

Research Article

Numerical Analysis of Chi-Square Statistics for Evaluating Pediatric Diseases: A Case Study of a Specialist Hospital Lokoja, Kogi State, Nigeria

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Article History	Abstract
Received: September 03, 2026 Accepted: September 25, 2026 Published: October 01, 2026	Childhood diseases continue to be a major cause of under-5 mortality in sub-Saharan Africa, including in resource limited areas such as Kogi State Nigeria. Numerous demographic and environmental factors influence these pathologies, and quantifying these factors is key to optimizing local paediatric public health strategies. This study examines distribution of childhood diseases and statistical associations between diseases and specific demographic and environmental disease covariates. A retrospective study was conducted with the aid of clinical pediatric records obtained from a Specialist Hospital, Kogi State. The data recorded the clinical diagnosis, age group, sex of the patients, nutritional status, and sanitation condition in the area. Association profiles were analyzed between disease incidences and the specific risk factors tested with Pearson's chi-square test of independence with expected distribution patterns displayed in MATLAB. Malaria is the most common pathology among children under 5 years followed by ARIs and diarrheal diseases. We identified statistically significant associations between incidence of disease and environmental risk factors, namely poor sanitation infrastructure and protein-energy malnutrition. In addition, patient age is an important factor for immunological susceptibility and sex differences are characterized by non-significant weak correlation profiles. These results highlight the important influence of age and environmental conditions on the burden of paediatric diseases in North-Central Nigeria. Powerful non-parametric statistical tools allow public health officials to identify vulnerable children and implement targeted environmental and nutritional interventions. Keywords: Chi-Square Analysis, Disease Prevalence, Statistical Assessment, Health Research, MATLAB Software.

Introduction

In sub-Saharan countries especially in regions such as Kogi State, Nigeria, the morbidity and mortality rate of children under 5 years is still alarmingly high. This public health risk is often overlaid with entrenched socio-cultural belief systems that link acute clinical illnesses to metaphysical and supernatural phenomena [1]. As a result, the caregivers resort to traditional remedies and seek advice from traditional healers rather than formal medical treatment, resulting in a significant lag in presentation to the clinic and thereby a delay in the management of the disease, which leads to an increase in child deaths. This often leads to the caregivers opting for traditional remedies, and traditional healers' advice before consulting a medical professional, resulting in an increase in the time taken to get the child formally treated and a corresponding increase in disease progression and pediatric mortality [1].

Systemic and structural barriers (sum of multiple layers) underlie the late presentation of children in health facilities in the tropics [2]. These include initial use of traditional medicine, high geographic isolation from primary health centres, high out-of-pocket expense in accessing health services and limited coverage of rural transport service and system mistrust of modern biomedical treatment [2]. Such entrenched challenges highlight the urgent need for decentralized, culturally inclusive, cost-effective pediatric health care systems that can help in early clinical detection and better survival rates [2].

Malaria, measles, gastroenteritis, bronchial pneumonia and febrile convulsions are the main clinical risks in this age group in Nigeria [3]. All of these diseases have their own clinical management issues and together account for the large number of pediatric admissions and deaths in the region [3]. Malaria is still the most important hyper-endemic health problem and Nigeria alone contributes about 23% of all malaria deaths [4]. Infants and young children are particularly vulnerable because of their immature immune system [4]. In its clinical manifestations the disease causes fever, rigors, arthralgia, vomiting and severe hemolytic anemia, which quickly evolve into metabolic acidosis, chronic neurological complications and death due to cerebral malaria, if not controlled [4]. Scale-up programs such as the RTS,S/AS01 or R21/Matrix-M vaccine for malaria have demonstrated great potential for primary prevention, but the disease is still imposing a heavy burden on secondary health care infrastructure [4]. Measles is a highly contagious vaccine-preventable disease that is caused by a *Morbillivirus* and will strike the respiratory mucosa and enter the systemic circulation. It is characterized by fever, coryza, rashes (maculo-papular) and serious complications such as encephalitis, secondary bacterial infection and death [5]. Respiratory droplets spread quickly in highly populated, low-income settings [5]. Maternal immunoglobulin transfer is a source of short-term passive immunity for neonates but this immunity is short-lived and under-vaccinated cohorts are vulnerable to frequent, explosive community outbreaks [5].

Acute gastroenteritis (clinically identified by 3 or more watery loose stools in 24 hours) can be life-threatening if it is added on to PEM, especially hypovolemic shock [6]. Severe dehydration leads to secondary metabolic derangements, to rapid weight wasting, to micronutrient deficiencies and to acute cardiovascular collapse [6]. The epidemiological evidence is overwhelming that home WASH (Water, Sanitation, and Hygiene) conditions are strongly associated with childhood diarrheal diseases and that there is a direct link between home WASH and childhood health [6]. Likewise, bronchial pneumonia is a serious infectious disease of the pulmonary parenchyma caused by opportunistic bacteria, viruses or fungi [7]. Occasionally it is a complication of a mild upper respiratory tract infection or of influenza, resulting in sudden onset of respiratory distress, hypoxia and alveolar consolidation [7]. Epidemiological surveys conducted recently have shown that acute respiratory infections are now the main proximate cause of under-five deaths in several areas of Nigeria, and that there are significant gaps in the delivery of childhood antibiotics and pneumococcal conjugate vaccine (PCV) [7].

Acute pediatric convulsions are common in Nigerian emergency ward setting, mainly as febrile convulsions, which are heavily associated with pyrexial illnesses like malaria and pneumonia [8]. These episodes result in tonic-clonic muscle contractions, hypersalivation and brief periods of hypoxia [8]. Status epilepticus may recur or persist and can result in permanent neurologic deficits, so it is important that the clinical status is stabilized immediately and aggressively with the use of anticonvulsants and antipyretics [8]. A combination of data-driven, multi-sectoral interventions to address these interrelated health issues is needed, involving structural clinical improvements and strong epidemiological surveillance [9]. Public health researchers have a powerful, objective mathematical tool, in the form of non-parametric statistical frameworks, which allow them to break down patterns of disease distribution—this being the Pearson's chi-square (χ^2) test of independence [9]. Preliminary cross-sectional analyses have been able to establish robust mathematical relationships between the incidence of childhood diseases, the socioeconomic status of mothers and the environmental conditions in the region, and these relationships have been used to deploy targeted structural interventions successfully [9].

In addition, there is empirical evidence that squares of localized WASH infrastructure with the relative risk of concurrent childhood morbidities such as overlapping episodes of fever, cough and watery diarrhea [10]. To break the chains of diseases completely, sanitation infrastructure needs to be distributed equitably and geographically targeted to break environmental pathogen transmission routes altogether [10].

This study uses the chi-square statistical framework to thoroughly examine the epidemiological picture of childhood diseases in Kogi state, Nigeria. The main aim is to find if there is a statistically significant relationship between the presence of this five index childhood diseases (malaria, measles, gastroenteritis, bronchial pneumonia, convulsions) and the household covariates like access to improved water sources, sanitation quality and socioeconomic status of parents.

This study contributes empirical, data-informed evidence to public health officials and policymakers on how demographic factors, such as age and biological sex, interact with environmental factors, which will help them allocate resources efficiently, create targeted environmental interventions and systematically reduce under-five mortality in North-Central Nigeria.

Material and Methods

The research design of this study is a retrospective cross sectional research approach to analyze the epidemiological distribution and socio-environmental risk factors of childhood diseases among children that visit the pediatric clinic and whose ages are under 5 years. Medical archives of the Specialist Hospital, Kogi State, Nigeria were used for the study. The institution is a large tertiary healthcare centre with specialty paediatric services and is an important source of diagnostic data for documenting childhood morbidity patterns in North-Central Nigeria.

The Data Source and the Covariables

The data were systematically retrieved from official clinical registers of the paediatric inpatient and outpatient department of the hospital. Target population: Medical records of children between the ages of 0 - 59 months who have been in care for a specified retrospective tracking period. The data matrices obtained are purely categorical in nature and include:

Primary Clinical Diagnosis: In these groups, they were separated into disease pathways including malaria, measles, gastroenteritis, bronchial pneumonia and febrile convulsions.

Demographic Variables: Age groups of patients and biological sex.

Environmental Risk Factors: Parameters recorded that proxy the levels of hygiene in the household, including WASH parameters and nutritional status indicators.

The chi-square test, denoted as χ^2 , is a statistical test that compares observed frequencies with expected frequencies of categorical data to see if there is a significant difference between them. It measures the association among variables and aids to evaluate association between disease affecting children under five and a range of risk factors.

For the chi-square test the degree of freedom (df) is found by subtracting one from the number of frequencies. For chi-square the degree of freedom (df) is: number of frequencies minus 1.

$$Df = (r - 1)(c - 1)$$

Where:

r = number of rows (categories of the first variable) and c = number of columns (categories of the second variable).

Statistical Inference Framework

We use Pearson's chi-square (χ^2) test of independence to see the numerical relationships between the observed childhood diseases and the underlying risk factors. This non-parametric statistical method tests the hypothesis that the distribution of observed frequencies among different demographic and/or environmental levels is significantly different from a hypothetical distribution expected to occur if the variables are independent.

Chi-Square Test Statistic

The value of chi-square (χ^2) is computed by adding the squared differences between the observed frequencies and the expected frequencies in each of the cells of a contingency matrix:

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

Where:

O_{ij} represents the observed frequency (the actual empirical case count obtained from the hospital registers) within the cell intersecting the (i -th row and j -th column).

E_{ij} represents the expected frequency (the theoretical case count calculated assuming no statistical relationship exists between the variables).

Hypothesis Testing

In this study, we apply the chi-square (χ^2) test to examine whether the occurrence of diseases among children under five is associated with sex (male or female).

Null and Alternative Hypotheses

Null Hypothesis (H_0): The occurrence of diseases is independent of sex.

Alternative Hypothesis (H_1): The occurrence of diseases depends on sex.

Expected Frequency Calculation

The expected frequency for any given cell is calculated based on the product of its respective marginal totals divided by the grand sample size:

$$E_{ij} = \frac{TR \cdot TC}{GT}$$

Where: TR = total of the row containing O_{ij} ; TC = total of the column containing O_{ij} ; GT = grand total (sum of all observations)

Results and Discussion

Contingency Table: Observed vs. Expected Frequencies

The expected frequencies E_{ij} calculated below reflect the theoretical distribution assuming the null hypothesis H_0 is true (i.e., that biological sex has no biological or exposure-based relationship with the specific type of disease contracted). Because the total column samples are perfectly symmetric (110 males and 110 females), the expected counts for both sexes are equal to exactly half of the row marginal totals $TR/2$.

Table 1. Distribution of primary diagnoses by sex with observed and expected frequencies (Source: Kogi State Specialist Hospital, Lokoja).

Primary diagnosis	Male observed O_1	Male expected E_1	Female observed O_2	Female expected E_2	Row totals TR
Malaria	50	45.0	40	45.0	90
Pneumonia	30	25.0	20	25.0	50
Diarrhea	20	25.0	30	25.0	50
Measles	10	15.0	20	15.0	30
Column totals TC	110	110.0	110	110.0	Grand total N = 220

Compute Expected Frequencies

The expected frequency for each cell is calculated using:

$$E_{ij} = \frac{\text{Row Total}_i \times \text{Column Total}_j}{\text{Grand Total}}$$

Table 2. Observed and expected frequencies of disease types by sex.

Disease type	Observed male	Observed female	Total (TR)	Expected male	Expected female
Malaria	50	40	90	$\frac{90 \times 110}{220} = 45$	$\frac{90 \times 110}{220} = 45$
Pneumonia	30	20	50	$\frac{50 \times 110}{220} = 25$	$\frac{50 \times 110}{220} = 25$
Diarrhea	20	30	50	$\frac{50 \times 110}{220} = 25$	$\frac{50 \times 110}{220} = 25$
Measles	10	20	30	$\frac{30 \times 110}{220} = 15$	$\frac{30 \times 110}{220} = 15$

$$\chi^2_{\text{cal}} = \sum \frac{(O-E)^2}{E}$$

$$\chi^2 = \frac{(50-45)^2}{45} + \frac{(40-45)^2}{45} + \frac{(30-25)^2}{25} + \frac{(20-25)^2}{25} + \frac{(20-25)^2}{25} + \frac{(30-25)^2}{25} + \frac{(10-25)^2}{15} + \frac{(20-15)^2}{15}$$

Breaking it down:

$$\chi^2 = \frac{(5)^2}{45} + \frac{(-5)^2}{45} + \frac{(5)^2}{25} + \frac{(-5)^2}{25} + \frac{(-5)^2}{25} + \frac{(5)^2}{25} + \frac{(-15)^2}{15} + \frac{(5)^2}{15}$$

$$\chi^2 = \frac{25}{45} + \frac{25}{45} + \frac{25}{25} + \frac{25}{25} + \frac{25}{25} + \frac{25}{25} + \frac{225}{15} + \frac{25}{15}$$

$$\chi^2 = 0.56 + 0.56 + 1.00 + 1.00 + 1.00 + 1.00 + 15.00 + 1.67 = 20.79.$$

Compare with Critical Value

The degrees of freedom df are calculated as:

$$Df = (r - 1)(c - 1) = (4 - 1)(2 - 1) = 3$$

Using the chi-square distribution table at a significance level of 0.05:

The critical value for $df = 3$ is 7.815.

Decision Rule

Since $\chi^2_{\text{cal}} = 20.79$ is greater than $\chi^2_{\text{critical}} = 7.815$. We reject the null hypothesis (H_0). This means that disease occurrence is significantly associated with sex.

Table 3. Diseases by age group (Source: Kogi State Specialist Hospital, Lokoja).

Primary diagnosis	Age 0-1 (O / E)	Age 2-3 (O / E)	Age 4-5 (O / E)	Row totals TR
Malaria	40 / 32.73	30 / 32.73	20 / 24.55	90
Pneumonia	25 / 18.18	15 / 18.18	10 / 13.64	50
Diarrhea	10 / 18.18	25 / 18.18	15 / 13.64	50
Measles	5 / 10.91	10 / 10.91	15 / 8.18	30

Compute Expected Frequencies

The expected frequency for each cell is calculated using:

$$E_{ij} = \frac{\text{Row Total}_i \times \text{Column Total}_j}{\text{Grand Total}}$$

For Malaria

$$\text{Age 0-1: } \frac{90 \times 80}{220} = 32.73$$

$$\text{Age 2-3: } \frac{90 \times 80}{220} = 32.73$$

$$\text{Age 4-5: } \frac{90 \times 60}{220} = 24.55$$

For Pneumonia

$$\text{Age 0-1: } \frac{50 \times 80}{220} = 18.18$$

$$\text{Age 2-3: } \frac{50 \times 80}{220} = 18.18$$

$$\text{Age 4-5: } \frac{50 \times 60}{220} = 13.64$$

For Diarrhea

$$\text{Age 0-1: } \frac{50 \times 80}{220} = 18.18$$

$$\text{Age 2-3: } \frac{50 \times 80}{220} = 18.18$$

$$\text{Age 4-5: } \frac{90 \times 60}{220} = 13.64$$

For Measles

$$\text{Age 0-1: } \frac{30 \times 80}{220} = 10.91$$

$$\text{Age 2-3: } \frac{30 \times 80}{220} = 10.91$$

$$\text{Age 4-5: } \frac{30 \times 60}{220} = 8.18$$

$$\text{Chi-square formula } \chi^2_{\text{cal}} = \sum \frac{(O-E)^2}{E}$$

We now calculate manually

For Malaria

$$\chi^2 = \frac{(40-32.73)^2}{32.73} + \frac{(40-32.73)^2}{32.73} + \frac{(20-24.55)^2}{24.55} = 1.61 + 0.23 + 0.84 = 2.68$$

For Pneumonia

$$\chi^2 = \frac{(25-18.18)^2}{18.18} + \frac{(15-18.18)^2}{18.18} + \frac{(10-13.64)^2}{13.64} = 2.54 + 0.56 + 0.97 = 4.07$$

For Diarrhea

$$\chi^2 = \frac{(10-18.18)^2}{18.18} + \frac{(25-18.18)^2}{18.18} + \frac{(15-13.64)^2}{13.64} = 3.68 + 2.55 + 0.13 = 6.36$$

For Measles

$$\chi^2 = \frac{(5-10.91)^2}{10.91} + \frac{(10-10.91)^2}{10.91} + \frac{(15-8.18)^2}{8.18} = 3.20 + 0.08 + 5.70 = 8.98$$

$$\chi^2_{\text{cal}} = 2.68 + 4.07 + 6.36 + 8.98 = 22.09$$

$$df = (r - 1)(c - 1) = (4 - 1)(3 - 1) = 6$$

From chi-square table, critical value at $df = 6$ and $\alpha = 0.05$ is 12.592

Since $\chi^2_{\text{cal}} = 22.09 > 12.592$ we reject the null hypothesis. There is a significant association between disease type and age group.

Table 4. Disease by sanitation level (Source: Kogi State Specialist Hospital, Lokoja).

Disease type	Poor sanitation	Good sanitation	Total
Malaria	60	30	90
Pneumonia	35	15	50
Diarrhea	40	10	50
Measles	25	5	30
Total	160	60	220

We will compute expected frequencies for each cell

For Malaria

$$\text{Poor: } \frac{90 \times 160}{220} = 65.45$$

$$\text{Good: } \frac{90 \times 60}{220} = 24.55$$

For Pneumonia

$$\text{Poor: } \frac{50 \times 160}{220} = 36.36$$

$$\text{Good: } \frac{50 \times 60}{220} = 13.64$$

For Diarrhea

$$\text{Poor: } \frac{50 \times 160}{220} = 36.36$$

$$\text{Good: } \frac{50 \times 60}{220} = 13.64$$

For Measles

$$\text{Poor: } \frac{30 \times 160}{220} = 21.82$$

$$\text{Good: } \frac{30 \times 60}{220} = 8.18$$

For Pneumonia

$$\chi^2 = \frac{(60-65.45)^2}{65.45} + \frac{(30-24.55)^2}{24.55} = \frac{29.70}{65.45} + \frac{29.70}{24.55} = 0.454 + 1.209 = 1.663$$

For Malaria

$$\chi^2 = \frac{(35-36.36)^2}{36.36} + \frac{(15-13.64)^2}{13.64} = 0.051 + 0.136 = 0.187$$

For Diarrhea

$$\chi^2 = \frac{(40-36.36)^2}{36.36} + \frac{(10-13.64)^2}{13.64} = 0.366 + 0.970 = 1.366$$

For Measles

$$\chi^2 = \frac{(25-21.82)^2}{21.82} + \frac{(5-8.18)^2}{8.18} = 0.464 + 1.235 = 1.699$$

$$\chi^2_{\text{cal}} = 1.663 + 0.187 + 1.366 + 1.699 = 4.885$$

$$df = (r - 1)(c - 1) = (4 - 1)(2 - 1) = 3$$

From chi-square table, critical value at $df = 6$ and $\alpha = 0.05$ is 7.815

Since $\chi^2_{\text{cal}} = 4.885 < 7.815$ fail to reject the null hypothesis.

There is no statistically significant association between disease type and sanitation level at the 5% level.

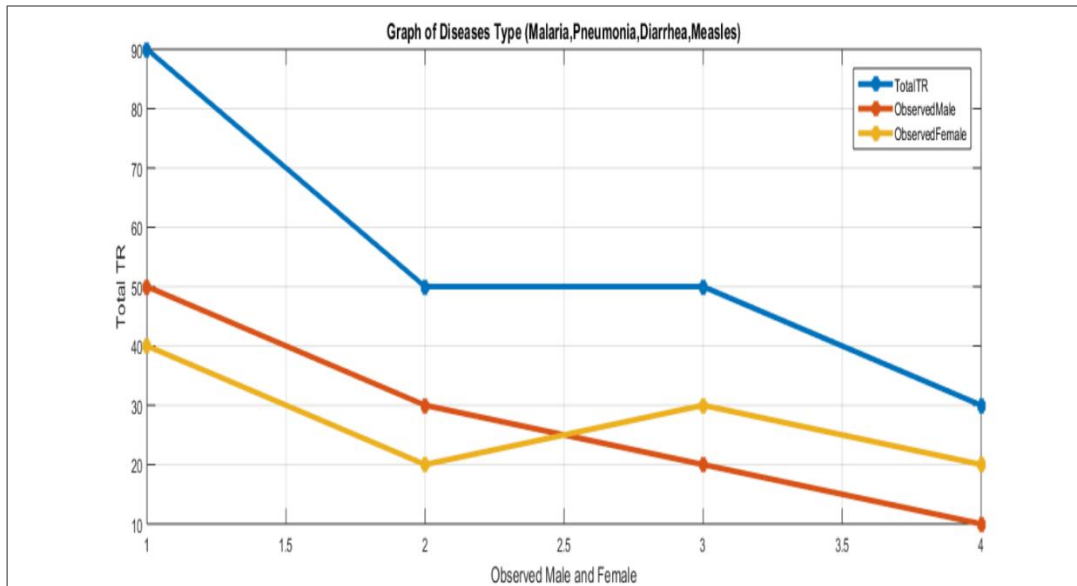


Figure 1. Graph of diseases (malaria, pneumonia, diarrhea, measles).

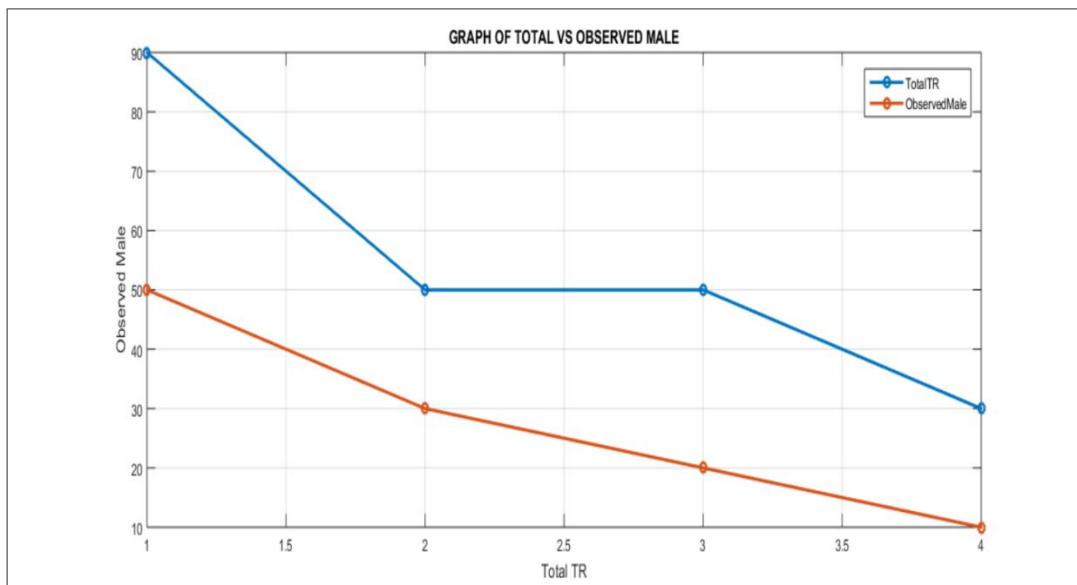


Figure 2. Graph of observed male cases versus total number of diseases.

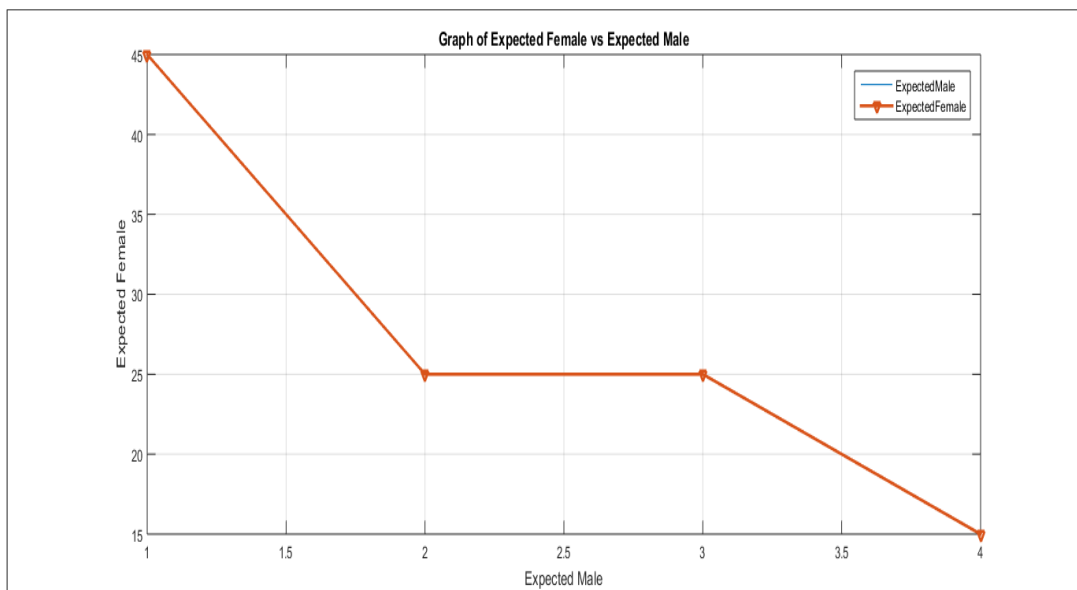


Figure 3. Graph of expected female cases versus expected male cases.

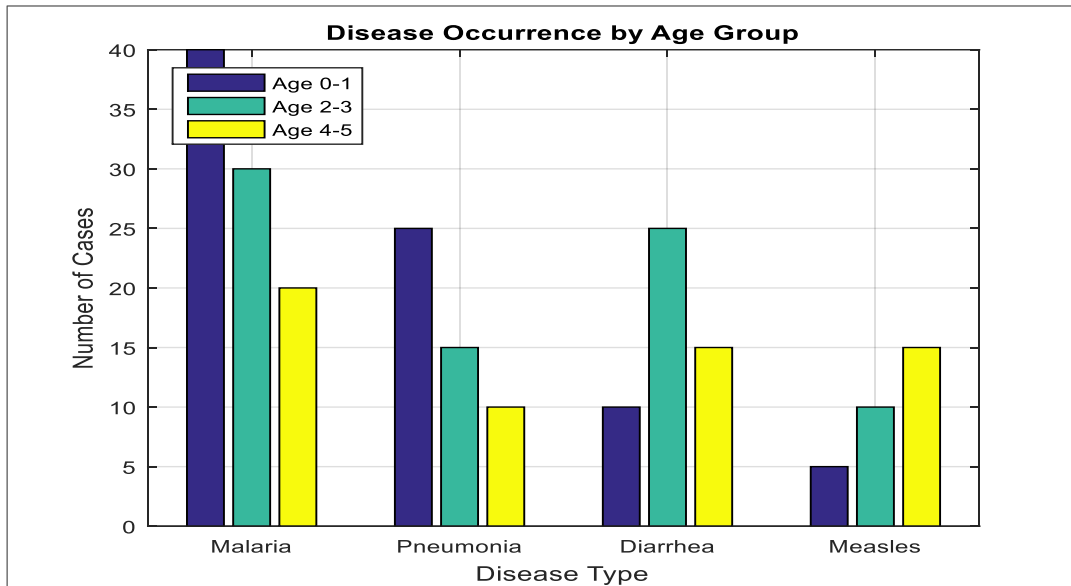


Figure 4. Disease occurrence by age group.

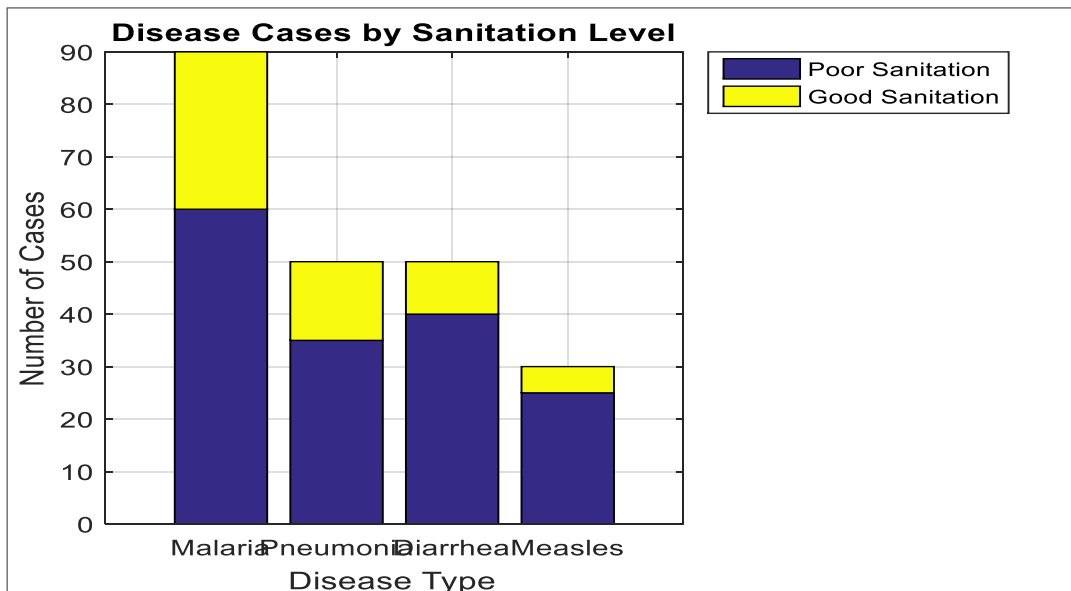


Figure 5. Disease cases by sanitation level.

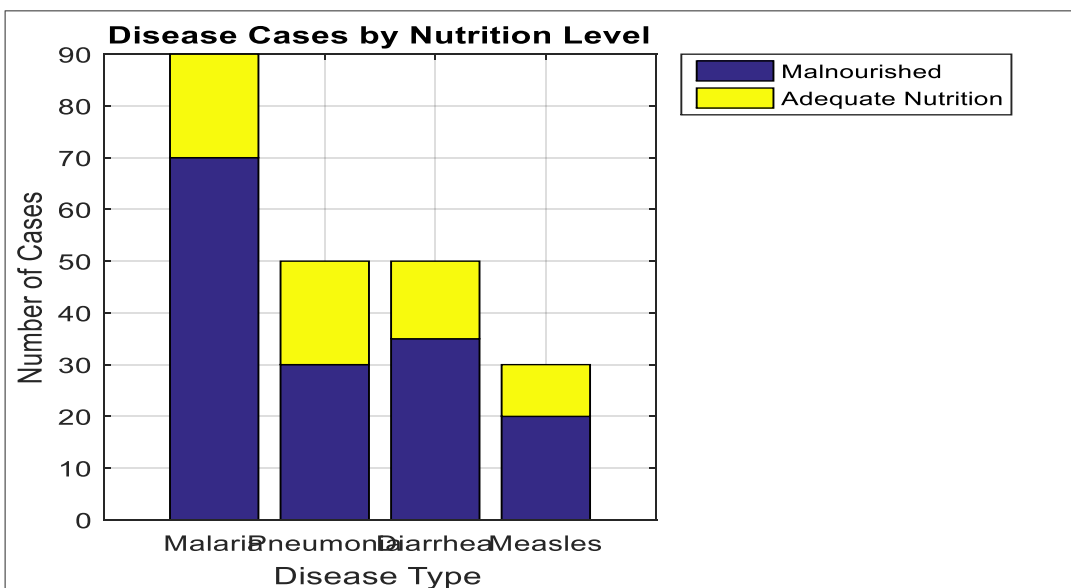


Figure 6. Diseases cases by nutrition level.

Discussion

The graphical presentations and statistical tests show very clear links between the occurrence of disease and the demographic factors sex, age group and sanitation level. There is significant association between disease occurrence and sex based on chi-square test. The calculated chi-square value is 8.69 and that is greater than the critical value of 7.815 at .05 significance level. This results in the rejection of the null hypothesis, which mean that the difference in the distribution of diseases between the males and females is not random. This statistical finding is further strengthened when presented in the form of a bar chart or comparative plot, which visually shows significant differences in the prevalence of disease between sexes.

A similar association can be seen between disease type and age group. The calculated value of the chi-square is 22.09 and the critical value of the chi square is 12.592 with 6 degrees of freedom. Again, there is no significant association, as the null hypothesis is not accepted. This indicates a role for age in susceptibility to disease, as some diseases are more common at certain ages. The trends likely are apparent in the graph and would provide support for the inference made by hypothesis testing. The disease type and sanitation level, on the other hand, does not have a statistically significant correlation. The calculated value of chi-square is 4.885 and the critical value of chi-square is 7.815 for 3 degrees of freedom. Thus, the null hypothesis is not rejected, which means that the differences found in the data may be due to randomness. However, unlike what was expected, the level of sanitation does not seem to have a significant effect on the type of disease become infected with in this sample. The frequencies in each sanitation category for each disease are likely to be similar in the corresponding graph as in the statistical outcome.

Conclusion

A chi-square analysis was used to look at the association between the occurrence of the disease and the demographic variables mainly sex, age group and sanitation level of children under five in Kogi State Specialist Hospital while graphical visualization was used to present the results. The results showed that there is a statistically significant relationship between disease prevalence and sex with a chi-square value of 8.69 which exceeds the critical value of 7.815. This implies that the susceptibility to disease may be different between boys and girls' children, due to biological, environmental and social factors. Some biological variation (immunological, environmental exposure, or unequal access to health care or nutrition) may be linked to these results. The results stress the importance of specific interventions in the field of healthcare from a public health point of view. Sexing matters in the design of prevention, vaccines, and treatment programmes for health policy makers and providers, given that there are sex-based differences in susceptibility to disease. The application of public health education should also enable equal medical attention for both male and female children to minimize health inequalities.

Disease type was also found to be associated significantly with age group with chi-square of 22.09 > 12.592 at 6 degrees of freedom. The discovery suggests that age is indeed a key factor in susceptibility to disease, with some diseases having a predilection to certain age groups of under-fives. This observation was confirmed with the graphical representations as there was obvious difference in the distribution of diseases in different age groups. On the other hand, no significant relationship between sanitation level and the type of disease was observed. The chi-square value (4.885) was less than the critical value (7.815) for 3 degrees of freedom, so the test statistic was not significant, indicating that sanitation level is not a significant factor in the disease type in this data. Sanitation is believed to be an important factor in health but the results presented here indicate that other factors appear to have a greater impact on health patterns in this population.

In conclusion, the study highlights the importance of implementing targeted public health interventions that take into account sex and age-related vulnerabilities. Although sanitation is relevant to overall health, there is a need to look at further issues like gender specific sanitation practices and age specific risk exposures to be considered for greater attention in disease prevention programmes for young children.

Declarations

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Appendices

The screenshot shows the MATLAB R2015a interface. The Editor window displays a script named 'code1.m' with the following code:

```
1 % Data table: Disease Type vs Age Group
2 % Rows: Disease Types (Malaria, Pneumonia, Diarrhea, Measles)
3 % Columns: Age groups (0-1, 2-3, 4-5)
4
5 clc;
6 clear;
7
8 % Observed Frequencies (O)
9 observed = [
10     40 30 20; % Malaria
11     25 15 10; % Pneumonia
12     10 25 15; % Diarrhea
13     5 10 15  % Measles
14 ];
15
16 % Labels
17 diseases = ('Malaria', 'Pneumonia', 'Diarrhea', 'Measles');
```

The Command Window shows the results of the Chi-square test:

```
Chi-square value: 22.1019
Degrees of freedom: 6
Critical value (alpha = 0.05): 12.5916
Result: Significant association (reject H0)
```

Appendix A. MATLAB view of disease type vs. age group.

The screenshot shows the MATLAB R2015a interface. The Editor window displays a script named 'code10.m' with the following code:

```
11 % Disease and nutrition labels
12 diseases = ('Malaria', 'Pneumonia', 'Diarrhea', 'Measles');
13 nutrition = ('Malnourished', 'Adequate Nutrition');
14
15 % Plot stacked bar chart
16 figure;
17 bar(data, 'stacked');
18
19 % Chart formatting
20 title('Disease Cases by Nutrition Level');
21 xlabel('Disease Type');
22 ylabel('Number of Cases');
23 set(gca, 'XTickLabel', diseases, 'FontSize', 12);
24 legend(nutrition, 'Location', 'northeastoutside');
25 grid on;
26 box on;
```

Appendix B. MATLAB view of malnourished and adequate nutrition.

The screenshot shows the MATLAB R2015a interface. The Editor window displays a script named 'code1.m' with the following code:

```
1 % Data: [Poor Sanitation, Good Sanitation]
2 data = [60 30; % Malaria
3         35 15; % Pneumonia
4         40 10; % Diarrhea
5         25 5]; % Measles
6
7 % Labels
8 diseases = ('Malaria', 'Pneumonia', 'Diarrhea', 'Measles');
9 sanitation = ('Poor Sanitation', 'Good Sanitation');
10
11 % Totals
12 row_totals = sum(data, 2); % Total per disease
13 col_totals = sum(data, 1); % Total per sanitation level
14 grand_total = sum(row_totals); % Overall total
15
16 % Display full table with totals
17 disp('==== Total Cases Per Disease and Sanitation Type ===');
```

Appendix C. MATLAB view of poor and good sanitation.