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Spatial Distribution Of Childhood Diseases And Their Determinants In Northern Nigeria: Key Insights For Health Policy And Intervention Planning

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Abstract:

Background: Childhood diseases remain leading causes of morbidity and mortality in sub-Saharan Africa, with Northern Nigeria disproportionately affected. Understanding the spatial distribution and determinants of these diseases is vital for effective health policy and targeted interventions.

Methods: The study employed a retrospective cross-sectional design using hospital records collected from selected tertiary and secondary healthcare facilities across six States in Northern Nigeria and the Federal Capital Territory. Data were extracted from a 10% sample of hospital records of children aged 0–59 months who received treatment between 2010 and 2020. The data were analyzed using SPSS version 23. Multinomial Logistic regression model assessed the determinants of childhood diseases among the children.

Results: The major diseases among under-five children in Northern Nigeria were Malaria, Neonatal Sepsis, Diarrhoea, Pneumonia, Preterm Complications and Yellow fever. There were some regional variations in the distribution. The main diseases in the North-East were Malaria (60.0%), Diarrhoea (11.4%), Yellow fever (10.5%), and Malnutrition (3.8%). In the North-West region the main diseases were Malaria (42.0%), Diarrhoea (9.0%), Yellow fever (6.9%), and Malnutrition (2.2%). In the North-Central, the major diseases were Neonatal Sepsis (12.8%), followed by Pneumonia (8.1%), Preterm Complications (5.2%) and Meningitis (2.8%).

The Multinominal logistic regression showed that the child's demographics (age, sex, residence, family type, family size, birth order, mother's age, and religion) and mother's socio-economic factors (education, occupation, and income) were powerful determinants of childhood diseases.

Conclusion: The burden of Childhood disease in Northern Nigeria is shaped by distinct geographic and socioeconomic patterns. Health policies must adopt spatially sensitive, evidence-based strategies to reduce child morbidity and mortality in the region.

Keywords: Childhood diseases, spatial distribution, Northern Nigeria, determinants, health policy, intervention planning

I. INTRODUCTION

Despite remarkable global improvements in child survival over the past three decades, preventable diseases remain among the leading causes of morbidity and mortality among under-five children in low- and middle-income countries. Earlier estimates show that about 11 million children died annually globally from these diseases. The sub- Saharan region seems to be the worst affected, accounting for most child deaths from preventable illnesses. According to a 2024 report of the United Nations Inter-Agency Group, approximately 4.8 million children under the age of five died globally in 2023, with nearly half of these deaths occurring in sub-Saharan Africa.

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Nigeria contributes about 13% of global under-five mortality.[3,4] Malaria, Diarrhea, and Acute Respiratory Infections (ARI) remain leading causes of childhood morbidity and mortality, often exacerbated by poverty, malnutrition, limited healthcare access, and environmental factors.[5-7] Vaccine-preventable diseases such as measles persist due to low immunization coverage, particularly in Northern Nigeria.[8]

Data from the Nigeria Demographic and Health Survey 2013, indicate variation in under-five mortality rates between the Geo-political zones with the North West recording 185 deaths per 1000 livebirths, the North East and North Central with 160 deaths and 100 deaths per 1000 livebirths respectively, the South East with 131 deaths per 1000 livebirths, the South- South with 91 deaths per 1000 livebirths and the South West with 90 deaths per 1000 livebirths.[4] Adebowale et al, in 2012 reported that childhood mortality is significantly higher in Northern Nigeria than in Southern Nigeria, with women's education and wealth index strongly inversely related to child death risk.[9]

Although numerous studies have examined individual diseases among under-five children in Nigeria, relatively few have simultaneously explored their spatial distribution and determinants using hospital-based data collected across multiple geopolitical zones in Northern Nigeria. Such information is essential for identifying disease hotspots, understanding geographical inequalities, and designing evidence-based interventions tailored to local contexts. Spatial analysis provides opportunities for more efficient allocation of health resources, improved disease surveillance, and targeted implementation of preventive programmes.

This study addresses this gap by mapping the spatial distribution of childhood diseases in Northern Nigeria and analyzing their determinants, providing critical insights for health policy and intervention planning.

The objectives of the study were to identify the major childhood diseases and their spatial distribution in the study area; describe the demographic, socio-cultural and economic factors that influence their presentation in the region and assess the implications of these for health intervention planning.

STUDY AREA AND METHODOLOGY

Northern Nigeria comprises 19 States across three geopolitical zones: North-Central, North-East, and North-West (Figure 1). With an estimated population of 127 million people in 2024, the region is characterized by high poverty rates, low literacy levels, and recurrent conflict, all of which shape health outcomes. To ensure adequate geographical representation, two States were selected for study in each Geopolitical zone. The selected States were Kaduna and Kebbi in the North-West, Benue and Kwara in the North-Central, Adamawa and Gombe in the North-East and the Federal Capital Territory (FCT) (Figure 2). The zone is characterized by considerable ecological diversity, extending from the Guinea Savannah in the southern part of the region to the Sudan and Sahel Savannah zones in the far north.

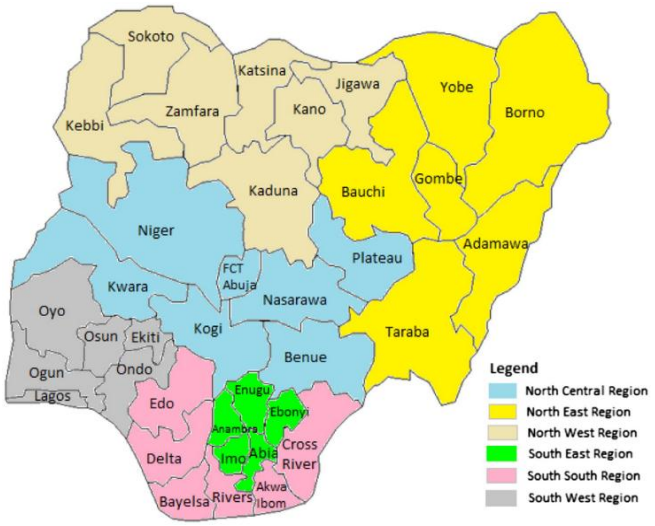

Figure 1: Map of Nigeria showing the Geo-political Zones

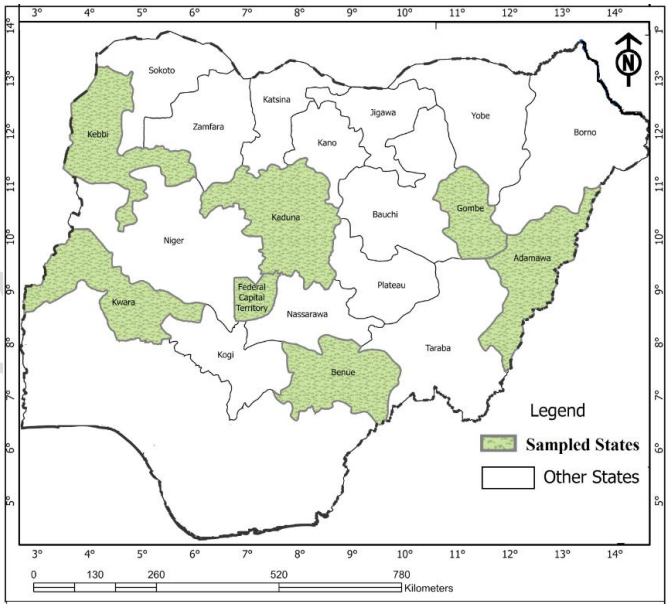

Figure 2: Map of Northern Nigeria Showing the Study Area

This study employed a retrospective cross-sectional design using hospital-based data to examine the spatial distribution and determinants of childhood diseases, including the identification of geographical and socioeconomic variations in childhood morbidity.

A multistage sampling procedure was adopted in selection of the sample for the study. The first stage categorized the 19 Northern States into three geopolitical zones. The second stage involved the selection of two States from each geopolitical zone. The third stage involved the selection of two healthcare facilities (a Secondary and a Tertiary facility) within each State and the Federal Capital Territory. The last stage involved a systematic sampling of 46,767 hospital records of eligible children aged 0-59 months who received treatment within a 10-year period between 2010 and 2020 from each participating hospital, representing 10% of the records of the children seen in the facilities within the study period. The data on the actual diseases were extracted from the hospital records by competent medical personnel.

The dependent variables were the diseases while the independent variables were the child's demographic and

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household characteristics and the mothers' demographic, cultural and socio-economic characteristics.

The data were coded, cleaned, and analysed using the Statistical Package for the Social Sciences (SPSS) Version 23. The spatial distribution of childhood diseases was illustrated using thematic maps. To identify determinants of childhood diseases, multinomial logistic regression analysis was employed.

Ethical approval for the study was obtained from the appropriate ethics committee of each health facility before data collection commenced. Patient confidentiality was maintained throughout the study.

II. RESULTS

DEMOGRAPHIC CHARACTERISTICS OF THE CHILDREN

There were regional variations in the age of the under-five children sampled in the study. In the North-central zone, the least number of children were in the 1-12 months age group (19.0%). In the North-East zone, the least number (15.1%) were those below 1 month of age, while in the North-West zone the least number (27.1%) were children in the 1-12 months age group. The proportions of male and female children was similar in all 3 geopolitical zones. With respect to the birth order, the largest group of children in the North-Central and North-West zones were between 1-3 (68.1% and 44.8% respectively), as against 54.0% in the North-East zone whose birth order was between 5-6. The details are shown in Table 1:

Variable	Geopolitical zone			Total
	North-Central (n: 24,869) No. (%)	North-East (n: 7,132) No. (%)	North-West (n: 14,766) No. (%)	(N: 46,767) No. (%)
Age (Months)				
< I month	9,843 (39.6)	1,080 (15.1)	4,272 (28.9)	15,195 (32.5)
1 – 12 months	4,736 (19.0)	2,520 (35.3)	3,999 (27.1)	11,255 (24.1)
13 – 60 months	9,623 (38.7)	3,503 (49.1)	6,475 (43.9)	19,601 (41.9)
Not recorded	667 (2.7)	29 (0.4)	20 (0.1)	716 (1.5)
Sex				
Male	13,803 (55.5)	3,430 (48.1)	7,360 (49.8)	24,593 (52.6)
Female	10,942 (44.0)	3,659 (51.3)	7,360 (49.8)	21,961 (47.0)
Not recorded	124 (0.5)	43 (0.6)	46 (0.3)	213 (0.4)
Birth Order				
1-3	16,934 (68.1)	1,721 (24.1)	6,611 (44.8)	25,266 (54.0)
4-6	4,681 (18.8)	3,849 (54.0)	6,018 (40.8)	14,548 (31.1)
7-9	425 (1.7)	994 (13.9)	1,404 (9.5)	2,823 (6.0)
Not recorded	2,829 (11.4)	568 (8.0)	733 (5.0)	4,130 (8.8)

Table 1: Demographic characteristics of the children

SOCIODEMOGRAPHIC CHARACTERISTICS OF THE MOTHERS

Majority of the mothers in the study area 26,697 (57.1%) were in the 20–29-year-old age group, while the lowest category was in the 40–49-year age group (1,207; 2.6%). Overall, the majority lived in urban settlements, though there were regional differences. The overwhelming majority, of the mothers in the North-Central zone 18,281 (73.5%) resided in urban settlements, unlike those in the North-East and North-West zones in which 4,977 (69.8%) and 8,379 (56.7%) respectively lived in rural settlements.

In the North-Central and North-West zones 20,143 (80.0%) and 27,804 (59.5%) respectively were in monogamous marriages, against the majority 5,757 (80.7%) in the North-East zone who were in polygynous marriages. Overall, there were more Christians in the study 24,423 (52.25%), with regional variations. The vast majority in the North-Central zone 17,431 (70.1) were Christians, while in the North-East and North-West zone there were more Muslims 5,661 (79.4) and 8,746 (59.2) respectively. In all 3 geopolitical zones, majority of the mothers were fulltime housewives. (Table 2)

Variable	Geopolitical zone			Total
	North-Central (n: 24,869) No. (%)	North-East (n: 7,132) No. (%)	North-West (n: 14,766) No. (%)	(N: 46,767) No. (%)
Age group (years)				
15-19	428 (1.7)	750 (10.5)	982 (6.7)	2,160 (4.6)
20-29	11,625 (46.7)	5,549 (77.8)	9523 (64.5)	26,697 (57.1)
30-39	9,294 (37.4)	811 (11.3)	3,863 (26.2)	13,968 (29.8)
40-49	835 (3.3)	0 (0.0)	372 (2.5)	1,207 (2.6)
Not Recorded	2,687 (10.8)	22 (0.3)	26 (0.2)	2,735 (5.8)
Residence				
Urban	18,281 (73.5)	2,099 (29.4)	6,329 (42.9)	26,707 (57.1)
Rural	6,385 (25.7)	4,977 (69.8)	8,379 (56.7)	19,741 (42.2)
Not Recorded	203 (0.8)	56 (0.8)	58 (0.4)	317 (0.7)
Family Type				
Monogamous	20,143 (81.0)	1,078 (15.1)	6,583 (44.5)	27,804 (59.5)
Polygynous	1,884 (7.6)	5,757 (80.7)	7,745 (52.5)	15,386 (32.9)
Single Parent	234 (0.9)	192 (2.7)	353 (2.4)	779 (1.7)
Not Recorded	2,608 (10.5)	105 (1.5)	85 (0.6)	2,798 (6.0)
Family Size				
< 3	12,197 (49.0)	847 (11.9)	4,277 (29.0)	17,321 (37.0)
3-4	7,695 (30.9)	2,352 (33.0)	5,017 (34.0)	15,064 (32.0)
5-6	1,803 (7.2)	1,890 (26.5)	3,031 (20.0)	6,724 (14.4)
7-8	385 (1.5)	1,114	1,369	2,868

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Variable	Geopolitical zone			Total
	North-Central (n: 24,869) No. (%)	North-East (n: 7,132) No. (%)	North-West (n: 14,766) No. (%)	(N: 46,767) No. (%)
		(15.6)	(9.3)	(6.1)
> 8	155 (0.6)	912	1,067	2,134
		(12.8)	(7.2)	(4.6)
Not Recorded	2,634	17 (0.2)	5 (0.03)	2,656
	(10.6)			(5.7)
Religion				
Christianity	17,431	1,224	5,768	24,423
	(70.1)	(17.2)	(39.1)	(52.2)
Islam	7,010	5,661	8,746	21,417
	(28.2)	(79.4)	(59.2)	(45.8)
Traditional/Others	35 (1.5)	216	235	596 (1.2)
		(3.0)	(1.6)	
Not Recorded	283 (1.1)	31 (0.4)	17 (0.1)	331 (0.7)
Educational Status				
Non-Formal	1,587 (6.4)	404	857	2,848
		(5.7)	(5.8)	(6.1)
Koranic	407 (1.6)	2358	3092	5857
		(33.1)	(20.9)	(12.5)
Primary	2465 (9.9)	1282	2278	6025
		(18)	(15.4)	(12.9)
Secondary	11789	1317	4325	17431
	(47.4)	(18.5)	(29.3)	(37.3)
Tertiary	6,623	418	2,808	9,849
	(26.6)	(5.8)	(19.0)	(21.0)
Not Recorded	1,998 (8.0)	1,353	1,406	4,757
		(19.0)	(9.5)	(10.2)
Occupation				
Civil Service	3,163	348	1,681	5,192
	(12.7)	(4.9)	(11.4)	(11.1)
Trading	5,803	1,193	2,846	9,842
	(23.3	(16.7)	(19.3)	(21.0)
Farming/Firewood	497 (0.02)	1,405	2,052	3,954
Harvesting		(19.7)	(13.9)	(8.5)
Housewife	8,861	4,117	6,969	19,947
	(35.6)	(57.7)	(47.2)	(42.7)
Others	3,954	52 (0.7)	1,201	5,207
	(15.9)		(8.1)	(11.1)
Not Recorded	2,591	17 (0.2)	17 (0.1)	2,625
	(10.4)			(5.6)
Monthly Income (Naira)				
<10,000.00	7,944	3,952	6,079	17,975
	(31.9)	(55.4)	(41.2)	(38.4)
10,001.00-20,000.00	8,464 (34)	1,150	3,877	13,491
		(16.1)	(26.3)	(28.8)
20,001 - 50,000.00	3,350	796	2,342	6,488
	(13.5)	(11.2)	(15.9)	(13.9)
> 50,000.00	13 (0.1)	150	185	348 (0.7)
		(2.1)	(1.3)	
Not Recorded	5,098	1,084	2,283	8,465
	(20.5)	(15.2)	(15.5)	(18.1)

Table 2: Sociodemographic characteristics of the mothers in the study

MAJOR CHILDHOOD DISEASES

A total of sixteen diseases with occurrence of at least 0.3% were identified from hospital records across the study area during the ten-year review period. The most prevalent diseases were Malaria (29%), Neonatal Sepsis (8.7%), Diarrhoea (8%), Pneumonia (7.1%), Preterm Complications (3.9%) and Yellow Fever (3.9%). The 'others', constituting 29.3%, were a group of diseases whose incidences were less than 0.3% of the total. (Figure 3).

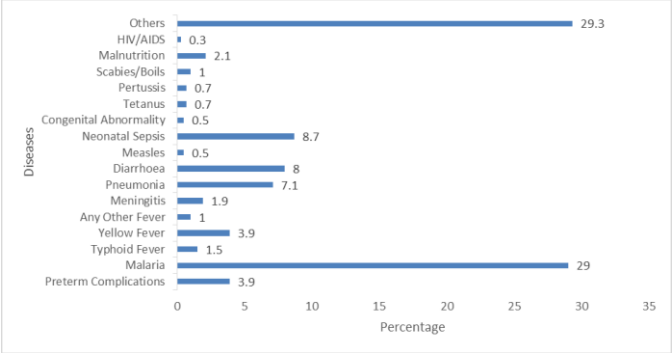

Figure 3: Major Childhood Diseases in Northern Nigeria

SPATIAL DISTRIBUTION OF MAJOR CHILDHOOD DISEASES IN THE STUDY AREA

The spatial distribution of childhood diseases revealed substantial geographical variation across the three geopolitical zones of Northern Nigeria (Figures 4–12).

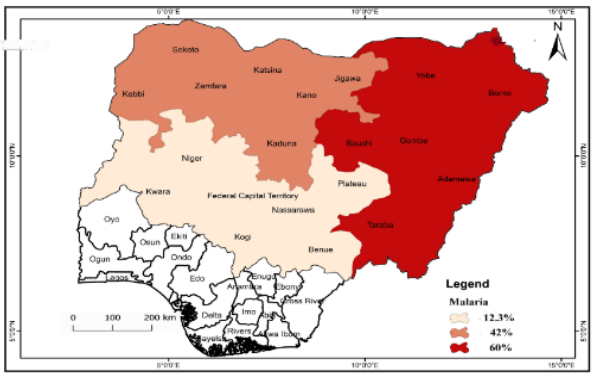

Figure 4: Percentage Distribution of Malaria

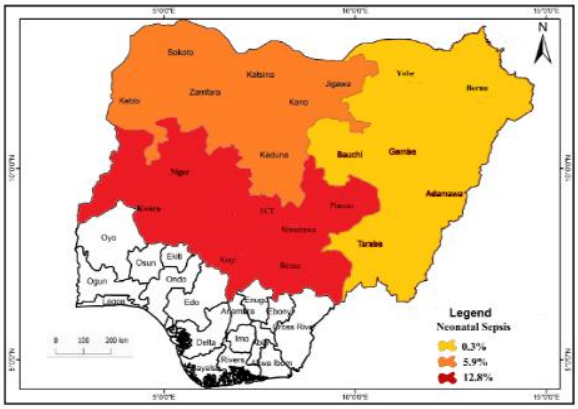

Figure 5: Percentage Distribution Neonatal Sepsis

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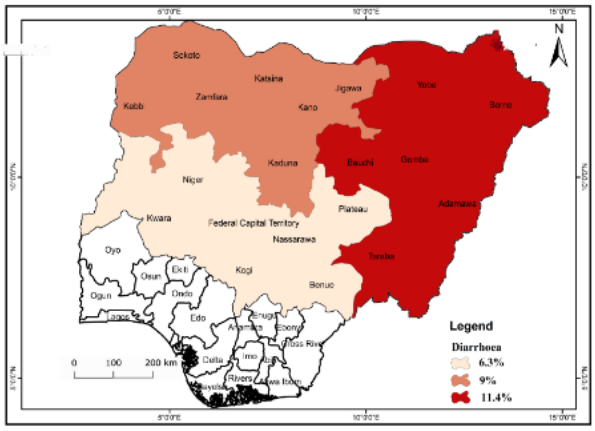

Figure 6: Percentage Distribution of Diarrhoea

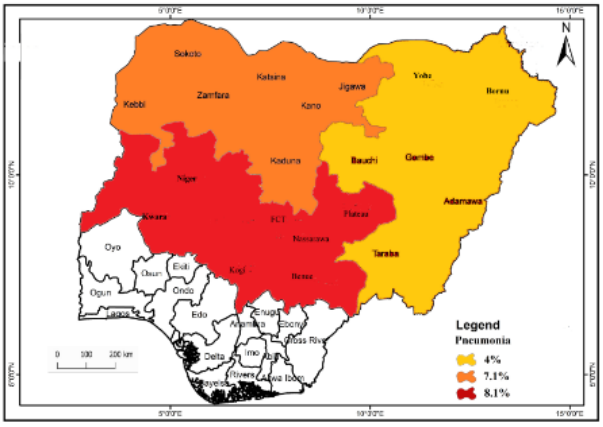

Figure 7: Percentage Distribution of Pneumonia

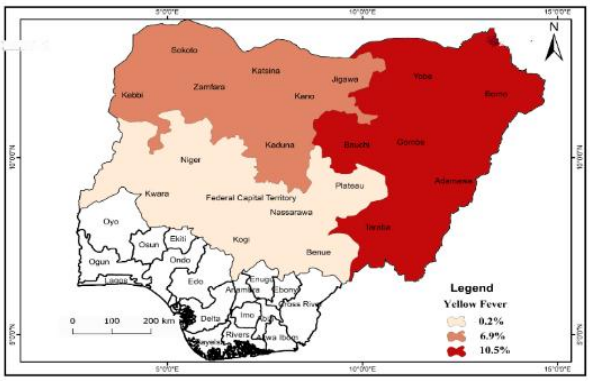

Fig 8: Percentage Distribution of Yellow Fever

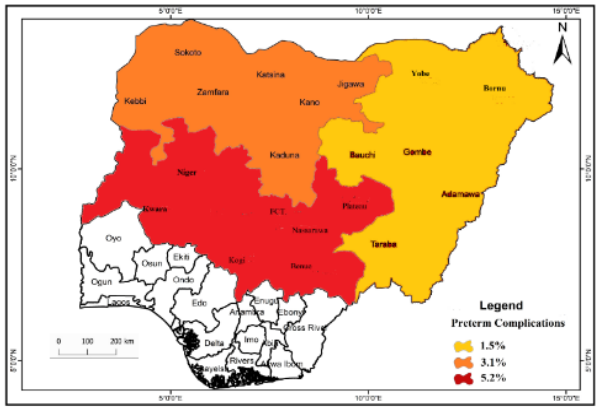

Fig 9: Percentage Distribution of Preterm Complications

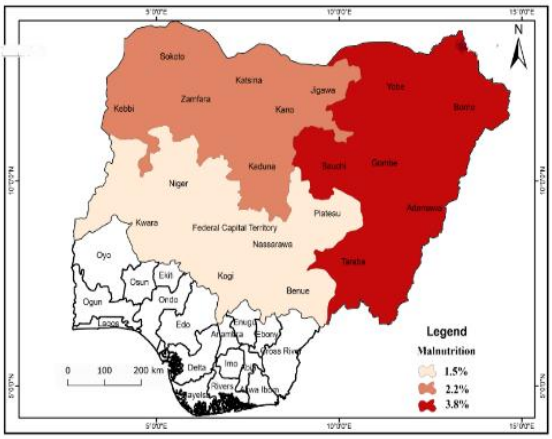

Figure 10: Percentage Distribution of Malnutrition

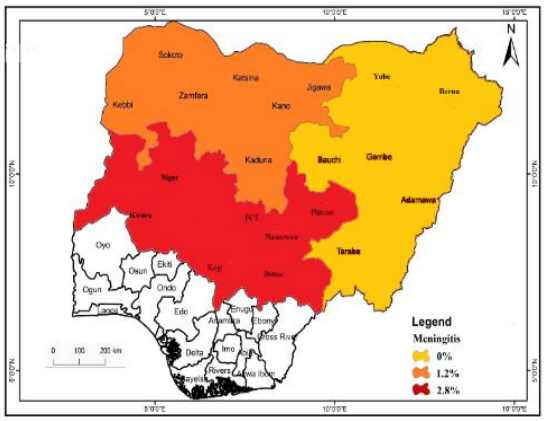

Figure 11: Percentage Distribution of Meningitis

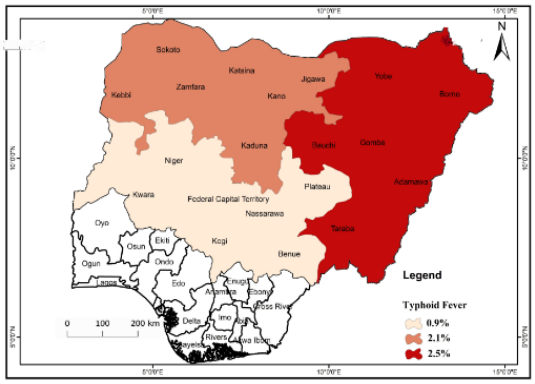

Figure 12: Percentage Distribution of Typhoid Fever by Zones

The results show that the major diseases in the North-East and North-West zones were Malaria (60.0%) and (42.0 %), Diarrhoea (11.4% and 9.0%), Yellow fever (10.5% and 6.9%) and Malnutrition (3.8% and 2.2%) respectively. In the North-Central zone, the major diseases were Neonatal Sepsis (12.8%), followed by Pneumonia (8.1%), Preterm Complications (5.2%) and Meningitis (2.8%).

DETERMINANTS OF CHILDHOOD DISEASES

The influence of demographic, socioeconomic, cultural, and household factors on childhood diseases in Northern Nigeria was examined using Multinominal logistic regression analysis. The analysis was restricted to the five major diseases (Malaria, Neonatal Sepsis, Diarrhea, Pneumonia, and Preterm

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Complications/Yellow Fever) as shown in Figure 3. Other diseases collectively referred to as "Others" occurred with a lower prevalence. These included malnutrition, typhoid fever, meningitis, and measles.

The regression analysis results show that all variables included in the model were statistically significant ($p < 0.05$ at $p = 0.0000$) (Table 3). Both the child's demographics (age, sex, residence, family type, family size, birth order, mother's age, and religion) and mother's socio-economic factors (education, occupation, and income) were powerful determinants of childhood diseases.

The regression results show that the child's demographic factors such as age ($\beta = 0.186$; $\chi^2 = 2365987.863$), sex ($\beta = 1.173$; $\chi^2 = 216.408$), residence ($\beta = 0.011$; $\chi^2 = 123.003$), household characteristics (family type ($\beta = 0.103$; $\chi^2 = 316195.547$), family size ($\beta = 1.556$; $\chi^2 = 47804.715$), birth order ($\beta = 0.658$; $\chi^2 = 573508.484$), significantly influenced disease risk, indicating that both biological and household factors play critical roles in child health. Maternal cultural characteristics (religion - $\beta = 1.330$; $\chi^2 = 198.063$), socio-economic variables - particularly education ($\beta = 0.853$; $\chi^2 = 22704.040$), occupation ($\beta = 0.321$; $\chi^2 = 262423.234$), and income ($\beta = 1.206$; $\chi^2 = 576,119.491$) were the strongest predictors.

Variables	Beta Coefficient	Chi-Square	P value	Standard Error	95% Confidence Interval	Odds ratio
Child's Age	0.186041	2365987.863	0.0000	0.171927	0.592	0
Sex	1.173950	216.408	0.0000	0.874144	1.0557	0
Residence	0.011438	123.003	0.0000	0.758584	1.2235	0
Family Type	0.103559	316195.547	0.0000	0.578887	0.3566	1
Family Size	1.556080	47804.715	0.0000	0.138381	0.0726	0
Birth Order	0.658771	573508.484	0.0000	0.138381	1.4733	1
Mother's Age	1.614529	974908.939	0.0000	0.692295	1.2998	1
Mother's Religion	1.330014	198.063	0.0000	0.772037	0.0000	1
Mother's Education	0.853868	22704.040	0.0000	0.125561	1.8363	2
Mother's Occupation	0.321938	262423.234	0.0000	0.125561	0.6996	1
Mother's Income	1.206286	576119.491	0.0000	0.599949	1.0308	3

Table 3: Multinomial logistic regression analysis on determinants of under-5 Childhood diseases

III. DISCUSSION

The study shows a clear spatial distribution of childhood diseases in the study area, reflecting socioeconomic deprivation, weak health systems, and insecurity. The findings of this study highlight the multifactorial determinants of childhood diseases, reflecting both demographic and socio-economic influences. Child-specific characteristics such as age, sex, and birth order were significant predictors of disease occurrence. The increased vulnerability of younger children aligns with previous studies showing that immature immune systems predispose children to higher risks of infections in early life.[10] Similarly, the effect of sex on disease burden supports evidence of gender-based differences in exposure and care-seeking behavior, particularly in developing contexts where cultural norms influence child health outcomes.

Household and family characteristics also played important roles. Larger family size and extended family types were associated with higher disease prevalence, likely due to overcrowding and competition for limited household resources. These findings corroborate the work of Adebowale et al. who found that household crowding and large family structures increase the risk of childhood morbidity in Nigeria. The influence of maternal age suggests that both very young and older mothers may face challenges in providing optimal child care, consistent with evidence linking extremes of maternal age to poor child health outcomes.

Socio-economic variables, particularly maternal education, occupation, and income, emerged as the strongest determinants of childhood diseases. Educated mothers are better equipped with knowledge on hygiene, nutrition, and healthseeking practices, which translates into improved child survival.[13,14] Maternal income further enhances the ability to access healthcare services and provide adequate nutrition, echoing the conclusions of Rutstein that socio-economic status remains a fundamental driver of child health inequities.[15] Religion also significantly influenced health outcomes, reflecting the role of cultural beliefs in shaping health utilization and acceptance of preventive practices such as immunization.

Taken together, these results underscore the importance of addressing structural determinants of health, particularly maternal education and household economic empowerment, in reducing the burden of childhood diseases. Interventions that combine poverty alleviation with targeted maternal education programs may therefore be most effective in improving child health outcomes in Nigeria and similar settings.

IMPLICATIONS FOR HEALTH POLICY AND INTERVENTION PLANNING

The analysis shows areas of high-burden diseases which will guide distribution of health resources (medical personnel, infrastructure, vaccines) based on needs rather than a uniform approach. Variations in type of diseases by age will require specific health education and awareness by both parents and health care providers and strengthening Primary Healthcare for early diagnosis of diseases and treatment. Many of the rural areas have inadequate infrastructures and many unreported cases of childhood diseases. There is therefore the need for provision of mobile clinics and outreach programmes. Knowledge of environmental risk factors of childhood diseases is high. However, there is need for improving access to clean water, proper waste disposal and to focus on behavioural change strategies.

IV. CONCLUSION

The study reveals marked geographic disparities in the distribution of childhood diseases across the study area, with malaria predominating in the North-East and North-West zones, while neonatal sepsis and pneumonia are more prevalent in the North-Central zone. These findings underscore the need for zone-specific, evidence-based health policies and interventions tailored to the unique disease patterns of each zone. Given that the determinants of childhood diseases are multifaceted, effective disease control requires targeted strategies that address the demographic, household, and socioeconomic factors influencing health outcomes. Consequently, resource allocation should be guided by the disease burden and specific needs of each zone to effectively reduce under-five morbidity.

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