

Original article:

Wheezing and Associated Risk Factors Among Children in Flood Prone Areas of a Central Nigerian Metropolis

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Abstract

Objectives: Our study investigated the prevalence of wheeze and its associated factors among children between the ages of 0 and 8 years in flood prone areas of Lafia local government area (LGA). **Study Design:** The study was a cross-sectional study. **Materials and Methods:** A total of 1,767 children resident in 300 households drawn from five council wards participated in the study. Questionnaires were used to obtain information relating to the children and their immediate environment. Relative humidity of each house was also measured. Wheezing in children was determined from interaction with their parents and confirmed through examination by trained health workers. **Results and Discussion:** Mean relative humidity of the wards ranged from 52.5%rh to 76.3%rh with 66.8% of children living in houses with relative humidity of >60%rh. Findings revealed a prevalence of 13.0% (n = 230) in the study area. Ages 3-8 years accounted for 70% wheeze cases while 0-2 years accounted for 30%. Age (AOR = 1.560; 95% CI = 1.023 – 2.378), mud houses (AOR = 1.812; 95% CI = 1.080 – 3.040), use of antibiotics (AOR = 143.593; 95% CI = 81.582 – 252.741) and local herbal concoctions (AOR = 114.530; 95% CI = 12.522 – 1047.494) were significantly associated with wheezing in children. **Conclusion:** The prevalence of wheeze in our study varied among children and was influenced by factors such as age, living in mud houses and recent or current use of antibiotics. This study advocates proper care and protection of children against factors that predispose them to wheezing.

Keywords: Wheeze, flood, age, antibiotic, risk, relative humidity.

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Introduction

Indoor environments in residential buildings have reported effects on the health of inhabitants. This arises from the relationship between moisture level, dampness, fungal presence and respiratory diseases development. Fungal growth in damp buildings as obtainable in flood prone areas, is considered an increasing problem globally mainly due to the health and financial implications which arise from it.¹ Some studies have identified a relationship between dampness in a home and development of wheezing, with increased risks in homes where dampness and mold growth were found²⁻⁴. Damp conditions elevate the

concentration of fungi and dust mites, both of which produce allergens known to be associated with allergies and asthma development. Some fungi toxins are also known to exert negative effects on respiratory health of humans⁵.

Wheeze refers to a condition that manifests as a continuous whistling sound during breathing and suggests a narrowing or obstructions in some parts of the respiratory tract⁶. Wheeze can be caused by some conditions, especially asthma and bronchiolitis⁷, but less frequently by congenital anatomical abnormalities, foreign body aspiration, other pulmonary disorders (eg, cystic fibrosis), and cardiac, immune, and gastrointestinal disorders⁶.

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Wheeze and asthma are frequently misdiagnosed as pneumonia in developing countries due to similarities in symptoms. Hence, mortality and morbidity arising from this condition has increased in children aged 5 years and less⁶. Similarly, wheeze has been identified to affect one-third of children aged 1-6 years in Europe and the United States of America⁸, with at least 50% of children reporting at least one episode in the first six years of life⁹. In Canada, a prevalence rate of 22% was reported in children aged 5 years and less¹⁰. Unfortunately, many parents are unable to accurately differentiate between wheeze and other respiratory symptoms in their children, leading to discrepancies between diagnosis by parents and those by doctors^{12,13}.

Wheeze and associated risk factors have been related with asthma prevalence¹³ but is only considered as an asthma symptom in the absence of other infections¹⁴. A report by Rodriguez et al.¹⁵ revealed that poor housing conditions may be an important contributory factor to the development of wheeze in children. In an international study by Weinmayr et al.¹⁶, bedding material and smoking by mothers were identified as important risk factors for wheeze. Respiratory infections¹⁷ and poor environmental conditions^{2,18} to which children get exposed can also trigger wheeze. Wheeze in children results in poor quality of life and frequent hospital visits⁷. If wheezing is not detected early, it can result to reduced lung function and persistent severe disease in adulthood¹³. Children are more vulnerable to respiratory attacks because their lungs are young and are hence, easily affected by pollutants¹⁹. Their high level of physical activity²⁰ and frequent intake of air through the mouth also exposes them to longer breathing periods and higher breathing rates which in turn exposes them to higher doses of air-borne pollutants¹⁹. Symptoms of recurrent wheezing is estimated to manifest in one-third of school-age children within the first five years of their life²¹.

Although not so much has been studied regarding wheeze among African children when compared to developed countries, developing countries have higher prevalence rates for wheeze^{21,22}. In South Africa, association of wheeze with polluted air has been previously established, with reported incidence of 31.6% and 18.2% previous wheeze and current wheeze cases respectively among school children aged 13 to 14 years. Furthermore, 16.4% of younger children had experienced wheeze before²³. In another South African study,

a prevalence rate of 18.8 % (1 to 12 months old) and 12.9% (13 to 26 months old) was reported²⁴. In Nigeria, the International Study of Asthma and Allergies in Childhood (ISAAC) team reported an increase in the incidence of wheeze among children between 1999 (10.7%) and 2014 (20%)²⁵. Earlier studies in Lagos²⁶ and Ibadan²⁷ reported incidences of 10.2% and 5.1% respectively among children of 6-11 years. Similarly, Galadanci et al.²⁸ reported a prevalence rate of 17.3% among children in Kano state.

The prevalence of wheeze among children in Nasarawa state is scarcely known. Lafia experiences floods during the rainy season in some parts of the city, resulting in flooded homes many of the times. This study sought to ascertain the incidence of wheezing among children in flood prone areas in Lafia and to investigate wheeze related factors in children.

Materials and Methods

Study area

Lafia local government area (LGA) where the study was conducted is located in the Guinea savannah region of Central Nigeria and doubles as the capital of Nasarawa state. The town lies between latitude 8°25'40" to 8°34'15" North and longitude 8°24'25" to 8°38'19" East²⁹. Its climate is typically tropical, having two distinct seasons every year. The wet or rainy season lasts from May to October, while the dry season begins in November to April of the following year. Annual rainfall figures range between 1100mm to about 2000mm. The averagely high rainfall experienced within Lafia, makes peasant farming a common delight of its natives²⁹. The high rate of rainfall coupled with a shortage of adequate drainage channels in some parts of the town, makes flooding a recurring event.

Study design

The research, which was a purposeful random sampling study, was performed between September and November. Wakwa, Makama, Gayam, Ciroma and Akurba wards of the LGA that experience flooding yearly were identified and selected for the study.

Data collection

A pre-survey exercise preceded the actual sampling primarily to ensure that only homes which experienced flooding and had children 8 years and less, participated in the study. Sixty (60) houses were randomly selected in each of the five (5) council wards, making a total of three hundred (300) houses. A total of 1,767 children were

involved in the study. Ten (10) primary health workers (2 for each council ward) were trained and recruited for the study. A structured questionnaire was used to obtain information from the parents of the children. The health workers spoke in the native Hausa language with those who did not understand English language. Wheezing was effectively described to the parents by a qualified health worker as whistling sound, shortness of breath or breathlessness¹¹. The health workers examined the children to confirm the position of their parents. Cases that were determined not to be wheezing were excluded.

Measurement of physical parameters

The relative humidity of the homes was measured using a wet and dry thermo-hygrometer. The readings were taken after about 10 minutes, and the mean relative humidity of each council ward computed.

Statistical analysis

Data collated were analyzed using SPSS version 20 (IBM Corp., Armonk, New York). Simple means, sums, percentages and frequencies were computed. Differences in association between categorical variables were determined using Chi square (χ^2) test while means were compared using Analysis of Variance (ANOVA). Crude and adjusted odds ratios were also computed using univariate and multivariate logistic regression at 95% confidence interval. Statistical significance was considered when p was less than 0.05.

Results

A total of 1,767 children participated in the study (Table 1). Of this number, 733 (41.5%) were 2 years or less while 1,034 (58.5%) were between the ages of 3 to 8 years. Based on the kind of material used for building houses in the study area, 1,287 (72.8%) of the children lived in houses built with cement blocks while 459 (26.0%) and 21 (1.2%) lived in mud and wood built houses with most of the roofs (78.3%) leaking water during heavy rains. Most of the children (1,376) were not exposed to any form of farming activity while most of the houses (66.8%) had relative humidity above 60%rh.

Table 1. Characteristics of study participants and their abode (N = 1, 767).

Characteristic	Number	Frequency (%)
Age (Years)		
0 – 2	733	41.5
3 – 8	1034	58.5
House type		
Cement block	459	26.0
Mud block	1287	72.8

Characteristic	Number	Frequency (%)
Wooden structure	21	1.2
Leaky roof		
Yes	1384	78.3
No	383	21.7
Farming activity		
No farming	1376	77.9
Animal farming	230	13.0
Crop farming	134	7.6
Animal and crop farming	27	1.5
Relative humidity of house		
<60%rh	586	33.2
>60%rh	1181	66.8

Wheeze was more prevalent among children aged 3 to 8 years (70.0%) than those aged 0 to 2 years (30.0%) (Table 2). Most of the children with wheeze (80.0%) lived in houses made with mud blocks. Households not involved in any form of farming activity had the highest number of children with wheeze (77.4%). Similarly, houses with relative humidity higher than 60%rh had more wheeze cases (65.2%) than those with relative humidity of less than 60 (34.8%). Most of the children with wheeze (53.0%) were taken for medical attention by their parents with 59.1% using one form of antibiotic or the other, and 2.2% using local herbal concoctions at the time of this study. There was a statistically significant difference in the prevalence of wheeze with respect to age, type of house, frequency of wheezing and current treatment being undertaken ($p < 0.05$).

Table 2. Characteristics of study population with and without current wheeze (N = 1, 767).

Characteristic	No. with wheeze (%)	No. without wheeze (%)	P value
Age (Years)			
0 – 2	69 (30.0)	664 (43.2)	<0.001*
3 – 8	161 (70.0)	873 (56.8)	
House type			
Cement block	43 (18.7)	416 (27.1)	0.026*
Mud block	184 (80.0)	1103 (71.8)	
Wooden structure	3 (1.3)	18 (1.2)	
Leaky roof			
Yes	190 (82.6)	1194 (77.7)	0.091
No	40 (17.4)	343 (22.3)	
Farming activity			
No farming	178 (77.4)	1198 (77.9)	0.066
Animal farming	23 (10.0)	207 (13.5)	
Crop farming	22 (9.6)	112 (7.3)	
Animal and crop farming	7 (30.0)	20 (1.3)	
Relative humidity of house			
<60%rh	80 (34.8)	506 (32.9)	0.576
>60%rh	150 (65.2)	1031 (67.1)	
Hospital visit?			
Yes	122 (53.0)	16 (1.0)	<0.001*
No	108 (47.0)	1521 (99.0)	

Characteristic	No. with wheeze (%)	No. without wheeze (%)	P value
Current treatment			
None	89 (38.7)	1519 (98.8)	
Antibiotics	136 (59.1)	17 (1.1)	<0.001*
Local herbs	5 (2.2)	1(0.1)	

<60 = Less than 60; >60 = Greater than 60; * Significant (<0.05)

Table 3 records the prevalence of wheeze and mean relative humidity of the respective wards. Mean relative humidity was highest in Gayam ward (76.3%rh) and least in Wakwa ward (52.5%rh). Gayam and Ciroma wards which both had the highest prevalence for wheezing (16.1% and 15.0% respectively) also had mean relative humidity greater than 60%rh. Of all the study population, 25.4% were from Gayam ward while Ciroma ward formed 13% of the study population, being the lowest. Differences in the prevalence of wheeze among children in the respective wards were not statistically significant ($p>0.05$). However, there was a statistically significant difference in the mean relative humidity across the wards ($p<0.05$).

Table 3. Prevalence of wheeze among children aged 0 – 8 years in each ward.

Ward	No. with wheeze (%)	No. without wheeze (%)	Total No. of children (%)	P* value	Mean RH(%rh)	P** value
Gayam	67 (15.0)	381 (85.0)	448 (25.4)		76.3	
Wakwa	49 (12.5)	343 (87.5)	392 (22.2)		52.5	
Akurba	40 (9.9)	366 (90.1)	406 (23.0)		57.1	
Ciroma	37 (16.1)	193 (83.9)	230 (13.0)		68.5	
Makama	37 (12.7)	254 (87.3)	291 (16.5)	.130	58.8	0.05
Total	230 (13.0)	1,537 (87.0)	1,767 (100)		-	

RH = Relative humidity; * Chi squared test;

**Analysis of Variance (ANOVA)

Table 4 shows the relationship between wheeze and associated factors as determined by univariate and multivariate logistic regression analysis. Our model reported a percentage accuracy of classification up to 93.9% and explained 28% to 52% of the variance in our dependent variable. Age range of 3 to 8 years significantly increased wheeze likelihood in the study population (AOR = 1.560; 95% CI = 1.023 – 2.378). Compared to children living in houses built with cement blocks, children living in mud houses stood a higher risk of wheezing (AOR = 1.812; 95% CI = 1.080 – 3.040). Current treatment status of the children with regards to the use of antibiotics and herbal

preparations were observed to be significant. Wheezing was most likely among children who had used or were currently using antibiotics (AOR = 143.593; 95% CI = 81.582 – 252.741) and more likely in those who had used or were using local herbal concoctions (AOR = 114.530; 95% CI = 12.522 – 1047.494). Living in a house with or without leaky roof during rain, relative humidity and type of farming activity were not found to influence wheezing in the study population.

Discussion

The present study has revealed a prevalence of 13.0% for wheeze in children aged 0 – 8 years within the study area. Earlier reports in Nigeria (Lagos and Ibadan) reported lower rates of 10.2% among ages 8-11 years²⁶ and 5.1% among children aged 6-7 years²⁷. A higher prevalence rate of 22.1% was earlier reported in children 5 years and below between 2000 and 2001 in Canada¹⁰. An earlier report of a study in Brazil by Moraes et al.¹³ also showed a higher incidence of wheezing in children between the ages of 0-6 years than in those aged between 7-14 years. Cases of wheezing was observed in the both age groups (0-2 and 3-8 years) of children involved in this study. Children are prone to respiratory conditions due to the young and developing nature of their respiratory organs, as well as their higher breathing periods and rates^{19,20}. The unique physiological, metabolic, behavioral, and self-care ability of children also explains their vulnerability to environmental hazards³⁰. A study by Tambalis et al³¹ reported that children were engaged in more physical activity than adolescents.

Our findings revealed a higher prevalence of wheezing in the older age group (3-8 years) which is in line with an earlier report of a higher incidence in the age group of 2-6 years¹³. This may not be unconnected with the behavior exhibited by this group of children. Older group tend to be more exposed to the environment than the younger ones who stay more in the care of their mothers. Interaction with inhabitants in the study area showed that motherly care reduced as the children grew older. Mothers tend to focus more care on the younger children and the newborns than the older ones, who are left to self-care. Hence, a number of the children play around without guidance and may sometimes sleep without proper covering, thereby exposing them to the cold environment. A research on dengue infection in children have also reported that environmental factors such as where and how children play contribute to high risk of the

Table 4. Factors associated with wheeze in children 0 – 8 years (n = 230).

Factor	No. with wheeze (%)	COR (90% CI)	P value	AOR (90% CI)	P value
Age (Years)					
0 – 2	69 (30.0)	1		1	
0 - 3	161 (70.0)	1.775(1.315 – 2.395)	<0.001*	1.560 (1.023 – 2.378)	0.039*
House type					
Cement blocks	43 (18.7)	1		1	
Mud blocks	184 (80.0)	1.614(1.137 – 2.292)	0.007*	1.812(1.080 – 3.040)	0.024*
Wooden structure	3 (1.3)	1.612(0.456 – 5.695)	0.458	0.786(0.108 – 6.108)	0.818
Leaky roof?					
No	190 (82.6)	1		1	
Yes	40 (17.4)	1.365(0.951 – 1.959)	0.092	0.767(0.463 – 1.270)	0.302
Farming activity					
None	178 (77.4)	1		1	
Animal farming	23 (10.0)	0.748(0.473 – 1.183)	0.214	0.689(0.358 – 1.328)	0.266
Crop farming	22 (9.6)	1.322(0.815 – 2.144)	0.258	1.419(0.728 – 2.764)	0.304
Mixed (crop and animal)	7 (30.0)	2.356(0.982 – 5.651)	0.055	0.699(0.138 – 3.543)	0.699
Relative humidity					
<60%rh	80 (34.8)	1		1	
>60%rh	150 (65.2)	0.920(0.688 – 1.232)	0.576	0.894(0.587 – 1.360)	0.600
Current treatment					
None	89 (38.7)	1		1	
Antibiotics	136 (59.1)	136.539(78.963 – 236.098)	<0.001*	143.593(81.582 – 252.741)	<0.001*
Local herbs	5 (2.2)	85.337(9.865 – 738.230)	<0.001*	114.530(12.522 – 1047.494)	<0.001*

COR = Crude odds ratio; CI = Confidence interval; AOR = Adjusted odds ratio; <60 = Less than 60; >60 = Greater than 60

*Significant (<0.05); COR or AOR of 1 indicates reference group.

infection in children³². To protect younger children especially infants against wheeze, prolonged breastfeeding by mothers and exposing children to Daycare centers only after 6 months of age have been used³³.

Dampness in buildings relates to the presence of moisture and has been associated with health problems such as asthma and other respiratory symptoms in both adults and children. Dampness results from some factors, one of which is flooding³⁴. A study in New Orleans conducted after a flooding incidence reported a mean relative humidity of between 56% and 70%³⁵. These values are lower than those recorded in some households in this study. Our study was conducted over a period notorious for yearly flooding in the

metropolis with the selected wards always being worse hit. A high relative humidity encourages elevated mould growth³⁶⁻³⁸ which could in turn, increase the risk of respiratory symptoms arising from airborne spores. Indoor air in areas with high relative humidity has been shown³⁹ to have a higher concentration of fungi when compared with air within low relative humidity areas. Following this, a relative humidity of at least 70%rh is generally considered ideal for the proliferation of fungi in indoor air. Although relative humidity indirectly affects health, a change in relative humidity does not increase or decrease the frequency or severity of these effects. It has been established that a relative humidity of between 40-60%rh is optimum for minimizing adverse health effects⁴⁰.

The mean relative humidity of the wards included in this study were below 70%rh except in one ward. This did not influence the development of wheeze in the study population based on the result of our logistic regression model.

The nature of building in which children slept was observed to significantly influence the development of wheeze in this study. Majority of children in which wheezing was established lived in houses built with blocks made from mud. In some cases, neither the walls nor the floor is plastered with cement, thereby leaving the surfaces exposed. More studies may be required to explain how living in mud built houses influence development of wheezing as has been found by this study. Also, our study did not establish any relationship between wheezing and living in a house with leaky roofs. Participation or otherwise in crop, animal or mixed farming (crop and animal) did not also influence development of wheezing in this study. Findings of this study also revealed that episodes of wheezing were occasionally experienced by more children in the study area. Only 2.2% households reported frequent wheezing by their children. Furthermore, most of the children have had hospital visits on account of the wheezing problem. A recent study in South Africa reported antibiotic use as a likely factor that influences wheeze in children²⁴. In the present study, current antibiotic use was also predicted to influence development of wheeze in children as majority of those who had used or were currently using antibiotics had wheeze. The level of hospital visits observed from the response of the parents may be due to some level of awareness occasioned by the activities of primary healthcare workers who go from house to house to create health awareness. Notwithstanding, the establishment of more primary healthcare centers may make healthcare more accessible to inhabitants of the study area. A sizable number of households however, sought no form of treatment for children with wheezing. Similarly, hospital visit was not considered by some of the parents. Most of the wards being largely rural to semi-urban communities, the use of herbal concoctions for alleviation of symptoms in a small population of children was also observed. This may place children at risk of developing acute respiratory conditions with attendant health effects. Wheezing is associated with some diseases aside asthma, although it is a symptom in many asthmatic patients⁴¹. For instance, an epidemiological study found 25% of subjects with wheeze but only 7%

had asthma⁴². Similarly, 5.1% of children were reported with wheezing in an earlier study in Ibadan but only 3.1% of the population was found to have asthma⁴³. In children who have reported wheeze as a major respiratory problem, conditions such as asthma and bronchiolitis have formed part of major diagnosis⁴⁴. Although most children who experience wheeze are likely to overcome it after the age of 6 years⁴⁵, it is important that children who wheeze are further screened to unveil the actual cause of the observed symptom.

Conclusion

The current study being a pilot study in Lafia, suggests that children in flood prone areas are exposed to factors that could predispose to developing respiratory problems as they grow. Symptoms such as wheezing could be a pointer to the possibility of other conditions in the children which may not be obvious yet. Age, Living in a mud house and the use of antibiotics and local herbal concoctions were significantly associated with wheezing in children. Younger children are more prone to wheezing than older children who are more physiologically mature. Closer care and attention by parents could reduce exposure of these category of children to environmental factors that trigger respiratory problems. Flood control through construction of drainages would be a better preventive measure as it could reduce flooding of buildings.

Limitations of the study

One limitation of this study was that only children in flood prone wards of the Lafia local government area were included. Including children from areas free of flooding as well as a study of flood prone areas during the dry season would have provided control groups with which to better explain findings reported by this study and availed data on relative humidity of homes for the two seasons. Some studies⁴⁶⁻⁴⁸ have related the presence of air pollutants such as gases, smoke, fungal spores and dust particles to development of wheezing in children. This study was, however, unable to include these kind of risk factors. Also, although our findings revealed a possible relationship between wheezing in children and the structural material of the house in which they live, we have not found sufficient evidence to support this.

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Conflict of interest: The authors declare that no competing interests exist.

Ethical approval: The study was approved by the ethics committee of the Nasarawa State Ministry of Health, Lafia (REF: S/MOH/843). The study was clearly explained in English or Hausa and informed consent was sought from the parents before their children were recruited into the study. Homes which did not consent to being part of the study were replaced.

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Author's contribution: Conceptualization and study design was by Aleruchi Chuku; all authors participated in performing the experiments and data collection. Godwin Attah Obande analyzed and interpreted collected data. The first draft of the manuscript was prepared by Godwin Attah Obande, Aleruchi Ckuku, and Mwanret Namang. All authors participated in the editing, proof-reading and approval of the final manuscript.

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