitted with pneumonia, while controls were under-five children admitted with other illnesses in pediatric wards, maintaining a 1:2 case-to-control ratio. Before the interview, the purpose of the study was explained, and informed consent was obtained from each participant. Each interview lasted approximately 20–30 minutes.

Information on diagnosis, weight, height, age, nutritional status, HIV status, and history of asthma was extracted from medical records or patient charts [11]. Immunization status was assessed according to the Federal Ministry of Health (FMOH) guidelines [15]. Caregivers were asked whether the child had received vaccinations, and immunization cards were reviewed to

verify if the child was fully vaccinated for age.

Anthropometric measurements followed standard procedures: height was measured for children over two years, while length (recumbent) was measured for those under two years or shorter than 85 cm. Weight was taken using a digital scale, and both height and weight were measured twice to ensure accuracy, with discrepancies cross-checked [16].

Three trained data collectors proficient in Afan Oromo and currently working in pediatric units participated in data collection. They were trained for two days along with supervising BSc nurses or public health officers, focusing on the study objectives, data collection techniques, and adherence to IMNCI protocols.

2.9. Data Quality Assurance

To ensure data quality, the data collection tool was developed after reviewing relevant literature. Clinical nurses and other health professionals were recruited as data collectors. All data collectors and supervisors received two days of training from the principal investigator before the pre-test and data collection phases. The training focused on familiarizing participants with the questionnaire, anthropometric measurement procedures, and appropriate interviewing techniques.

A pre-test involving 5% of the total sample size was conducted at Hiwot Fana Comprehensive Specialized Hospital, which was outside the study area, to assess the validity and reliability of the tool. Necessary modifications were made based on the pre-test findings. During data collection, supervisors and the principal investigator reviewed completed questionnaires daily for completeness and consistency, providing immediate feedback to data collectors in the field.

Completed questionnaires were coded and entered into EpiData version 7, where data cleaning was performed before analysis. The accuracy of weighing scales was also routinely checked using a 5 kg calibration weight to ensure precision during anthropometric measurements.

2.10. Data Processing and Analysis

The collected data were checked for completeness and coding accuracy before being entered into Epi Info version 7. The cleaned data were then exported to SPSS for statistical analysis. Prior to analysis, inconsistencies and missing values were verified and corrected by cross-checking with the original questionnaires.

Descriptive statistics were used to summarize the data in terms of frequencies and percentages. Binary logistic regression was applied to assess the association between each independent variable and the dependent variable. Variables with a p-value < 0.25 in the bivariate analysis were included in the multivariable logistic regression model to control for potential confounders. Statistical significance was determined at a p-value < 0.05, using the adjusted odds ratio (AOR) with a 95% confidence interval (CI). An odds ratio was considered statistically significant if its confidence interval did not include one.

To check for model adequacy, multicollinearity among independent variables was assessed using the Variance Inflation Factor (VIF), and the Hosmer–Lemeshow goodness-of-fit test was performed. A p-value > 0.05 indicated that the model adequately fit the data.

2.11. Ethical Consideration

Ethical clearance was obtained from the Dire Dawa University Institutional Review Board (DDU-IRB). An official permission letter was submitted to the respective hospitals prior to data collection. Study participants were informed about the purpose, procedures, and significance of the study, and their right to withdraw or refuse participation at any stage was clearly explained.

Written informed consent was obtained from each caregiver or mother before data collection. To maintain confidentiality, no personal identifiers were recorded on the data collection tools. All collected information was treated with strict confidentiality questionnaires were stored in a locked cabinet, and electronic data were kept on a password-protected computer. The information obtained was used solely for research purposes.

3. Results

3.1. Sociodemographic Factors of Respondents

A total of 255 children were initially targeted for the study, and data were successfully collected from 249 participants, yielding a 97.65% response rate. Six children (2.35%) were excluded, 4 (1.57%) due to sudden severe illness and 2 (0.78%) due to death before interviews could be conducted. Among participants, 74 (89.2%) cases and 136 (81.9%) controls were rural residents. Female children accounted for 46 (55.4%) of the cases and 87 (52.4%) of the controls, while male children represented 37 (44.6%) of cases and 79 (47.6%) of controls. The mean age of the children was 21.69 months (SD ±15.41). Regarding marital status, 7 (8.4%) of cases and 2 (1.2%) of controls were divorced, while 4 (4.8%) of cases and 15 (9.0%) of

controls were categorized as other. Concerning husbands' educational status, 28 (33.7%) of cases and 52 (31.3%) of controls had no formal education (Table 2).

Table 2: Descriptive results for sociodemographic factors of respondents and their association with pneumonia in under-five children admitted at public hospitals in East Hararghe, Eastern Ethiopia, 2025.

Variables	Categories	Cases		Control	
		Frequency	Percent	Frequency	Percent
Age of the child	<12	30	36.1	65	39.2
	>= 12	53	63.9	101	60.8
Sex of the child	Female	46	55.4	87	52.4
	Male	37	44.6	79	47.6
Residence	Urban	11	13.3	32	19.3
	Rural	72	86.7	134	80.7
Marital status	Married	72	86.7	149	89.8
	Divorced	7	8.4	2	1.2
	Widowed	2	2.4	5	3
	Others	2	4.8	15	9
Husband's educational level	Not attend formal education	28	33.7	52	31.3
	Primary	43	50.8	91	54.8
	Secondary and above	12	14.5	14	8.4

3.2. Maternal Factors of Respondents

Only a small proportion of mothers or caregivers were under 18 years of age, comprising 3 (3.6%) among cases and 14 (8.4%) among controls. Regarding educational status, nearly half of the mothers in both groups had no formal education 42 (50.6%) among cases and 82 (48.2%) among controls.

A larger proportion of mothers were housewives, representing 46 (55.4%) of cases and 111 (66.9%) of controls. With respect to antenatal care (ANC) follow-up, 58 (69.9%) of cases and 120 (72.3%) of controls had received ANC, while 25 (30.1%) of cases and 46 (27.7%) of controls had not. In terms of birth order, most mothers had three or more children, accounting for 52 (62.7%) of cases and 80 (48.2%) of controls (Table 3).

Table 3: Descriptive and bivariate results for maternal factors of respondents and in under-five children admitted at public hospitals in East Hararghe, Eastern Ethiopia,2025.

Variables	Categories	Cases		Control	
		Frequency	Percent	Frequency	Percent
Mothers age	less than 18	3	3.6	14	8.4
	18-24	37	44.6	80	48
	>=25	43	51.8	72	43
Mothers educational level	illiterate	42	50.61	82	49
	Primary	26	31.3	51	31
	Secondary and above	15	18.1	33	20
Mothers Occupation	Housewife	46	55.4	111	67
	Employed	6	7.2	10	6
	Merchant	2	2.4	9	5.4
	Daily laborer	29	34.9	36	22
ANC Follow-up	Yes	58	69.9	120	72
	No	25	30.1	46	28
Prevention information from HF on respiratory infection	Yes	56	67.5	116	70
	No	27	32.5	50	30
Birth Orders	1st child	8	9.6	38	23
	2nd child	23	27.7	48	29
	3rd child and above	52	62.7	80	48

3.3. Environmental and Home Factors

Most participants lived in households with five or more family members, accounting for 74 (89.2%) of cases and 135 (81.3%) of controls. Regarding the type of fuel used for cooking, nearly all households 79 (95.2%) of cases and 158 (95.2%) of controls used wood, charcoal, or animal dung.

In terms of cooking location, 38 (45.8%) of cases and 130 (78.3%) of controls cooked in a separate kitchen, whereas 36 (43.4%) of cases and 22 (13.3%) of controls cooked inside the main house. Additionally, 42 (50.6%) of cases and 126 (75.9%) of controls reported having no separate kitchen from the main living area.

Concerning ventilation, 48 (57.8%) of cases and 39 (23.5%) of controls lived in houses without windows. Cigarette smoking was reported among 13 (15.7%) of cases and 37 (22.3%) of controls. During cooking, 32 (38.6%) of cases and 65 (39.2%) of controls reported carrying the child on the back. Regarding handwashing practices, 42 (50.6%) of cases and 72 (43.4%) of controls used only water, while 34 (41.0%) of cases and 78 (47.0%) of controls used soap and water during child feeding and handwashing (Table 4).

Table 4: Descriptive and bivariate results for environmental and home-related factors of respondents and their association with pneumonia in under-five children admitted at public hospitals in East Hararghe, Eastern Ethiopia,2025.

Variables	Categories	Cases		Control	
		Frequency	Percent	Frequency	Percent
Total number of people in the house	< 5	9	10.9	31	18.7
	≥5	74	89.2	135	81.3
Types of cooking materials used	Wood, charcoal and animal dug	79	95.2	158	95.2
	Electricity	1	1.2	3	1.8
	Kerosene	3	3.6	5	3
The place of mainly used for cooking	main house	36	43.4	22	13.3
	kitchen	38	45.8	130	78.3
	outdoors	9	10.8	14	8.4
Types of kitchens	not separated from main house	42	50.6	126	75.9
	separated	41	49.4	40	24.1
Availability of the window in the main house	Yes	35	42.2	127	76.5
	No	48	57.8	39	23.5
Cigarette smoking	Yes	13	15.7	37	22.3
	No	70	84.3	129	77.7
Location of the child during cooking	holds on the back	32	38.6	65	39.2
	Outside the cooking room	51	61.4	101	60.8
Presence of water around hand-washing facilities	Yes	78	96.4	160	96.4
	No	5	6	6	3.6
Hand washing before feeding the child	Soap and Water	34	41	78	47
	Water and Ash	2	2.4	10	6
	Only Water	42	50.6	72	43.4

3.4. Child Factors and Comorbidities of Respondents

Regarding birth weight, 5 (6%) of cases and 8 (4.8%) of controls weighed less than 2.5 kg. In terms of breastfeeding practices, 78 (94%) of cases and 158 (95.2%) of controls were exclusively breastfed. Concerning vaccination status, 44 (53%) of cases and 82 (49.6%) of controls were fully vaccinated, while 10 (12%) of cases and 25 (15.1%) of controls were unvaccinated.

Measles infection was reported among 6 (7.2%) of cases and 9 (5.4%) of controls. For vitamin A supplementation, 58 (69.9%) of cases and 114 (68.7%) of controls had not received supplementation. Within the two weeks preceding data collection, 33 (32.7%) of cases and 68 (36.7%) of controls had diarrhea, while 23 (27.7%) of cases and 48 (28.9%) of controls experienced an upper respiratory infection.

Only 1 (1.2%) case and 2 (1.2%) of controls had a history of asthma, and HIV infection was detected in 2 (2.4%) of cases and 1 control. Regarding nutritional status, underweight children (weight-for-age Z-score ≤ -2) accounted for 18 (21.7%) of cases and 17 (10.2%) of controls, while wasting (weight-for-height/length ≤ -2 Z-score) was observed in 12 (14.5%) of cases and 15 (9%) of controls (Table 5).

Table 5: Descriptive and bivariate results for child factors and comorbidities of respondents and their association with pneumonia in under-five children admitted at public hospitals in East Hararghe, Eastern Ethiopia, 2025.

Variables	Categories	Cases		Control	
		Frequency	Percent	Frequency	Percent
Birth weight	<2.5	4	4.8	7	4.2
	2.5 -4	79	95.2	159	95.8
Breastfeeding practices	Exclusive	78	94	158	95.2
	Mixed	5	6	8	4.8
Vaccination status	Fully vaccinated	40	48.2	88	53
	UpToDate	33	39.8	55	33.1
	Not vaccinated	10	12	23	13.9
Vitamin A supplementation	Yes	25	30.1	52	31.1
	No	58	69.9	114	68.7
History of diarrhea infection in the last 2 weeks	Yes	33	32.7	68	36.7
	No	50	60.2	98	66.2
History of URTI infection in the last 2 weeks	Yes	23	27.7	48	28.9
	No	60	72.3	118	71.1
Measles infection	Yes	6	7.2	9	5.4
	No	70	84.3	163	98.2
Asthma	Yes	1	1.2	2	1.2
	No	82	98.8	164	98.8
HIV	Yes	2	2.4	1	0.6
	No	81	97.6	165	99.4
Weight for age	Underweight (=<-2Zscore)	18	21.7	17	10.2
	Normal (>-2 Z-score)	65	78.3	149	89.8
Weight for Height	Wasting (=<-2Zscore)	12	14.5	15	9
	Normal (>-2 Z-score)	71	85.5	151	91

3.5. Determinants of Pneumonia Among Under-Five Children

In the bivariate logistic regression analysis, several variables showed a positive association with pneumonia among admitted under-five children at a significance level of $p < 0.25$. These included urban residence (COR = 2.909; 95% CI: 1.466, 5.771), family members who smoke cigarettes (COR = 2.571; 95% CI: 1.571, 4.767), carrying the child on the mother's back while cooking (COR = 2.0; 95% CI: 1.317, 4.767), lack of vaccination (COR = 2.0; 95% CI: 1.082, 2.784), no vitamin A supplementation (COR = 1.75; 95% CI: 1.100, 2.784), history of diarrhea

within the past two weeks (COR = 2.148; 95% CI: 1.361, 3.391), and history of upper respiratory infection within the past two weeks (COR = 2.04; 95% CI: 1.241, 3.365).

The multivariable analysis revealed that children living in urban areas had about 2.5 times higher odds of developing pneumonia compared to their rural counterparts (AOR = 2.57; 95% CI: 1.237, 5.203). Children from families with smokers were twice as likely to develop pneumonia as those from non-smoking families (AOR = 2.083; 95% CI: 1.053, 3.134). Furthermore, children with a recent history of diarrhea within the past two weeks had 1.8 times higher odds of developing pneumonia compared to those without diarrhea (AOR = 1.853; 95% CI: 1.053, 3.134) (Table 6).

Table 6: Multivariate logistic regression model for determinants of pneumonia among under-five children admitted at public hospitals in East Hararghe, Eastern Ethiopia, 2025.

Factors	Categories	Pneumonia		P-value	AOR (95% CI)
		Case	Control		
Sex	Female	46	87	0.109	0.89 (0.746, 1.142)
	Male	37	79		1
Residence	Urban	11	32	0.001	2.538 (1.237, 5.203**
	Rural	72	134		1
Marital status	Married	72	149		1
	Divorced	7	2	0.084	0.214 (0.65, 1.121)
	Widowed	2	7	0.0711	0.027 (0.37, 1.114)
	Others	2	10	0.061	0.391 (0.034, 4.469)
ANC Follow Up	Yes	58	120		1
	No	25	46	0.0741	1.79 (0.843, 2.461
Cigarette smoking	Yes	13	37	0.002	2.083 (1.053, 4.132) **
	No	70	29		1
Place of the child while cooking	on the back	32	65	0.0723	1.8 (0.606, 1.889)
	outside the cooking room	51	101		1
Vaccination Status	Fully vaccinated	40	88		1
	Up to date	33	55	0.064	1.48 (0.913, 2.03)
	not vaccinated	10	23	0.053	1.41 (0.756, 2.646)
Vitamin A supplementation	Yes	25	52		1
	No	58	114	0.0701	1.3 (0.751, 2.543)
Diarrhea	Yes	33	68	0.001	1.853 (1.138, 3.018) **
	No	50	98		1
Upper respiratory Infection	Yes	23	48	0.2	1.048 (0.562, 1.954)
	No	60	118		1

*Note: ** Significant at P value < 0.05*

4. Discussion

The study identified urban residence, exposure to cigarette smoke, and a recent history of diarrhea as significant determinants of pneumonia among under-five children admitted to

public hospitals. Understanding these factors is essential for developing effective prevention and management strategies against childhood pneumonia.

Children from urban areas were about twice as likely to develop pneumonia compared to rural counterparts. This finding aligns with studies conducted in the Tehulederie District (North East Ethiopia) and Tripoli, Libya [14,15], which also reported higher pneumonia risks in urban settings. The increased risk could be due to factors such as higher population density, overcrowded living conditions, and poor air quality, which facilitate the transmission of respiratory pathogens. Moreover, limited sanitation and inadequate waste management in some urban areas can contribute to increased exposure to infectious agents.

Cigarette smoking by family members was another important determinant, with children from smoking households being twice as likely to develop pneumonia. This result is consistent with findings from studies in Hosanna Town, Adama Hospital and Medical College (East Shewa Zone, Oromia), Western Uganda, and Indonesia [11,16–18]. In contrast, a study from Wolaita Sodo University Teaching and Referral Hospital found no significant association between parental smoking and acute respiratory infections [19]. The biological explanation lies in the harmful effects of cigarette smoke, which damages the epithelial lining of the respiratory tract, reducing mucociliary clearance and impairing the body's natural defenses. Passive exposure also increases vulnerability by introducing toxic chemicals that weaken children's lung function and immune response [11,17,18].

Furthermore, the study revealed that children with a history of diarrhea in the past two weeks had a 1.8 times higher risk of developing pneumonia compared to those without such a history. Similar findings were reported in studies from Adaba District (West Arsi Zone), Adama Medical Hospital College, Hiwot Fana Comprehensive Specialized Hospital (Eastern Ethiopia), and Hosanna Town (Hadiya Zone, SNNPR) [10,16,20,21]. This relationship may be explained by the nutritional depletion and dehydration caused by diarrhea, which weaken the immune system and impair the body's resistance to respiratory infections.

Despite these important insights, the study has limitations. Its institution-based design may restrict the generalizability of the findings to the broader community. Additionally, recall bias could have affected data accuracy since some information relied on participants' memory.

Overall, the findings emphasize the need for targeted interventions, including promoting smoke-free households, improving urban sanitation, and integrating diarrhea prevention with pneumonia control efforts to reduce under-five morbidity and mortality in Ethiopia.

5. Conclusion

This study identified key determinants of pneumonia among under-five children in hospital settings, including urban residence, exposure to cigarette smoke, and recent episodes of diarrhea. Urban living was linked to a higher risk, possibly due to overcrowding and poor sanitation that facilitate infection spread. Exposure to cigarette smoke weakens respiratory defenses, increasing children's vulnerability to pneumonia. Likewise, recent diarrhea episodes nearly doubled the risk, likely because they weaken immunity and reduce resistance to respiratory infections.

To reduce pneumonia cases, integrated prevention and control efforts should be strengthened across community, facility, and district levels. These include promoting hand hygiene, proper waste disposal, clean drinking water, and smoking cessation; enhancing health education, early detection, timely referrals, and data-driven interventions; and regularly evaluating the effectiveness of current public health initiatives targeting under-five pneumonia.

Abbreviations

ANC: Antenatal Care, AOR: Adjusted Odds Ratio, ARI: Acute Respiratory Tract Infection, CBNC: Community-Based Newborn Care, CMAM: Community Management of Acute Malnutrition, GAPPD: Global Action Plan for Control of Pneumonia and Diarrhea, HIV: Human Immunodeficiency Virus, ICCM: Integrated Community Case Management, IMNCI: Integrated Management of Neonatal and Child Health Illness OR: Odds Ratio, SAM: Severe Acute Malnutrition, SD: Standard Deviation, SNNRP: Southern Nation, Nationalities and Regions People, SPSS: Statistical Package for Social Sciences, UNICEF: United Nations Children's Fund, URTI: Upper Respiratory Tract Infection, VIF: Variance Inflation Factor, WHO: World Health Organization.

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study.

Authors Contribution

All authors contributed equally to the conceptualization and design of the study. They were involved in the methodology development, data analysis, investigation, and interpretation of the findings. All authors participated in writing, reviewing, and editing the manuscript, and approved the final version for submission.

Ethics Approval

Ethical approval was obtained from the Institutional Review Board of Dire Dawa University. An official letter was then submitted to the hospitals to request permission to conduct the research. All relevant offices and departments were informed about the purpose, timing, and duration of the data collection and kindly asked for their cooperation. There was no direct risk to the study subjects. Confidentiality was strictly maintained by ensuring that no patient names or healthcare provider identities were disclosed in relation to the findings.

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Conflict of Interests

The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Availability of Data and Materials

All data supporting the study is available with the reasonable request.

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