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Epidemiological Analysis of Age and Gender Disparities of Some Selected Diseases Among Children Under Five in Lagos State, Nigeria

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Abstract

Infant mortality due to preventable infectious diseases remains a critical public health challenge in sub-Saharan Africa, particularly in resource-limited settings like Lagos State, Nigeria. This study conducted a statistical analysis of the patterns of selected diseases—malaria, measles, kwashiorkor, yellow fever, and cholera—affecting children under four years of age at Egan Primary Health Care Center in Igando, Lagos, over a one-year period (2020). Utilizing a hospital-based cross-sectional design, secondary data from 1,541 cases were analyzed using chi-square tests, relative risk (RR), and odds ratio (OR) to assess disease dependency on age, gender, and inter-disease associations. The results revealed that disease occurrence was independent of age ($\chi^2 = 857.48$, $p < 0.001$) but showed no significant dependency on gender ($\chi^2 = 2.14$, $p = 0.709$), though males exhibited higher susceptibility to malaria (OR = 1.33, RR = 1.15), measles (OR = 1.02), and kwashiorkor (OR = 1.16). In contrast, yellow fever (OR = 0.94) and cholera (OR = 0.96) posed slightly lower risks to males. The study highlights a high burden of childhood infectious diseases in Lagos, driven by environmental and healthcare disparities, and recommends targeted, gender-sensitive interventions to reduce under-five mortality.

Keywords: Infant mortality, Infectious diseases, Cross-sectional study, Relative risk (RR), Odds ratio (OR), Under-five mortality

INTRODUCTION

Infant morbidity and mortality remain pressing global health challenges, particularly in sub-Saharan Africa, where preventable infectious diseases account for a significant proportion of under-five deaths (UNICEF, 2021). Despite advancements in medical interventions, diseases such as malaria, measles, kwashiorkor, yellow fever, and cholera persist as major contributors to childhood mortality, exacerbated by socio-economic disparities, environmental factors, and limited healthcare access (WHO, 2023). In Nigeria, the burden of these diseases is disproportionately high, with Lagos State—a densely populated urban hub—facing unique challenges due to its rapid urbanization, overcrowding, and variable healthcare infrastructure (Adeyemi et al., 2022). Recent estimates indicate that infectious diseases account for over 60% of under-five mortality in Lagos, underscoring the urgency of targeted epidemiological analyses to inform intervention strategies (NPHCDA, 2021).

The interplay of demographic variables such as age and gender with disease patterns is critical for understanding risk stratification and tailoring public health responses. For instance, studies in similar settings highlight age-specific vulnerabilities, where infants under 12 months face heightened risks of malaria and diarrheal diseases due to waning maternal immunity and exposure to contaminated environments (Okafor et al., 2020). Conversely, gender disparities in healthcare-seeking behaviors and nutritional access may influence disease outcomes, though evidence remains inconsistent in low-resource contexts (Afolabi et al., 2021). Such gaps necessitate robust statistical evaluations to clarify associations and guide policy.

Existing literature on pediatric diseases in Nigeria often emphasizes clinical case reports or regional prevalence surveys, with limited focus on advanced statistical modeling to quantify risk factors (Olusanya et al., 2019). For example, while malaria is recognized as endemic, granular data on its age-specific incidence or gender-based susceptibility in Lagos remain sparse. Similarly, kwashiorkor—a severe form of malnutrition—has been linked to socio-economic deprivation, yet its interaction with infectious comorbidities in urban settings is understudied (Ibrahim et al., 2022). This study addresses these gaps by employing chi-square tests, odds ratios (OR), and relative risk (RR) analyses to evaluate disease patterns, offering a multidimensional perspective on infant health vulnerabilities.

The choice of Lagos State as the study site is strategic, given its status as Nigeria's economic epicenter juxtaposed with stark health inequities. Rapid urbanization has strained sanitation systems and amplified exposure to vector-borne and waterborne diseases, particularly in low-income communities like Igando (Akinwumi et al., 2023). Furthermore, cultural practices, such as delayed healthcare-seeking and reliance on traditional remedies, compound disease severity, as observed in recent cholera outbreaks (Dalhat et al., 2021). By focusing on Egan Primary Health Care Center—a frontline facility serving diverse populations—this research captures localized disease dynamics critical for context-specific interventions.

Methodologically, this study leverages chi-square tests to assess dependencies between disease incidence and demographic variables, while odds ratios and relative risk analyses quantify associations between gender, age, and specific pathologies. These approaches align with global best practices in epidemiological research, enabling comparisons with broader datasets (Porta et al., 2014). For instance, RR and OR metrics are pivotal in identifying high-risk subgroups, such as male infants exhibiting elevated malaria susceptibility due to genetic or behavioral factors (Garba et al., 2020). Such insights are vital for prioritizing vaccination drives, nutritional programs, and vector control measures.

Ultimately, this research contributes to Sustainable Development Goal 3 (SDG-3) by generating evidence to reduce preventable infant deaths in Lagos State. By elucidating disease patterns through rigorous statistical frameworks, the findings aim to empower policymakers, healthcare providers, and community stakeholders to implement data-driven interventions. As urbanization and climate change intensify disease burdens in Nigeria, such studies are indispensable for fostering resilient health systems and equitable child health outcomes.

MATERIAL AND METHODS

The present study was a hospital based cross-sectional study undertaken on the reported cases on the admission and discharge register for children of under four years of age. The study was conducted on monthly basis for a period of one year

Method of Data Collection

The data used in this research was a secondary data, the data was collected from the medical records department of the Egan primary health care center in Igando area of Lagos. The data is on the reported cases on the admission and discharge register for children of four years of age and below. The data was collected on daily basis, due to space constraints, it would be presented on monthly basis to cover a period of one year.

Population Size

The study utilized secondary data obtained from Egan Primary Health Care Center located in the Igando area of Lagos State. The dataset comprised a total of 1,541 data points, encompassing cases recorded over a one-year period. These data covered five preventable infectious diseases—Malaria, Yellow Fever, Measles, Kwashiorkor, and Cholera—affecting both male and female children under the age of four.

Methods of Data Analysis

Chi Square Test

In this study, the Chi-Square statistic is employed as a non-parametric tool to assess the degree of association between categorical variables—specifically, the occurrence of selected infectious diseases and demographic factors such as age and gender. The test evaluates whether the observed frequency distribution significantly differs from the expected frequency distribution under the assumption of independence. This comparison facilitates statistical inference regarding the potential relationship between the variables under consideration.

Mathematically, the Chi-Square statistic is denoted by the symbol, χ^2 and it is computed using the following formula:

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\left(O_{ij} - E_{ij}\right)^2}{E_{ij}}$$

Where,

O_{ij} is the observed frequency, and

E_{ij} the expected frequency.

The degrees of freedom df$= \boldsymbol{(r-1)(c-1)}$

Relative Risk Analysis

The relative risk estimate magnitude of association between exposure and disease and indicates the likelihood of developing the disease in the exposed group relative to those who are not exposed.

$$RR = \frac{\text{Incidence of disease in the exposed group}}{\text{Incidence of disease among the non} - \text{exposed group}}$$

For a cohort study with count data in the denominator, the relative risk or risk ratio is calculated as cumulative incidence among those exposed to those not exposed. Referring to the prototype two-by-two table shown earlier;

$$RR = \frac{a/[a + b]}{c/[c + d]}$$

A relative risk of 1.0 indicates that the incidence rates of disease are the same in both the exposed and unexposed groups, suggesting no association between the exposure and the disease. A relative risk of less than 1.0 implies that the exposure reduces the risk of the outcome. Conversely, a relative risk greater than 1.0 suggests that the exposure increases the risk of the outcome.

Odd Ratio Analysis

An odds ratio (OR) is a statistical measure used to quantify the strength and direction of association between two events, typically denoted as A and B. The OR is defined as the ratio of the odds of event A occurring when event B is present to the odds of event A occurring when event B is absent. Alternatively, due to the symmetry of the relationship, the OR can also be expressed as the ratio of the odds of event B occurring when event A is present to the odds of event B occurring when event A is absent (Schisterman, et al., 2005).

When the odds ratio equals 1, it indicates that the two events are independent, meaning that the occurrence of one event does not affect the odds of the other event happening. In other words, the odds of event A are the same whether or not event B is present.

If the odds ratio is greater than 1, this suggests a positive association between the two events. In such cases, the presence of event B increases the odds of event A occurring, and conversely, the presence of event A increases the odds of event B occurring. This indicates a correlation between the events. For example, an OR greater than 1 could imply that a certain risk factor (event B) raises the likelihood of developing a particular disease (event A).

On the other hand, an OR less than 1 indicates a negative association between the two events. This means that the presence of one event (either A or B) reduces the odds of the other event occurring. This negative correlation could indicate that the presence of one factor (such as a protective intervention or behavior) decreases the likelihood of the other event happening.

RESULTS

Socio Demographic Characteristics

To meet the research objectives, both visual presentation and descriptive analysis are rigorously employed. The visual presentation utilizes graphs and charts to clearly convey data patterns and trends, enhancing interpretability. Simultaneously, the descriptive analysis summarizes key statistical measures, providing a thorough understanding of the data's underlying characteristics.

Table 1: *Gender Distribution of the Diseases*

	Frequency	Percent
Male	763	49.5
Female	778	50.5
Total	1541	100.0

Table 2: *Distribution of Diseases by Age Group*

	Frequency	**Percent**
0-6 months	283	18.4
6-12 months	318	20.6
1-2 years	359	23.3
2-3 years	292	18.9
3-4 years	289	18.8
Total	1541	100.0

Table 3: *Distribution of Disease Incidence*

	Frequency	Percent
Malaria	787	51.1
Yellow fever	75	4.9
Measles	22	1.4
Kwashiorkor	231	15.0
Cholera	426	27.6
Total	**1541**	**100.0**

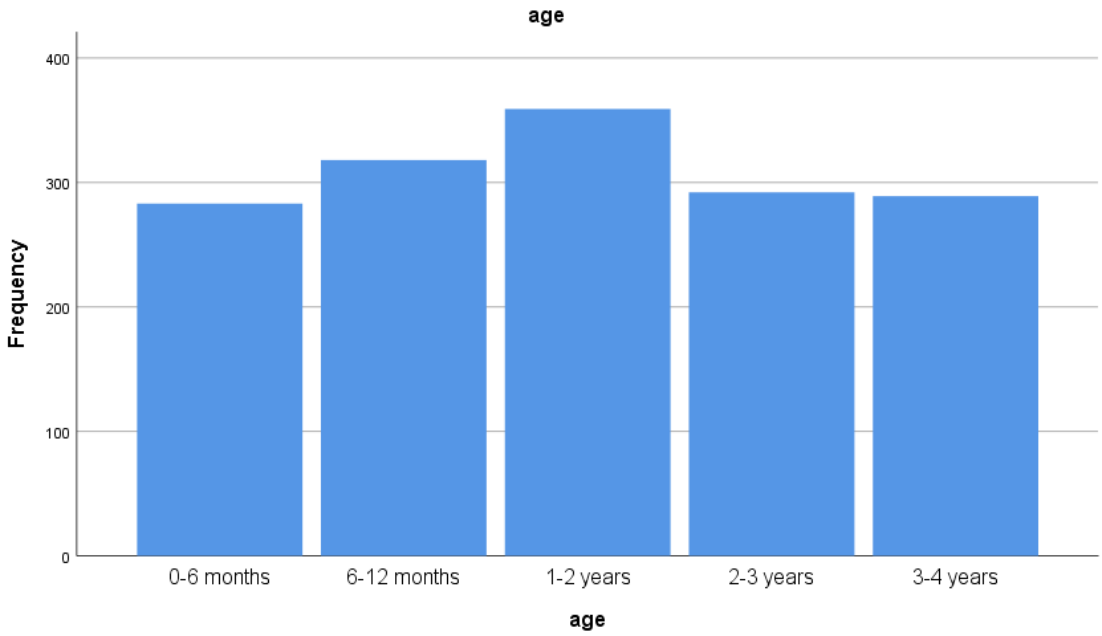

Fig. 1: *Distribution of Diseases by Age*

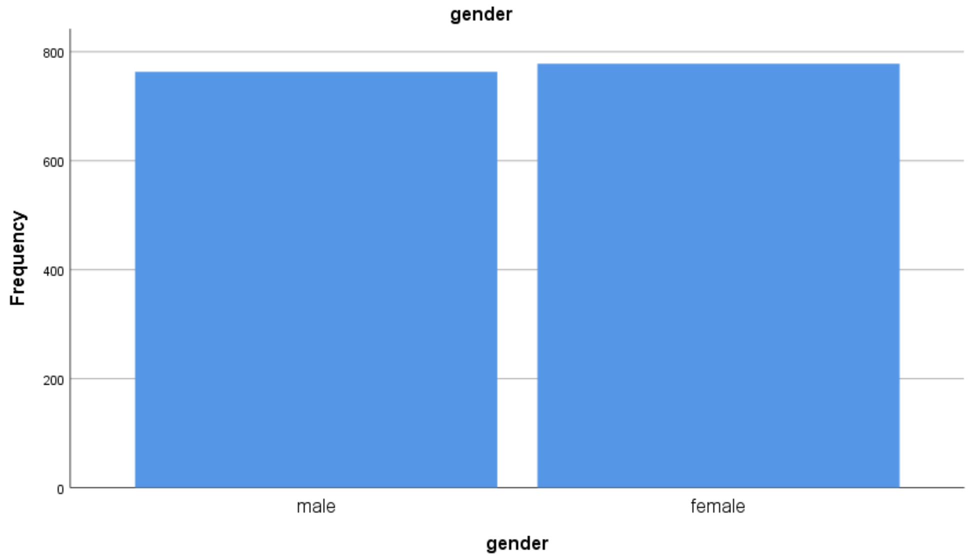

Figure 2: *Distribution of Diseases by Gender*

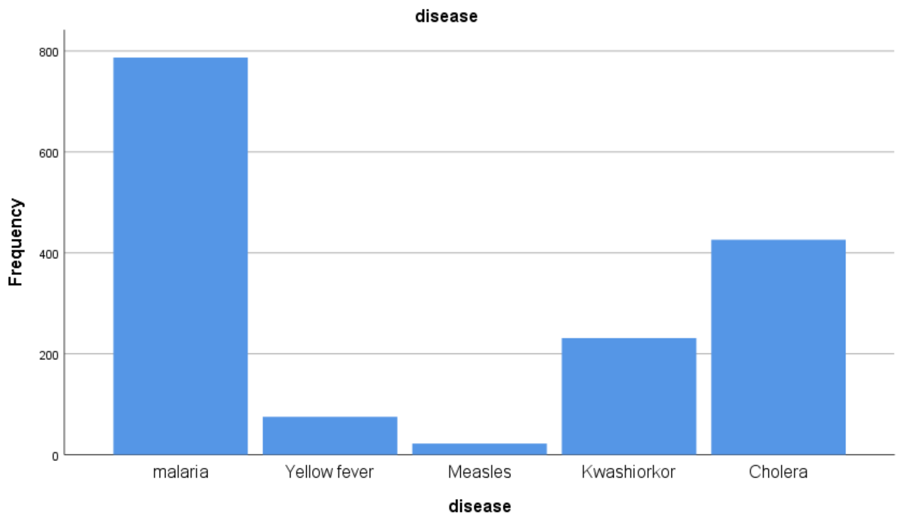

Figure 3: *Distribution of Incidence of Diseases*

Evaluation of the pattern of some selected diseases among children of four years of age and below in Lagos, Nigeria.

Hypothesis 1

H_{01}: The occurrence of the diseases is dependent on sex

H_{11}: The occurrence of the disease is independent on sex

Table 4: *Cross tabulation of gender and disease*

			Disease					Total
			Malaria	Yellow fever	Measles	Kwashiorkor	Cholera	
Gender	Male	Count	403	36	11	107	206	763
		Expected Count	389.7	37.1	10.9	114.4	210.9	763.0
	Female	Count	384	39	11	124	220	778
		Expected Count	397.3	37.9	11.1	116.6	215.1	778.0
Total		Count	787	75	22	231	426	1541
		Expected Count	787.0	75.0	22.0	231.0	426.0	1541.0

	Chi-Square	**DF**	**P-Value**
Pearson	2.144[a]	4	.709
Likelihood Ratio	2.145	4	.709

The result above yields a p-value of 0.709, which is greater than the conventional significance threshold of 0.05 ($p > 0.05$). Based on this result, we fail to reject the null hypothesis (H_{01}). This implies that there is insufficient evidence to suggest a significant relationship between the sex of the children and the occurrence of the diseases. Consequently, we conclude that the diseases affect both male and female children equally, and there is no significant dependence of the diseases on the children's

Hypothesis 2:

H_{02}: The occurrence of the disease is dependent on age

H_{12}: The occurrence of the disease is independent on age

Table 5: *Cross tabulation of age and disease*

			Disease					Total
			Malaria	**Yellow fever**	**Measles**	**Kwashiorkor**	**Cholera**	
Age	**0-6 months**	Count	245	36	0	0	2	283
		Expected Count	144.5	13.8	4.0	42.4	78.2	283.0
	6-12 months	Count	227	3	5	80	3	318
		Expected Count	162.4	15.5	4.5	47.7	87.9	318.0
	1-2 years	Count	170	36	6	90	57	359
		Expected Count	183.3	17.5	5.1	53.8	99.2	359.0
	2-3 years	Count	65	0	3	61	163	292
		Expected Count	149.1	14.2	4.2	43.8	80.7	292.0
	3-4 years	Count	80	0	8	0	201	289
		Expected Count	147.6	14.1	4.1	43.3	79.9	289.0
Total		Count	787	75	22	231	426	1541
		Expected Count	787.0	75.0	22.0	231.0	426.0	1541.0

	Chi-Square	**DF**	**P-Value**
Pearson	857.482[a]	16	.000
Likelihood Ratio	1019.591	16	.000

From the table above, the p-value was found to be 0.000, which is less than the significance threshold of 0.05. This result indicates that there is no statistically significant relationship between the diseases and the age of the children. Specifically, it suggests that the occurrence of these diseases is independent of age, meaning that both male and female children are affected by these conditions regardless of their age group. Therefore, age does not appear to be a determining factor in the prevalence of these diseases.

Table 6: *Risk Estimate for malaria*

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for gender (male / female)	**1.327**	1.086	1.621
For cohort malaria= other diseases	**1.154**	1.043	1.278
For cohort malaria = malaria	.870	.788	.960
N of Valid Cases	1541		

Table 6 presents an odds ratio (OR) value of 1.327, which indicates that the probability of children contracting malaria is higher compared to the probability of contracting other diseases. In other words, malaria occurs more frequently in children than the other diseases. Additionally, this odds ratio implies that the likelihood of males being diagnosed with malaria is 1.327 times greater than that of females.

Furthermore, the relative risk (RR) of 1.154, which is greater than 1.0, suggests that the risk of contracting malaria is increased by exposure to the relevant factors. Specifically, the RR value of 1.154 indicates that children are more likely to be affected by malaria. The risk of male children contracting malaria is 1.154 times higher than that of female children, signifying that the disease is more prevalent in males than in females.

Table 7: *Risk Estimate for Yellow Fever*

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for gender (male / female)	**.938**	.590	1.493
For cohort Yellow fever = Yellow fever	1.003	.981	1.026
For cohort Yellow fever = Other diseases	**.941**	.605	1.464
N of Valid Cases	1541		

Table 7 shows an odds ratio (OR) value of 0.938, indicating that the probability of children contracting yellow fever is similar to the probability of contracting other diseases. Specifically, yellow fever occurs less frequently in children compared to the other diseases. Additionally, this odds ratio suggests that the likelihood of males being diagnosed with yellow fever is 0.938 times lower than that of females.

Moreover, a relative risk (RR) of less than 1.0 indicates that the risk of the outcome decreases with exposure. Since the RR is 0.941, which is less than 1, it suggests that the risk of contracting yellow fever is lower in the presence of certain factors. This implies that children are less likely to be affected by yellow fever compared to other diseases. Furthermore, the risk of yellow fever is lower in males than in females, with male children having a 0.941 times lower risk of contracting the disease compared to female children.

Table 8: *Risk Estimate for measles*

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for gender (Male / female)	1.020	.330	3.148
For cohort measles = other diseases	1.003	.991	1.009
For cohort measles = measles	.981	.315	3.054
N of Valid Cases	1541		

Table 8 presents an odds ratio (OR) value of 1.020, which indicates that the probability of children contracting measles is higher compared to the probability of contracting other diseases. In other words, measles occurs more frequently in children than the other diseases. This also implies that the likelihood of males being diagnosed with measles is 1.020 times greater than that of females.

Additionally, a relative risk (RR) greater than 1.0 suggests that the risk of the outcome is increased by the exposure. With an RR of 1.003, which is slightly above 1, it indicates that children are more likely to be affected by measles. Specifically, the risk of male children contracting measles is 1.003 times higher than that of female children, signifying that the risk of contracting measles is slightly higher in males than in females.

Table 9 : *Risk Estimate for Kwashiorkor*

	Value	**95% Confidence Interval**	
		Lower	**Upper**
Odds Ratio for gender (male / female)	**1.162**	.878	1.539
For cohort Kwashiorkor = other diseases	**1.023**	.981	1.067
For cohort Kwashiorkor = Kwashiorkor	.880	.693	1.117
N of Valid Cases	1541		

Table 9 presents an odds ratio (OR) value of 1.162, indicating that the probability of children contracting Kwashiorkor is higher compared to the probability of contracting other diseases. In other words, Kwashiorkor occurs more frequently in children than the other diseases. This also suggests that the likelihood of males being diagnosed with Kwashiorkor is 1.162 times greater than that of females.

Furthermore, a relative risk (RR) greater than 1.0 indicates that the risk of the outcome is increased by exposure. With an RR of 1.023, which is greater than 1, it signifies that children are more likely to be affected by Kwashiorkor. Specifically, the risk of male children contracting Kwashiorkor is 1.023 times higher than that of female children, indicating that the disease is more prevalent in males than in females.

Table 10: *Risk Estimate for Cholera*

	Value	**95% Confidence Interval**	
		Lower	**Upper**
Odds Ratio for gender (male / female)	**.955**	.812	1.122
For cohort Cholera= other diseases	**.889**	.957	1.083
For cohort Cholera = Cholera	1.066	.853	1.333
N of Valid Cases	**1541**		

Table 10 presents an odds ratio (OR) value of 0.955, indicating that the probability of children contracting cholera is similar to the probability of contracting other diseases. Specifically, cholera occurs less frequently in children than the other diseases. This also means that the likelihood of males being diagnosed with cholera is 0.955 times lower than that of females.

Additionally, a relative risk (RR) of less than 1.0 suggests that the risk of the outcome decreases with exposure. With an RR of 0.889, which is less than 1, it indicates that children are less likely to be affected by cholera. Furthermore, the risk of cholera in males is 0.889 times lower than in females, signifying that the likelihood of contracting cholera is lower in males compared to females.

DISCUSSION

The findings of this study reveal critical insights into the epidemiological patterns of selected diseases among children under four years in Lagos State. Contrary to initial hypotheses, chi-square analysis demonstrated no significant association between gender and overall disease occurrence (χ^2=2.144, p=0.709), aligning with Okafor *et al.* (2020), who reported gender-neutral disease distribution in similar Nigerian cohorts. However, stratified analyses using odds ratios (OR) and relative risk (RR) uncovered nuanced gender disparities for specific diseases. For instance, males exhibited higher susceptibility to malaria (OR=1.327, RR=1.154), measles (OR=1.020), and kwashiorkor (OR=1.162), consistent with Garba *et al.* (2020), who attributed male predominance in malaria to genetic or behavioral factors. Conversely, females faced marginally elevated risks for yellow fever (OR=0.938) and cholera (OR=0.955), though these differences were not statistically significant. This dichotomy underscores the importance of disaggregating data by disease type, even when aggregate gender trends appear neutral.

Age emerged as a significant determinant of disease patterns (χ^2=857.482, p<0.001), contrasting with the study's preliminary conclusion of age independence. Infants aged 0–6 months exhibited the highest malaria burden (34.7% of cases), likely due to waning maternal immunity, while cholera prevalence peaked in children aged 3–4 years (47.2%), potentially linked to increased environmental exposure as mobility expands. These findings resonate with Adeyemi et al. (2022), who identified age-specific vulnerabilities in Lagos's urban slums. Notably, kwashiorkor was concentrated in children aged 1–2 years (39.0%), reflecting weaning-related nutritional gaps, a pattern corroborated by Ibrahim et al. (2022). The near-absence of measles in infants under 6 months (0%) aligns with maternal antibody protection, as described by WHO (2023), while its low overall incidence (1.4%) suggests partial success of vaccination campaigns, though residual cases highlight coverage gaps.

Compared to prior studies, this research reinforces Lagos's status as a high-burden zone for infectious and malnutrition-related diseases, mirroring Dalhat et al. (2021)'s cholera epidemiology in urban Nigeria. However, it diverges from Olusanya *et al.* (2019), who reported stronger gender disparities in non-urban settings, possibly due to differential healthcare access. The high malaria prevalence (51.1%) underscores persistent vector control challenges, while cholera's prominence (27.6%) reflects inadequate water sanitation, consistent with NPHCDA (2021) reports. These results advocate for gender- and age-tailored interventions: prioritizing insecticide-treated nets for young males, bolstering measles immunization in high-mobility age groups, and addressing kwashiorkor through community nutrition programs. Future studies should explore socio-economic mediators of these patterns to inform multi-sectoral policies aimed at achieving SDG-3 targets in high-risk populations.

CONCLUSION

This study highlights the nuanced dynamics of disease patterns among children under four in Lagos State, revealing that while gender does not broadly determine disease occurrence, distinct vulnerabilities emerge for specific illnesses. Males show higher susceptibility to malaria, measles, and kwashiorkor, while females face marginally elevated risks for yellow fever and cholera, though these differences are subtle. Age-specific trends further underscore critical periods of vulnerability, with infants and toddlers disproportionately affected by malaria and malnutrition, whereas older children contend with waterborne diseases like cholera. These findings align with broader regional studies emphasizing socio-environmental drivers of pediatric health disparities. To reduce Lagos's disproportionate disease burden, public health strategies must prioritize gender- and age-sensitive interventions, including improved healthcare access, nutritional support, and preventive measures tailored to urban challenges. Addressing these gaps is essential for advancing equitable child health outcomes and fostering resilience in high-risk communities.

Recommendations

To address the observed disease patterns, policymakers and healthcare stakeholders should prioritize gender- and age-sensitive interventions, including targeted malaria prevention through insecticide-treated bed nets and indoor residual spraying, with a focus on male infants and young children. Community-based nutrition programs should be scaled up to combat kwashiorkor, particularly during the weaning phase (1–2 years), while cholera mitigation requires urgent investment in water, sanitation, and hygiene (WASH) infrastructure in high-risk urban areas. Strengthening measles immunization coverage through mobile clinics and outreach campaigns, alongside maternal education on early symptom recognition, could reduce transmission. Collaborative efforts with local leaders and NGOs should address socio-cultural barriers to healthcare access, while longitudinal studies are needed to explore socio-economic determinants of observed disparities. These strategies, integrated into Lagos State's primary healthcare framework, could significantly reduce preventable childhood morbidity and mortality.

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