Determinants, Prevalence and Spatial Variation of Pneumonia Among Children Under Five Years in Ainamoi Sub-County, Kericho County, Kenya

Nicholas Tonui[1], Kennedy N. Ondimu[2] & Amon M. Karanja[3]

[1]Egerton University, Kenya

[2]Department of Geography, Egerton University, Kenya

[3]Department of Geography, Masinde Muliro University of Science and Technology, Kenya

**Corresponding author: tonuinicholas43@gmail.com*

https://doi.org/10.62049/jkncu.v5i2.322

Abstract

The incidence of acute respiratory infections (ARIs) in Kenya has seen a steady increase, from 8% in 2008 to 9% in 2014 and 14% in 2020, despite concerted governmental efforts to reduce pneumonia-related mortality in children under five. The prevalence of pneumonia in Kenya stands at 16%, higher than the regional average of 14% across Africa. This study sought to evaluate pneumonia prevalence, its determinants, spatial distribution, and household response strategies. An empirical and theoretical review formed the foundation of the research, drawing on germ theory and protective motivation theory. The study utilized a mixed-methods approach combining questionnaires and key informant interviews. The sample size of the study was 391 respondents who were selected using snowball sampling. Data analysis was done using frequencies, percentages, and Chi-square tests. The findings indicated that the pneumonia prevalence rate among children under five in the study area remained high (36%), across key indicators such as cough, breathing issues, and chest complications. The determinants of pneumonia prevalence included hereditary factors, humid cleaning practices, residential location, and frequency of exposure to overcrowded environments (p-value < 0.005). Child pneumonia prevalence in Ainamoi Sub-County.Findings present the three symptoms related to pneumonia: cough, breathing, and chest symptoms.

.

Background of Study

Although global child mortality rates have declined consistently over the last decades, preventable infectious diseases continue to require special attention. Infectious diseases are the most significant causes of under-five mortality and account for 68% of all deaths (Perin *et al*., 2022). According to The United Nations Inter-Agency Group for Child Mortality Estimation (UN IGME) (2024) report, the leading cause of death among under-five children were preterm birth complications, acute respiratory infections, intrapartum-related complications, congenital anomalies, and diarrhoea. Acute respiratory infection (ARI) is characterized by cough accompanied by short rapid breathing and commonly resulted in death through comorbidities with other childhood illnesses (Tam *et al*., 2017). Pneumonia is a form of acute respiratory infection (ARTI) that affects the lungs. It causes inflammation of the lung's parenchymal structure, an infection of the lower respiratory tract. Globally, pneumonia is the leading infectious cause of childhood morbidity and mortality worldwide (Ayuk, 2024; Watkins & Sridhar, 2018). Pneumonia remains a leading cause of death among children under five years old. In 2019, it accounted for 740,180 deaths representing 14% of all under-five mortalities. More recently, in 2021, pneumonia and diarrhoea combined were responsible for approximately 1.17 million deaths among children under five, constituting 23% of all deaths in this demographic.

Pneumonia continues to be a significant health concern for children under five in East Africa and Kenya. Recent studies indicate that the prevalence of pneumonia among under-five children in Eastern Africa remains high (Perin *et al*., 2022). In Kenya, pneumonia remains a leading cause of death among children under five, accounting for approximately 14% of child deaths in 2019. Notably, the introduction of pneumococcal conjugate vaccines (PCVs) in 2011 has led to a substantial reduction in severe pneumonia cases and related deaths. Regarding regional data, a 2014 study in Kericho County, located in the Rift Valley region, reported a pneumonia prevalence rate of 8.3% among children under five, corresponding to 5,457 cases (Vanderslott *et al*., 2022).

High prevalence of pneumonia contributes to high child mortality in the short term, and in long-term decreases work capacity and increases risk of adult morbidity and early death (Koh *et al*., 2017). In 2016, lower respiratory infections caused 652, 572 deaths (95% uncertainty interval (UI) 586 475–720 612) in children younger than 5 years 1 080 958 deaths (943 749–1 170 638) in adults older than 70 years, (2 377 697) deaths and (2 145 584–2 512 809) in people of all ages, worldwide. Chronic respiratory disease accounts for 3.8 million deaths; 9% in the world (WHO, 2016). In developing countries out of ten deaths reported, seven deaths in under five children were due to Acute Respiratory Infection (ARI), 10-50 times higher than in developed countries (WHO, 1999). Despite considerable effort by health agencies and organizations, mortality rates due to pneumonia in most developing countries are growing at an alarming rate (Liu *et al.,* 2018).

Literature Review

Prevalence of Pneumonia

Pneumonia remains an important public health concern that is widely recognized as the major cause of mortality and morbidity among children under five. Globally, one-fifth of mortality among under-five children is attributable to Acute respiratory infections (ARIs), predominantly pneumonia, which is particularly responsible for 18% of total under-five deaths. Pneumonia alone is responsible for approximately 20% of child deaths globally, majority of which occur in sub-Saharan Africa and South Asia (GBD Chronic Respiratory Disease Collaborators, 2020; WHO and UNICEF, 2013).

ARIs continue to persist as the single largest morbidity contributor among children and is responsible for approximately 70% of under-five childhood morbidities in developing countries. Approximately 3.5% of the global disease burden was caused by Pneumonia and are responsible for 30% to 50% of total pediatric outpatient visits and up to 30% of pediatric admissions in developing countries (Adesanya *et al.,* 2016). Kenya was ranked among the top 15 countries regarding pneumonia prevalence and contributed approximately 74% of the world's annual pneumonia cases in 2018, 6 per 1000 live births. Kenya's status under five mortality rates is due to pneumonia in 2018, according to United Nation International Children's Emergency Fund (UNICEF, 2014).

The World Health Organization (WHO) estimates that respiratory infections account for 6% of the total global burden of disease; this is a higher percentage compared to the burden of diarrheal disease, cancer, human immunodeficiency virus (HIV) infection, ischemic heart disease or malaria (Mizgerd, 2006). Acute respiratory infections (ARI), in general and pneumonia, in particular, continue to be the leading causes of childhood morbidity and mortality worldwide. This leads to a substantial burden on the healthcare system and can cause serious complications leading to economic and psychological burden at the household level also it accounts for an average 94,037000, (6.3% of total) disability adjusted life years (DALY) and 1.9 million deaths throughout the world. The disease is among the most common causes of both illness and mortality in children aged below 5 years in developing countries- mortality due to pneumonia is 10–50 times higher (Broor *et al.*, 2007; Colvin *et al.*, 2013; UNICEF/WHO, 2014; Williams *et al.,* 2002).

About 20% of all deaths in children under 5 years are due to Acute Lower Respiratory Infections (ALRIs - pneumonia, bronchiolitis and bronchitis); 90% of these deaths are due to pneumonia. *Streptococcus pneumonia* is rated to be the leading cause of lower respiratory infection morbidity and mortality globally, contributing to more deaths than all other etiologies combined in 2016 (WHO, 2016).

According to Johnson and Karim (2013) pneumonia is manifested by cough accompanied by short rapid breathing which may be associated with death especially when there are other comorbidities. According to this study, a significant decline in pneumonia cases has been achieved over the past two decades. 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 (GBD, 2017). Pneumonia affects children and families everywhere but is most prevalent in South Asia and sub-Saharan Africa. Pneumonia is preventable through simple interventions, and treatment with low-cost, low-tech medication and care (WHO, 2019).

The prevalence of maternal mortality is high (circa 500 per 100,000 live births). The county perinatal mortality rate is 63 per 1,000 meaning that one in every 15 infants die in birth or within their first 7 days of life. Children face challenges from birth and often do not reach their 5th birthday (child mortality circa 55 in 1,000) due to lack of immunizations, poor environmental conditions, poorly educated parents, also 16% of Kericho County residents have no formal education and 22% of the residents have a secondary level education or above.

In 2007, South-east Asia and Africa were the two continents with high magnitudes of childhood pneumonia, had estimated 61 million and 35 million annual cases of pneumonia in under-five children respectively

(Rudan, 2008). The magnitude of under-five pneumonia decreased to 120 million (with 0.88 million deaths) in 2010 and to 102 million (with 0.7 million deaths) in 2015 globally. This decrease was due to a decrease in the magnitude of its key risk factors, increasing socioeconomic development and preventive interventions, improved access to care and quality of care in hospitals. Despite this progress, pneumonia is still a major public health problem for children, especially in developing countries. Under-five children are more vulnerable to pneumonia leading to morbidity and mortality in those children (McAllister, 2015).

Pneumonia Policy

Kenya focuses on management and control of high prevalence of pneumonia especially in crowded rural homes and management strategies should target these vulnerable populations which include under five years of age.

Conceptual Framework

The prevalence of pneumonia among children is dependent variables. The individual level factors such as personal hygiene, previous underlying conditions and level of immunity influence pneumonia prevalence.The intervening variables in the framework included the government policy guidelines such as Public Health Act (CAP 242) and public health sanitation guidelines.

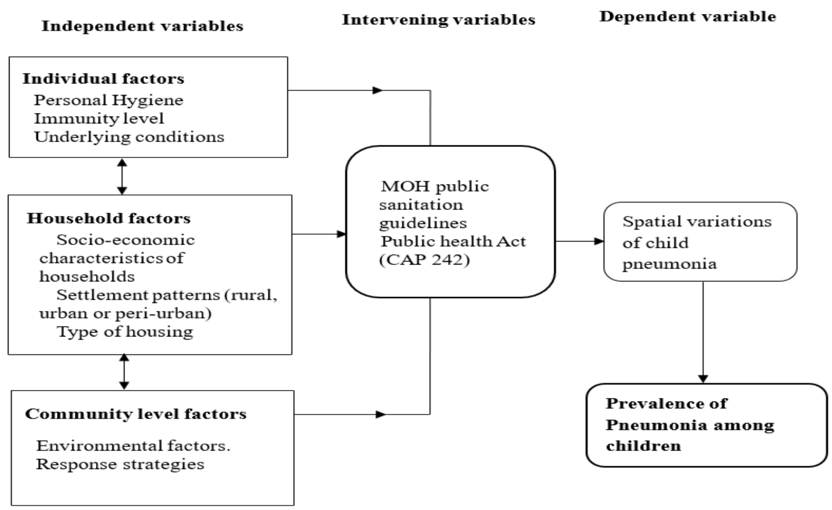

Figure 1: Conceptual Framework

Source: Adopted from Lanks et al. (2019)

Study Area

The study was carried out in Ainamoi sub-County, Kericho. Ainamoi is one of the six sub-Counties in Kericho County. The headquarters of the county are in Kericho Town. It lies in latitude between 0°13'30" S to 0°22'30"S and longitude between 35°15'0"E to 35°19'30"E. The estimated area is 239.9 square kilometers comprised of eleven (11) location and twenty-four (24) sub-locations. Ainamoi sub-county has a population of 170,625, with 86,671 males 83,947 females and 7 intersex as per 2019 Kenya Population and House Census and household size of 44, 246. The average size of the households is 3.8 (KNBS, 2019). The six administrative wards are Kapsoit, Ainamoi, Kapkugerwet, Kipchebor, Kipchimchim and Kapsaos.

The estimating population of Ainamoi Sub-County was 170,625 with 86,671 men, 83,947 women and 7 intersexes as at 2019. It has a child rich population, where 0–14-year-olds constitute 44% (354,800) of the total population (KNBS, 2019). Household and environmental conditions in the over 55% of households lacking access to safe water, and up to 80% of households are without latrines. Environmental degradation in the County is caused by an increase in the number of tea and coffee factories, population pressure on available land including water catchment areas and hilltops, rural-urban migration, unplanned and uncontrolled settlements, ineffective enforcement of Environmental Policies and Laws, inefficient solid waste management and lack of awareness on environmental issues. Waste disposal is still a major challenge in most urban centers in Kericho County (KCO Strategic plan 2019-2020 and SGCIDP, 2018-2022)

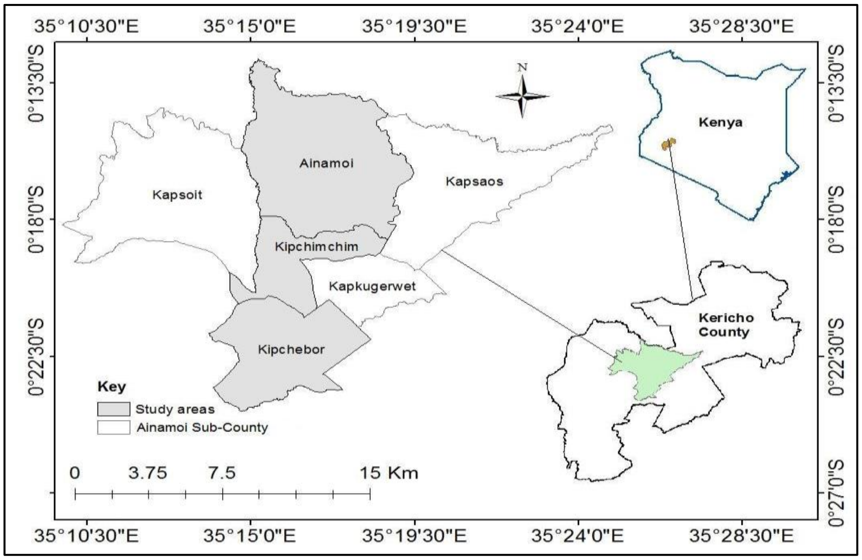

Figure 2: Map of the Study Area showing study sites

Source: ESRI DATA (2017)

Research Design

The study adopted exploratory research design. Quantitative data was collected using household questionnaires that were administered to selected households on face-to-face interviews. On the other hand, qualitative data was collected using semi-structured interviews that were held among key informants in health facilities in the study area and other relevant stakeholders such as public health departments and community health promoters. Data was collected on the number of pneumonia cases recorded during the survey period. This information was used to complement data collected from the survey. The two-research methodology was integrated using a triangulation method.

Sampling was done at household level and health facilities level because the pneumonia determinants is best evaluated at household level while the prevalence rates can be available at health facilities. For the administration of survey questionnaires to households, the participants were identified using multistage and stratified. Multistage sample design techniques were administered in three stages. Stage 1 was stratification i.e., rural, urban or peri urban. Stratified sampling protocol was used to select the study locations. Stage two was giving proportions thus providing clusters

Target Population

The target population of the study was all the households in three selected wards in Ainamoi Sub-County with children under five years. The study also targeted all health care facilities within the three wards. Since the average household size is 3.8, the target households are 16774.The interview schedule was used to collect qualitative data from key informants.

Sampling Procedure and Sample Size

Yamane formula (1967) was used to determine the sample size of the study. In the three selected wards—Ainamoi, Kipchimchim and Kipchebor, the estimated population size was 63,743 which forms the sampling frame (KNBS, 2019). Since the average household size was 3.8, the target households were 16774. In each ward one location was sampled. According to Yamane (1967) a sample size n can be determined as follows.

$$n = \frac{N}{1+e^2N} \quad (1)$$

Where:
n- sample size
N- Target population = 16774
e- error term = 0.05

$$n = \frac{16774}{1 + (0.05^2 * 16774)}$$

n = 391

The study area was selected since Ainamoi sub-county had aspect of urban and rural settlement types which highlight the variation in pneumonia prevalence and potential conclusive evaluation of the causative factors. In sampling, three aspects of demographic were observed. The first aspect is the urban component which represents a setting with exclusive town setting characterized by planned buildings, or with some uniformity in settlement pattern and often densely populated. Based on these characteristics, Kipchebor ward was classified as urban. The second component is the peri-urban which represents the landscape interface between urban (town) and rural (countryside)**,** and in the study area, Kipchimchim ward was delineated as rural—urban transition zone where urban and rural uses and functions mix and often clash. The last component is the rural area, which exclusively represents the settlement patterns characterized by sparse or clustered or nucleated patterns with no major town setting and is dominated by agricultural activities.

Sampling was done at household level and health facilities level because the pneumonia determinants is best evaluated at household level while the prevalence rates can be available at health facilities. For the administration of survey questionnaires to households, the participants were identified using multistage and stratified. Multistage sample design techniques were administered in three stages. Stage 1 was stratification i.e., rural, urban or peri urban. Stratified sampling protocol was used to select the study locations. Stage two was giving proportions thus providing clusters. Proportional sampling was used to select households from each stratum. Each of the six wards was treated as unique strata. Three administrative wards were selected based on nature and type of settlement, Kipchebor ward (urban) with four locations namely, Kapsuser, Kakiptui, Township and peri-urban wards of Motobo, Kipchimchim ward has three locations Kichimchim, Chepkolon, Taiywet and Ainamoi ward represents rural classification, and it has three locations; Poiywek, Laliat and Ainamoi. In each ward, two locations were selected as representative samples. Stage three involved the identification of households by using purposive sampling which relied on community health promoters and area chiefs to get households with children under five.

A total of eight health facilities were visited and medical practitioners were interviewed because health data records were inaccessible. This qualitative data was used to triangulate quantitative data and provided comparison of both sets of data. Additionally, the qualitative data was used to identify the common pneumonia response strategies based on morbidity cases in health facilities.

Data Collection

Structured household questionnaires were used to collect information for the study. In addition, the interview schedule was used to validate the data on prevalence of pneumonia by collecting information on the morbidity rates, infant mortality and etiological information. The information collected in household questionnaire included household characteristics that includes; levels of household hygiene, type of housing, type of fuel used, parental occupations, literacy levels among the parents, income levels, food profile, population density, general household lifestyles, ventilation status; individual factors that includes presence or absence of underlying conditions, prevalence of pneumonia, immunity levels, determinants of pneumonia prevalence, spatial variation of pneumonia that includes the rural and urban based component, effectiveness of household strategies such as enhanced level of awareness, following the MOH guidelines, hygiene, improved housing structure, promoting child immunization.

Ethical Considerations

To ensure ethical procedures were followed, the researcher obtained ethical clearance from Egerton University Ethics committee. An introductory letter from the Graduate School, Egerton University, was obtained to assist in the application of a research permit from the National Council for Science and Technology and Innovations (NACOSTI). Moreover, the researcher obtained a letter from the department of public health and sanitation, Kericho County acknowledging the data collection exercise in their jurisdiction. The researcher also informed the office of provision administration on the data collection activities.

Data Analysis

The collected data was cleaned and tested for normality using boxplots and Q-Q plots and outliers were removed. To determine the prevalence of pneumonia among children under five, descriptive statistics were used. These include frequencies and percentages. Characteristics of pneumonia patient's cases were compared for rural and urban and peri-urban using chi-squared test for categorical variables. To assess the relationship between pneumonia and its determinants, the Chi-square test was used. To assess the spatial variation of pneumonia among the households, thematic maps were used. The areas with denser colour scheme indicate higher prevalence of pneumonia cases. For better visualization, Kernel density was adopted which displays the attribute with smoothing edges rather than regular polygon. To identify pneumonia control strategies among the households, descriptive statistics that include frequencies and percentages.

Results and Discussion

Determinants of Pneumonia Prevalence in Ainamoi Sub-County

Analysis of Pneumonia Risk Factors

Results in Table 1 show selected determinants of pneumonia prevalence in the study area. Chi-square tests of association between risk factors and prevalence. The results showed that four factors had statistical association with pneumonia prevalence namely, the hereditary factors, humid cleaning, residential locations, and overcrowded households. Hereditary had a statistical relationship with pneumonia prevalence (p = 0.000). The hereditary factor was assessed using the history of occurrence of the pneumonia among any household member under study. Family history indicates strong statistical evidence that genetic factors are highly correlated with pneumonia risk due to inherited immune system characteristics and familial genetic vulnerabilities to respiratory infections. In support of these findings, Campos *et al*. (2021) have shown that genetic variations contribute to individual differences in susceptibility to pneumonia. Specific genetic loci and genes, such as those on chromosomes 15, 16, and 9, have been associated with pneumonia risk. These include genes related to immune response and inflammation.

The results also indicated that locality (p = 0.018) had significant statistical relationship between living environment and pneumonia prevalence. Locality where people live, whether in rural, urban, or peri-urban areas, impacts pneumonia prevalence. For example, rural areas, although presumed low, have potential risk factors associated with poor housing structures, and possible exposure to agricultural environments. On the other hand, some locales in urban areas also predispose to pneumonia because of higher population density, overcrowded living conditions, and increased chances of pollution exposure, garbage disposal sites and industrial risks. Social and environmental interactions, which include locality and crowded homes, play a significant role in the determination of pneumonia prevalence.

Table 1: Determinants of Pneumonia prevalence

Risk Factor/Determinants	N	Chi-square	df	Sig.
Hereditary	322	23.814[a]	5	0.000
Type of family house/building materials	322	30.572[a]	35	0.682
Type of fuel/source of energy	322	8.839[a]	20	0.985
Major HH food profile	322	34.467[a]	30	0.263
HH income levels	322	19.021[a]	20	0.52
Locality (E.g. Rural, Urban, Peri-urban)	322	21.517[a]	10	0.018
Proximity to industrial plant/Factory/Mining	322	20.821[a]	15	0.143
Overcrowded houses	322	25.329[a]	15	0.046
Seasonality	318	2.738[a]	5	0.740
Air ventilation in your house	322	17.209[a]	20	0.639
Method of waste/garbage disposal applied	322	5.521[a]	10	0.854
Frequency Humid cleaning in HH	322	37.969[a]	25	0.047

Source: Field data 2024

The level of household crowdedness was also statistically related to pneumonia prevalence (p = 0.046). This means the household size is a significant pneumonia risk factor. This finding aligns with Naz and Ghimire (2020) who argued that children living in overcrowded homes have a higher risk of developing pneumonia. Similarly, in urban Dhaka, Bangladesh, crowding was identified as a risk factor for pneumonia in children (Ram *et al*., 2014). Moreover, in support of these findings Naz *et al*. (2020) posited that overcrowded living conditions are a significant risk factor for childhood pneumonia. Studies in Pakistan and Gambia found that children living in overcrowded homes had higher odds of developing pneumonia. Similarly, in humanitarian settings, crowded living conditions, such as refugee camps, were linked to higher pneumonia incidence.

The humid cleaning in households also significantly influences pneumonia occurrence (p = 0.047). The variable (humid cleaning) was assessed on number of times a household performs humid cleaning per month. This factor inversely influences the prevalence of pneumonia because the more the households perform humid cleaning, the less likely they will experience pneumonia prevalence. These findings align with the previous findings such as Liu, *et al*. (2024) who reported that the frequent cleaning and ventilation, such as opening windows and exposing bedding to sunlight, can reduce the risk of childhood pneumonia associated with indoor dampness. Conversely, the use of air humidifiers and air conditioners may increase the risk and the dampness in the home, including damp clothing, bedding, and visible mold, is significantly associated with an increased risk of childhood pneumonia. Improved ventilation and cleanliness can help mitigate these risks, additionally Lamichhane *et al*. (2019) showed that the use of household humidifiers, particularly those with disinfectants, has been linked to lung injuries and may increase the risk of interstitial pneumonia. This suggests that while humidifiers can be beneficial for air quality, their use should be carefully managed to avoid adverse health effects.

Additional factors such as type of family house/residence, seasonality, fuel/energy source, household food profile, household income levels, proximity to industrial plants/factories/mining, air ventilation, and waste/garbage disposal method play a significant role, despite being non-significant statistically. While factors such as seasonality were not statistically significant the current study, Lu *et al*. (2023) posit that seasonality is a significant risk factor for childhood pneumonia, influenced by various climatic and environmental conditions. Muthumbi *et al*. (2017) also argued that among a wide range of air-pollution variables, only two were significant in the univariate analyses; cooking in a room with only one ventilation exit (the door) was more common among cases; cooking for oneself was more common among controls.

In the study, the type of fuel used was not statistically related to pneumonia occurrence among children. This supports the findings in Muthumbi *et al*. (2017) that pneumonia was not associated with indoor cooking, nor sleeping in the cooking room, nor with the type of fuel used for cooking. However, Budhathoki *et al*. (2020) reported that household air pollution, primarily from the use of polluting cooking fuels, is a significant risk factor for childhood pneumonia. Additionally, Zhuge *et al*. (2018) argued that indoor environmental factors like dampness, cooking with solid fuels or natural gas, and using new construction materials are risk factors for childhood pneumonia. Both natural gas and solid cooking fuels were positively associated with pneumonia compared with electricity.

Although the findings reveal no significant statistical relationship between type of house or building materials with pneumonia incidences, Zhuge *et al*. (2018) who made comparison between cement, construction materials including synthetic fiber, laminated wood, real wood, paint, emulsion paint and wallpaper revealed a positive associated with pneumonia.

Analysis of the Frequency of Humid Cleaning Among the Households

Results in Table 2 show that 67 percent of respondents never conduct humid cleaning, which suggests significant hygiene and household maintenance challenges. According to Muthumbi *et al*. (2017) humid cleaning is a method that involves using moisture, such as water, steam, or damp cloths, to remove dirt, dust, and contaminants from surfaces. Moreover, 19 percent of respondents maintain relatively regular cleaning, representing a minority of households with consistent cleaning practices. On the other hand, 6 percent, 4 percent and 3 percent reported infrequent cleaning categories which include less than once a month, once a month, a few times a month and only 1 percent perform humid cleaning daily. This highlights the potential of high risk of dust accumulation thus increased vulnerability to respiratory diseases such as pneumonia due to limited humid cleaning practices in the area.

The findings were in contrary to assertion by Carrión *et al*. (2019) who posit that the exposure to household air pollution is associated with an increased carriage of bacterial pathogens in the nasal passages of infants as opposed to dusty environment, which can lead to bacterial pneumonia. This association is more pronounced in children exposed to traditional cooking methods compared to those using improved biomass or LPG stoves and the household hygiene practices. Nkwopara *et al*. (2019) who emphasized that Lilongwe, Malawi, areas with higher rates of poverty, informal settlements, and poor sanitation had higher than expected enrollment in a fast-breathing child pneumonia clinical trial.

Table 2: Frequency of humid cleaning in your house

Variable	**Frequency**	**Number of respondents (%)**
Daily	5	1
A few times a week	60	19
A few times a month	10	3
Once a month	12	4
Less than once a month	19	6
Never	217	67
Total	323	100

(Source: Field data 2024)

Effect of Household Size (Crowdedness) on the Prevalence of Child Pneumonia

Table 3 presents a crosstabulation of household crowdedness (measured by the number of people per household) and the prevalence of child pneumonia categorized into five levels (Very Low, Low, Moderate, High, Very High). The results show that there is positive association between household size and pneumonia prevalence. Pneumonia prevalence appears to increase as household crowdedness increases, with higher crowdedness levels (4+ members) associated with a greater number of cases ranked as high and very high prevalence categories. For example, among households with 12 members, all 5 cases show "Very high" pneumonia prevalence. Similarly, households with 10 members shows predominantly "High" or "Very high" prevalence. On the other hand, the smaller households (1-3 members) account for only 16.5% prevalence rate. Medium households (4-6 members) account for 55.3% of the pneumonia cases. The Chi-

Square tests further revealed a significant positive correlation between household size and the pneumonia prevalence (p = 0.046).

This finding means overcrowding is a significant risk for childhood pneumonia. This support Cardoso *et al*. (2019) who posits that children in overcrowded households were 1.5 to 3 times more likely to develop pneumonia compared to those in less crowded conditions. Sonego *et al*., 2015) reported similar results in Sub-Saharan Africa where households with more than 4-5 people per sleeping area were strongly associated with increased pneumonia cases.

The results show a sharp increase in pneumonia prevalence when household size exceeds 4 members, aligning with research suggesting that the threshold for increased risk is around 4-5 people per household (Dagvadorj *et al*., 2020). According to Dagvadorj *et al*. (2020) large households are likely to increase pathogen exposure, limited ventilation, and cross-infection risk, contributing to a higher pneumonia burden. They also highlight that household air pollution and poor ventilation exacerbate pneumonia risks in crowded settings.

Table 3: Crosstabulation of Level of HH Crowdedness and the Prevalence 0f Child Pneumonia

		Prevalence Level					**Total**
		Very low	**Low**	**Moderate**	**High**	**Very high**	
No. of people in Households	1	1	1	4	0	3	9
	2	0	0	10	2	9	21
	3	4	0	6	3	10	23
	4	11	11	12	8	23	65
	5	16	7	20	5	17	65
	6	8	7	14	4	15	48
	7	9	4	8	3	10	34
	8	6	3	9	2	9	29
	9	4	2	5	1	7	19
	10	0	0	0	1	1	2
	11	0	0	2	0	0	2
	12	0	0	0	0	5	5
Total		59	35	90	29	109	322

(Source: Field Data 2024)

Relationship Between Residential Risk Factors and Child Pneumonia Prevalence

Results in Table 4 indicate the locales in the study area in terms of stratification which include rural/Countryside, Peri-urban Setting and Urban Setting. Rural/Countryside was one distribution of residential settings where 52 percent showed significant variation in living conditions which indicates a predominantly rural population therefore this suggests agricultural or remote community characteristics with potential implications for access to healthcare, infrastructure and services. Peri-urban setting is the second largest cohort, transitional areas between urban and rural zones representing 34 percent of the respondents and it's characterized by mixed land use and developing infrastructure. Urban Setting suggests limited concentration in the study area and are likely direct exposure to environmental and health risks due to waste disposal and industrial pollution. This result corroborates with Zhuge *et al*. (2018) who posit that Urban children had more pneumonia than suburban (29.9%) and rural children (24.9%), with more residential risk factors found in urban dwellings.

Table 4: Locality Classification

Variable	Frequency	Number of respondents (%)
Urban setting	45	14
Peri-urban setting	110	34
Rural/Countryside	168	52
Total	323	100

Source: Field data 2024

Conclusion

The pneumonia determinants prevalence dominates in —hereditary predisposition, humid cleaning practices, residential location, and household crowding— play a critical role in shaping childhood pneumonia risk. Genetic susceptibility, as indicated by family history, emerged as a significant underlying factor, reinforcing the need to integrate genetic awareness into public health care programs. Additionally, environmental and behavioral factors, including overcrowding, poor ventilation, exposure to indoor air pollution, and low household income, exacerbate pneumonia risk, particularly in peri-urban areas where biomass fuel use remains prevalent.

Recommendations

The study revealed high prevalence in crowded rural homes and the response and management strategies should target these vulnerable populations.

A longitudinal study on prevalence across children of all age groups and elderly population to determine the morbidity variation across different demographic groups.

Recommendations for further Research

A study on comprehensive socio-economic characteristics of households and their association with pneumonia cases.

References

Adawe, M., Odongo, A., & Kariuki, J. (2023). Risk factors associated with pneumonia among under 5 years children at Banadir Hospital, Mogadishu, Somalia. *Asian Journal of Medicine and Health, 21*(8). https://doi.org/10.9734/ajmah/2023/v21i8832

Adesanya, O. A., & Chiao, C. (2016). A multilevel analysis of lifestyle variations in...

Beletew, B., Bimerew, M., Mengesha, A., Wudu, M., & Azmeraw, M. (2020). Prevalence of pneumonia and its associated factors among under-five children in East Africa: A systematic review and meta-analysis. *BMC Pediatrics, 20*. https://doi.org/10.1186/s12887-020-02083-z

Colvin, C. J., Smith, H. J., Swartz, A., Ahs, J. W., de Heer, J., Opiyo, N., ... & George, A. (2013). Understanding care seeking for child illness in sub-Saharan Africa: A systematic review and conceptual framework based on qualitative research of household recognition and response to child diarrhoea, pneumonia and malaria. *Social Science & Medicine, 86*, 66-78.

Epstein, D., Reibel, M., Unger, J. B., Cockburn, M., Escobedo, L. A., Kale, D. C., ... & Gold, J. I. (2014). The effect of neighborhood and individual characteristics on pediatric critical illness. *Journal of Community Health, 39*(4), 753-759.

Koh, J. W. J. C., Wong, J. J. M., Sultana, R., Wong, P. P. C., Mok, Y. H., & Lee, J. H. (2017). Risk factors for mortality in children with pneumonia admitted to the pediatric intensive care unit. *Pediatric Pulmonology, 52*(8), 1076-1084.

Liu, H., Grantham, M. L., & Pekosz, A. (2018). Mutations in the Influenza A virus M1 protein enhance virus budding to complement lethal mutations in the M2 cytoplasmic tail. *Journal of Virology, 92*, e00858-17.

Liu, W., Chang, J., Zhang, N., Lai, W., Li, W., Shi, W., Wang, J., Wei, J., & Cai, J. (2024). Family cleaning behaviors and air treatment equipment significantly affect associations of indoor damp indicators with childhood pneumonia among preschoolers. *International Journal of Environmental Health Research*. Advance online publication. https://doi.org/10.1080/09603123.2024.2398092

Lutfey, K., & Freese, J. (2005). Toward some fundamentals of fundamental causality: Socioeconomic status and health in the routine clinic visit for diabetes. *American Journal of Sociology, 110*(5), 1326-1372. https://doi.org/10.1086/428914

Martins, R. B., Carney, S., Goldemberg, D., Bonine, L., Spano, L. C., Siqueira, M., & Checon, R. E. (2014). Detection of respiratory viruses by real-time polymerase chain reaction in outpatients with acute respiratory infection. *Memórias do Instituto Oswaldo Cruz, 109*, 716-721.

McAllister, D. A., Liu, L., Shi, T., Chu, Y., Reed, C., Burrows, J., ... & Nair, H. (2019). Global, regional, and national estimates of pneumonia morbidity and mortality in children younger than 5 years between 2000 and 2015: A systematic analysis. *The Lancet Global Health, 7*(1), e47-e57.

Paudel, D., Gupta, D., Chapagain, R., & Shrestha, A. (2024). Contributing risk factors to pneumonia in children under five years in Madhesh Province of Nepal. *International Journal of Innovative Science and Research Technology (IJISRT)*. https://doi.org/10.38124/ijisrt/ijisrt24aug1085

Perin, J., Mulick, A., Yeung, D., Villavicencio, F., Lopez, G., Strong, K. L., ... & Liu, L. (2022). Global, regional, and national causes of under-5 mortality in 2000-19: An updated systematic analysis with implications for the Sustainable Development Goals. *The Lancet Child & Adolescent Health, 6*(2), 106-115.

Phelan, J. C., Link, B. G., & Tehranifar, P. (2010). Social conditions as fundamental causes of health inequalities: Theory, evidence, and policy implications. *Journal of Health and Social Behavior, 51*(1_suppl), S28-S40. https://doi.org/10.1177/0022146510383498

Phelan, J. C., Link, B. G., Moore, R. E., & Stueve, A. (2008). The stigma of homelessness: The impact of the label "homeless" on attitudes toward poor persons. *Social Psychology Quarterly, 61*(4), 323-337. https://doi.org/10.2307/2787038

Pinzón-Rondón, Á. M., Aguilera-Otalvaro, P., Zárate-Ardila, C., & Hoyos-Martínez, A. (2016). Acute respiratory infection in children from developing nations: A multi-level study. *Paediatrics and International Child Health, 36*(2), 84-90.

Stansfield, S., & Shepard, D. (1993). Acute respiratory infection. In D. Jameson, W. Mosley, A. Measham, & J. Bobadilla (Eds.), *Disease control priorities in developing countries* (pp. 67-90). Oxford University Press.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education, 48*(6), 1273-1296.