Transactions of NAMP 22, (2025) 85-96

Transactions of
The Nigerian Association of
Mathematical Physics
Journal homepage: https://nampjournals.org.ng

PREVALENCE, MANAGEMENT, AND CONTROL OF TYPHOID FEVER IN AGBARHO, DELTA STATE, NIGERIA

[1]Acha, Chigozie Kelechi; [2]Oghre Emmanuel Olubayo; [3]Mokogwu, Ndubuisi, [4]Iwemjiwe, Nnazom Christian: [5]Oghenewaire Olowu

[1]*Department of Statistics, Michael Okpara University of Agriculture, Umudike.*
[2,5]*Department of Mathematics, University of Benin, Benin City*
[3] *Department of Public and Community Medicine, University of Benin Teaching Hospital, Benin City*
[4] *Health Clinic, University of Benin, Benin City*

ARTICLE INFO

Article history:
Received 26/6/2025
Revised 7/7/2025
Accepted 9/7/2025
Available online 17/7/2025

Keywords:
Typhoid,
Vaccination,
Treatment,
Typhoid fever,
Nigeria.

ABSTRACT

This study investigates the prevalence, management, and control of Typhoid fever, a critical public health concern in Nigeria, particularly in Agbarho, Delta State. Through extensive survey data collected from 80 participants, the study aims to assess the prevalence rate of Typhoid fever, evaluate community awareness regarding its causes and symptoms, and determine the knowledge of healthcare professionals regarding symptoms, diagnosis, and treatment options. The results revealed a high prevalence (73.75%) of Typhoid fever, with significant knowledge gaps in the community and among health workers regarding transmission routes and treatment protocols. The findings support the need for urgent educational interventions and effective control measures to combat Typhoid fever's impact in Nigeria.

1. INTRODUCTION

Typhoid fever is a life-threatening illness caused by the bacterium Salmonella enterica serovar Typhi (S. Typhi). It remains endemic in many developing countries, including Nigeria, where it poses a significant public health challenge. The World Health Organization estimates approximately 11–21 million Typhoid fever cases and 128,000 to 161,000 deaths caused by it annually, worldwide [1]. In Africa, it is estimated that 400,000 new cases arise every year, reflecting an incidence rate of about 50 cases per 100,000 (Nthiiri et al., 2016) [2].

Despite its significant impact, there is a distinct lack of a comprehensive public health policy concerning its management in Nigeria. Unlike countries such as Egypt and South Africa, where vaccination programs and treatment protocols are established, Nigeria faces challenges in controlling Typhoid fever.

*Corresponding author: ACHA, CHIGOZIE KELECHI.
E-mail address: acha.kelechi@mouau.edu.ng
https://doi.org/10.60787/tnamp.v22.550

Among the most pressing concerns is the high susceptibility of the general population to this disease, particularly once it is introduced into a community. Symptomatic individuals present opportunities for clinical intervention; however, asymptomatic carriers further complicate the disease's control, making eradication efforts more daunting (Naresh et al., 2008 [3]) and Simon-Oke and Akinbote (2020) [4].

Physicians in Nigeria frequently make treatment decisions based solely on clinical presentations or limited serological testing, like the Widal agglutination test, which possesses substantial limitations. Such practices have contributed to incorrect diagnoses, inappropriate antibiotic prescriptions, and consequently, increased antibiotic multidrug resistance (MDR) (Ohanu et al., 2019 [5]). Furthermore, most epidemiological research conducted in Nigeria relied on data from other countries, which may not accurately represent the local context, Ehidiamhen et al. (2025) [6] and Sanchez-Vargas et al. (2011) [7].

The major aim of this study is to determine the prevalence, management and control of Typhoid fever in Nigeria. This study aims to fill these knowledge gaps by not only assessing the prevalence and awareness of Typhoid fever within the community but also examining the knowledge of healthcare workers and the general population in Agbarho, Delta State, on the causes, symptoms, and treatment of Typhoid fever.

LITERATURE REVIEW

A body of literature exists that examines the epidemiology and control of infectious diseases like Typhoid fever using various statistical and mathematical models. For instance, Naresh et al. (2008) [3] and Oghre & Ako (2011) [8] developed models to explore the transmission dynamics of infectious diseases. More recently, Gombe et al. (2020) [9] applied a mathematical model of Typhoid fever transmission with vaccination using next-generation matrix methods to analyze disease stability. Their findings highlighted the range of the basic reproduction number, which is critical for understanding potential spread in a population of a disease.

Tilahun et al. (2017) [10] proposed a compartmental non-linear deterministic model applying optimal control theory. This approach is valuable as it aids in making informed decisions regarding policy formulation and control measures aimed at reducing disease incidence. However, the limitation of these studies often lie in the reliance on data gathered from Western nations, raising questions about the applicability of the findings to Nigeria's unique context.

A qualitative analysis conducted by Akinyemi et al. (2018) [11] examined Typhoid fever in Nigeria, specifically in Lagos, Abuja, and Kano, where they discovered prevalence rates ranging from 0.071% to 47.1%. These findings suggest significant geographical disparities in Typhoid incidence, further complicating public health interventions. Additionally, Enabulele & Awunor (2016) [12] noted that the reliance on the Widal agglutination test often leads to an overestimation of Typhoid fever cases, highlighting the need for thorough diagnostics.

Understanding the socio-environmental factors that contribute to Typhoid's persistence is essential. Increased urbanization, inadequate potable water supply, and poor waste management significantly heighten the risk of disease transmission (Adesegun et al., 2020) [13]. Furthermore, cultural practices such as consuming raw fruits and lesser hygiene standards compound this vulnerability.

2 METHODOLOGY

2.1 Study Setting and Population

This study was carried out in Agbarho town located in Ughelli North Local Government Area of Delta State. The town has a population of 333,110 with the predominant ethnic group being Urhobo. The inhabitants of Agbarho are mainly farmers and businessmen/women. The town has several healthcare facilities and a government-owned general hospital.

This research is a cross-sectional descriptive study. The study population consisted of members of the community and healthcare workers working in healthcare facilities in the town. A multistage cluster random sampling technique was employed to select healthcare participants from Primary healthcare facilities (PHC) in Agbarho, Delta State.. Additionally, purposive sampling was used to select members of the community who formed the respondents used to assess the populations knowledge of Typhoid fever.

Data on prevalence of typhoid fever was obtained from a record review of outpatients' clinic records, focusing on paediatric, internal medicine, and endemic disease clinics of tertiary healthcare facilities that have reported Typhoid cases over the last three years.

2.2 Data Collection

Data was obtained using interviewer administered questionnaires for the tools which assessed knowledge among the community. Knowledge of typhoid among healthcare workers was collected through self-administered tool. The questionnaires included 2 sections each made up of biodata of respondents and a second section which assessed prevalence, knowledge, treatment and control of typhoid fever.

2.3 Statistical Analysis

The filled questionnaires were thoroughly checked for inconsistences. Data coding and cleaning was done. Collected data was analysed using JMP software. Univariate analysis was done on categorical data such as sex, religion and marital status and presented as frequencies and proportions. Numerical data was summarized as means and standard deviation. Bivariate analysis was done to determine the association between socio-demographic characteristics and the outcome variables. Level of significance was set at $p < 0.05$ which was considered statistically significant. Results were presented as prose, frequency distribution tables and charts.

Ethical considerations

Approval was sought and obtained from the Ethical and Research Committee, University of Benin Teaching Hospital. Informed consent was also obtained from the respondents before administering the questionnaires. Names and addresses w omitted to ensure confidentiality. The respondents were informed that they had the right to withdraw from the study at any point and withdrawal posed no loss or harm.

2.4 Analysis and interpretation of Results

Prevalence of Typhoid Fever

Table 1: Prevalence of typhoid fever

Prevalence of Typhoid fever			
Characteristics	Category	Frequency(n=80)	Percentage (%)
History of typhoid	Yes	59	73.75
	No	21	26.25
Symptoms past years	Yes	32	40.00
	No	48	60.00
Sex	Female (with typhoid)	45	-76.3% (of those with typhoid)
	Male (with typhoid)	14	-23.7% (of those with typhoid)
Occupation	Medical Doctor (with typhoid)	20	-33.9% (of those with typhoid)
	Nurse (with typhoid)	15	-25.4% (of those with typhoid)

	Lab Tech (with typhoid)	24	-40.7% (of those with typhoid)

Acha's compliation 2025

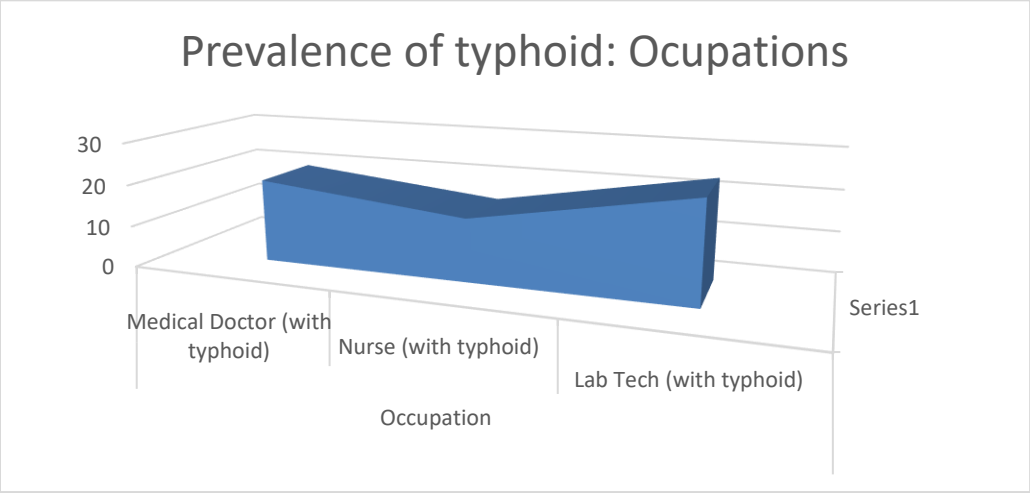


Figure 1: Prevalence of typhoid by Ocupations

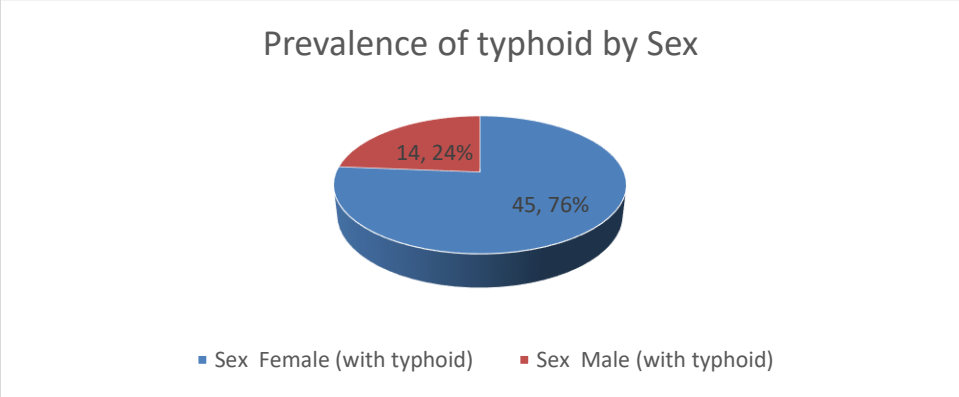


Figure 2: Prevalence of typhoid by Sex

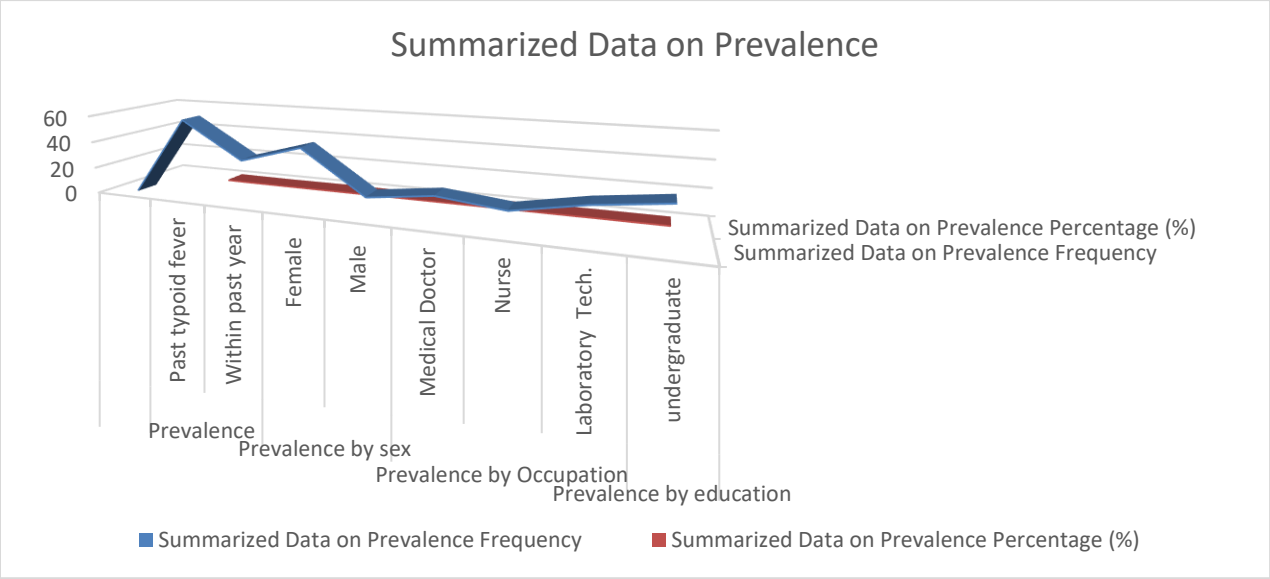
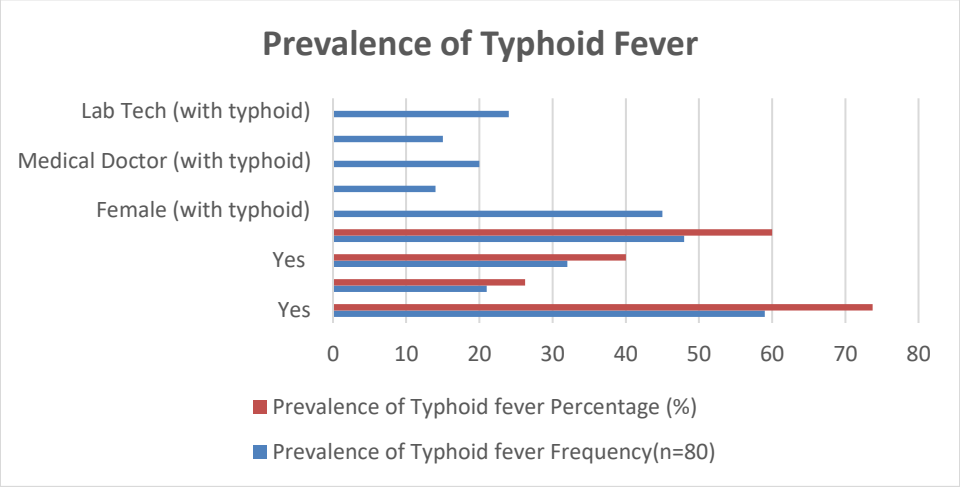


Figure 3: Summarized Data on Prevalence



4.1.1 Interpretation of the Result on Prevalence of Typhoid Fever

Table 1 and figures 1,2, and 3, assess the prevalence of Typhoid Fever in Agbarho, Delta State Nigeria. The result shows that out of 80 respondents, 59 (73.8%) reported having suffered from Typhoid fever at some point. This indicates a high prevalence in the population studied. An age breakdown indicates that most respondents believed all age groups are equally susceptible (51.25%), but a significant number identified adults over 65 as particularly vulnerable (26.25%).

a. History of Typhoid: 73.75% of the individuals (59 out of 80) reported a history of typhoid fever. 26.25% of the individuals (21 out of 80) reported no prior history of typhoid fever.
b. Symptoms in the Past Years: 40.0% of the individuals (32 out of 80) reported experiencing symptoms of typhoid fever in the past years. 60.0% of the individuals (48 out of 80) did not report any symptoms in the past years.
c. Sex: This section focuses on the sex distribution among those who have had typhoid. Among the individuals with typhoid fever, 76.3% were female (45 out of the 59 with a history of typhoid). Among the individuals with typhoid fever, 23.7% were male (14 out of the 59 with a history of typhoid).
d. Occupation: (This section focuses on the occupation distribution among those who have typhoid. Among those who have typhoid fever, 33.9% were medical doctors (20 out of the 59 with a history of typhoid). Among those who have typhoid fever, 25.4% were nurses (15 out of the 59 with a history of typhoid). Among those who have typhoid fever, 40.7% were lab technicians (24 out of the 59 with a history of typhoid).

4.1.2 Inferences and Potential Implications

i. High Prevalence: The data suggests a high prevalence of typhoid fever in the study population, given the large percentage reporting a history of the disease.
ii. Symptom Persistence/Recurrence: The fact that 40% reported symptoms in recent years might suggest persistent infection, recurrence, or chronic carriage of the bacteria.
iii. Sex Distribution: The higher percentage of females with typhoid may indicate that females are more prone to the disease. More research would be needed to find out why.
iv. Occupation and Exposure: The data indicates that health workers are affected. This could be due to the occupational exposure of these professionals (e.g., exposure to patients with typhoid, contaminated lab samples).

Table 2: Summarized Data

Summarized Data on Prevalence

Category	Description	Frequency (n=80)	Percentage (%)
Prevalence	Past typhoid fever	59	74%
	Within past year	32	48%
Prevalence by sex	Female	45	65%
	Male	14	35%
Prevalence by Occupation	Medical Doctor	20	55%
	Nurse	15	40%
	Laboratory Tech.	24	69%
Prevalence by education	undergraduate	30	56%
	postgraduate	9	22%

Researchers' compliation 2025

Table 2 highlights the prevalence of typhoid fever in the studied group reported having suffered from Typhoid fever, highlighting a significant prevalence rate in the community. Also, a gender breakdown displays that 43 females and 16 males reported having suffered from the illness, suggesting that women may have a higher reported prevalence in this sample. The time since the last reported illness appears distributed with 24 respondents indicating they had Typhoid fever within the last three months, which signifies ongoing risk within the community. The data advocates some potential risk factors like a prior history of the illness, sex, and occupation The data suggest a significant prevalence of Typhoid fever among the population in Agbarho, Delta State. Further efforts may be needed for prevention and treatment in this community.

Awareness and Knowledge

Table 3: Awareness of Typhoid Spread, Treatment, Development and Control

Knowledge Area	Correct Answer/Description	Frequency(n=80)	Percentage (%)
Transmission routes	Contaminated food/water	High	80%
	Blood transfusion	Significant	92%
Affected body system	Intestinal system	Varied	Varied
	Circulatory system	Substantial	88%
Major complication	Pneumonia	Majority	75%
	Kidney Stones	Frequent	56%
	Lung Collapse	Frequent	68%
Medication Route	intravenous	Majority	90%

Researchers' compliation 2025

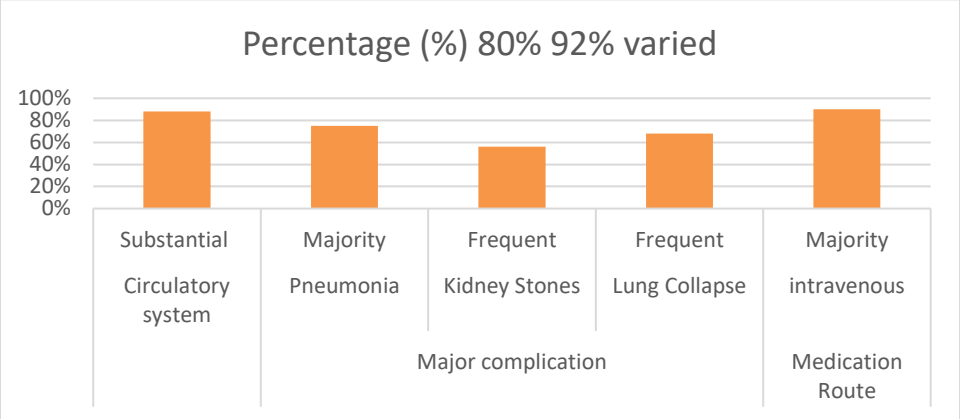


Figure 4: Awareness of Typhoid

Table 3and Figure 4 show the awareness of typhoid transmission varies by sex, with females having a higher awareness rate of 75% compared to males at 56% (95% CI: 40.1, 71.1). The overall awareness of typhoid transmission in the community is 64% (95% CI: 51.1, 76.1). Awareness of typhoid transmission also varies by occupation, with medical doctors having a higher awareness rate of 74% compared to nurses at 56% and laboratory technologists at 53%. Awareness of typhoid complications varies by sex, with females having a higher awareness rate of 85% compared to males at 71% (95% CI: 56.3, 84.3). The overall awareness of typhoid complications in the community is 78% (95% CI: 66.5, 87.5). Awareness of typhoid complications also varies by occupation, with medical doctors having a higher awareness rate of 85% compared to nurses at 71% and laboratory technologists at 65%. Awareness of typhoid transmission and complications also varies by educational level, with postgraduates having a higher awareness rate compared to undergraduates.

Moreover, the community Knowledge about Typhoid Fever revealed that most respondents (45%) identified contaminated food and water as the main transmission route, though some indicated misconceptions (e.g., the importance of airborne transmission). Additionally, awareness regarding the body system affected primarily by Typhoid fever appears mixed, with many identifying it as primarily affecting the circulatory system (51.25%). The knowledge of complications varied; pneumonia was notably recognized (67.5%), while other complications were less frequently mentioned. There is a moderate level of knowledge about symptomatic, transmission, and complications related to Typhoid fever, although misconceptions exist that suggest a need for community education.

In fact, how knowledgeable the general community is about Typhoid Fever, its causes and symptoms is another concern. Respondents demonstrated varied levels of knowledge about Typhoid's transmission. Contaminated food and water were recognized by 25 respondents as the primary transmission mode, which reflects a reasonable understanding. However, misconceptions also exist, as some respondents indicated airborne droplets or blood transfusions as transmission routes. Most respondents recognized the circulatory system as primarily affected (41 respondents), indicating a moderate awareness of the disease's impact. The awareness of complications shows a positive trend, with 54 respondents identifying pneumonia as a common complication, while others mentioned dehydration and lung collapse. In general, awareness is moderate but exhibits notable gaps, particularly about transmission routes, as misconceptions can hinder prevention efforts.

Knowledge Among Health Workers

Table 4: Impact of control measures

Factor	Description	Association with typhoid history
Administration Route	Belief that medications are given intravenously	Positive Association
Complication Knowledge	Belief that pneumonia is a common complication	Positive Association

Acha's compliation 2025

To determine the Knowledge of Symptoms, Diagnosis, and Treatment of Typhoid Fever among Health Workers

Healthcare workers showed a familiarity with Typhoid fever but variations in treatment knowledge were evident. Many indicated the use of blood transfusions, demonstrating a misunderstanding of treatment protocols. Among health workers, 59 (73.75%) reported having suffered from Typhoid fever. Medical doctors (27), nurses (21), and laboratory technologists (11) reported different levels of prevalence.

When asked about treatment, responses suggested familiarity with oral medications but variable knowledge about symptoms associated with complications like pneumonia and dehydration, showing potential gaps in essential healthcare training.

From the data it can be deduced that Health workers have a relatively high prevalence of personal experience with Typhoid fever, and their knowledge about symptoms and treatments is varied. Targeted training programs could improve overall healthcare responses to Typhoid fever.

To Determine the Knowledge of the Symptoms, Diagnosis, and Treatment of Typhoid Fever among Health Workers in Nigeria. Among health workers, 59 out of 80 indicated having suffered from Typhoid fever, specifically 27 medical doctors, 21 nurses, and 11 laboratory technologists. This personal experience may enhance their understanding of disease management. The analysis reveals a disparity in recognition of symptoms and treatment approaches among the healthcare workers, with some responding more accurately based on occupational exposure. Notably, health workers were more likely to have specific knowledge about treatment routes, with 38 indicating the use of blood transfusion though this may reflect misunderstanding, as blood transfusions are not a mode of treatment for Typhoid fever.

Chi-square

Categorical Variables Codings

			Parameter coding		
		Frequency	(1)	(2)	(3)
Which of the following is a common complication of untreated or severe typhoid fever?	Otitis media	8	1.000	.000	.000
	Pneumonia	54	.000	1.000	.000
	Encephalitis	16	.000	.000	1.000
	Urinary tract infection	2	.000	.000	.000

Classification Table[a,b]

Observed Predicted

			Have you suffered from Typhoid?		Percentage Correct
			YES	NO	
Step 0	Have you suffered from Typhoid?	YES	59	0	100.0
		NO	21	0	.0
	Overall Percentage				73.8

a. Constant is included in the model.
b. The cut value is .500

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	6.837	3	.077
	Block	6.837	3	.077
	Model	6.837	3	.077

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	85.268[a]	.082	.120

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

The chi-square tests evaluated the relationship between suffering from typhoid fever and the routes of administration of medication, revealing a non-significant p-value of 0.983 for one set of analysis, indicating no statistical association between these two variables. This means that individuals' reports of routes of administration (intravenous, intramuscular, oral) do not differ significantly based on whether they have suffered from typhoid fever; the choice of treatment method appears to be independent of disease history.

- For common complications of untreated typhoid fever, chi-square analysis returned significant results for one portion ($p = 0.010$), suggesting an association between the type of complication (e.g., pneumonia) experienced and the recent history of typhoid fever. This indicates that individuals who experienced pneumonia were more likely to have reported recent cases of typhoid, illuminating complications as potential health concerns that warrant attention.

- Another notable finding was a dependency observed in the responses related to relationships with patients suffering from typhoid and the routes of administration of treatment, yielding a p-value of $p = 0.000$, which suggests a notable connection between awareness and the routes of medication used by individuals who reported knowing someone affected by typhoid.

Implications:

- The chi-square tests provide insight into the community's understanding and awareness of typhoid and its complications. While certain associations were found, notably with the complication of pneumonia, the majority of associations did not yield significant insights, indicating no meaningful difference in perceptions or experiences based on suffering from typhoid.

- Health education efforts can benefit from these findings, as they highlight the need to improve public awareness concerning treatment options and complications associated with untreated typhoid. Increasing knowledge may impact the community's health behaviors, which could contribute to better prevention and control measures against the disease.

- The results also suggest that complications and treatment routes should be integrated into health interventions, ensuring that both healthcare providers and the community are educated about typhoid fever, its potential complications, and effective treatment options. This can lead to improved patient outcomes and possibly lower prevalence rates in the future.

SUMMARY

-Prevalence: High prevalence of Typhoid fever, documented at 73.75%. highlights show the need for urgent public health initiatives, especially among female respondents.

-Community Awareness: Knowledge gaps about transmission, symptoms, and treatment exist in both the general populace and among health workers, indicating the necessity for robust educational campaigns. There is mixed understanding of transmission and symptoms, with significant misconceptions.

While some health workers especially para-medics, have experienced Typhoid, their understanding of treatment and management remains inconsistent.

- Ongoing public health strategies should incorporate community education, health workers' training, and close monitoring of Typhoid incidence to effectively combat the disease in Agbarho, Delta State.

There is gap in Health Workers' knowledge despite personal experiences.

-Control Measures Impact: Indications that educational interventions are necessary and could potentially lower prevalence.

Finally, addressing Typhoid fever in Agbarho will require multifaceted interventions that prioritize education, training, and sustained public health efforts to mitigate this ongoing health crisis.

CONCLUSION

This study, conducted among healthcare workers and the general populace in Agbarho, Delta State, Nigeria, provides valuable insights into the prevalence of self-reported typhoid fever, awareness of its causes and complications, and potential relationships between these factors. The findings reveal a complex picture with both areas of concern and opportunities for intervention. Regarding prevalence, a significant proportion of respondents (59 out of 80) reported having suffered from typhoid fever at some point in their lives. While this indicates a perceived high prevalence, it's important to acknowledge this is based on self-report and may be influenced by reliance on less specific diagnostic methods like the Widal test. Furthermore, a substantial number of participants reported experiencing typhoid fever symptoms within the past year, with varying timeframes: one month (6), 3 months (24), 6 months (18), 12 months (26), indicating an ongoing burden of the disease. Analysis of awareness levels revealed several gaps in knowledge among healthcare workers. While many correctly identified contaminated food and water as transmission routes, a concerning number (38/80) believed blood transfusion to be a primary mode of transmission, indicating a significant misconception. Furthermore, there was variability in understanding which body system typhoid primarily affects, and common complications, which is concerning, as that may affect proper diagnosis, and treatment. Exploring potential control measures, the data suggests possible associations between knowledge of administration routes of medication, and complications. The logistic regression analysis attempting to link prevalence to knowledge of complications did not yield statistically significant results, indicating that the selected

complication variables, as measured in this study, may not be strong predictors of reported typhoid fever history.

The study suggests that there is a significant variation in the prevalence of typhoid and awareness of the disease among different groups, with females, medical doctors, and postgraduates showing higher levels of awareness and prevalence compared to males, nurses, and undergraduates. While most respondents identified contaminated food and water as primary transmission routes, misconceptions regarding airborne transmission and skin-to-skin contact were evident. Knowledge of the disease's impact varied, with 41 recognizing the circulatory system as the primary area affected. Complications were identified correctly in many cases, particularly pneumonia (54 respondents).

The findings underscore a pressing public health issue concerning Typhoid fever in Agbarho, Delta State, Nigeria. There's a critical need for improved community education regarding prevention and treatment. Additionally, health professional knowledge should be targeted in training programs to ensure they are equipped to effectively manage Typhoid fever and educate the populations they serve. Lastly, the study submits a relatively high self-reported prevalence of typhoid fever among healthcare workers in the studied area. There are notable gaps in the understanding of typhoid fever transmission and its complications, even among healthcare professionals. This highlights the need for targeted educational interventions to improve knowledge and promote evidence-based practices. The lack of significant findings in the logistic regression analysis indicates that the relationships between awareness of complications and typhoid prevalence may be more complex than initially hypothesized or that the sample size was insufficient to detect them. Further research is needed to confirm these findings and to explore other potential risk factors and co-infectious diseases.

RECOMMENDATIONS

1. Immediate Public Health Interventions: The high prevalence of 73.75% underscores a significant public health concern in Agbarho, Delta State. Immediate intervention strategies are warranted to address this health issue, including the implementation of vaccination programs and improved access to clean water and sanitation.
2. Comprehensive Educational Programs: The variable levels of understanding in the population indicate the need for comprehensive educational programs aimed at correcting misconceptions and enhancing awareness of Typhoid fever's transmission routes, symptoms, and prevention strategies.
3. Tailored Health Campaigns: Although chi-square tests revealed no statistically significant relationship between treatment methods and prevalence, the analysis indicates that tailored health campaigns integrating educational measures are necessary to effectively manage and reduce Typhoid fever rates in the community.
4. Enhance Diagnostic Practices: Move away from reliance on the Widal test for diagnosing Typhoid fever and implement more accurate diagnostic methods to improve the validity of Typhoid fever reports and reduce misdiagnoses.
5. Implement Educational Programs for Healthcare Workers: Develop targeted training programs for healthcare professionals to address gaps in knowledge regarding Typhoid fever transmission, symptoms, complications, and management practices, ensuring they can effectively treat and educate patients.
6. Focus on Vulnerable Populations: Tailor education and intervention strategies specifically for groups with lower awareness, such as males, nurses, and undergraduates, to ensure equity in health education and awareness regarding Typhoid fever.
7. Conduct Longitudinal Studies: Engage in longitudinal research to further explore the relationships between awareness of Typhoid fever complications, prevalence rates, and other

potential contributing factors. This can help clarify the complexity of the disease's epidemiology in the community.

ACKNOWLEDGEMENT

This Research work is carried out with the TETFUND 2021 National Research Grant Intervention, NRF/SETI/HSW.

REFERENCES

[1] World Health Organization. (2018) Typhoid and other invasive salmonellosis Vaccine-Preventable Diseases.

[2] Nthiiri J. K., Lawi G. O, Akinyi, C.O, Oganga, D. O. Muriuki, W. C, Musyoka, M. J, Otieno, P. O and Koech, L. (2016) Mathematical Modelling of Typhoid Fever Disease Incorporating Protection against Infection. British Journal of mathematics and computer science. 14(1) 1-10

[3] Naresh, R. Pandey, S. and Misra, A. K. (2008), "Analysis of a Vaccination Model for Carrier Dependent Infectious Diseases with Environmental Effects", Nonlinear Analysis: Modelling and Control, 13, 331-350

[4] Simon-Oke IA, and Akinbote MO (2020) Prevalence of Malaria and Typhoid Coinfection in Relation to Haematological Profile of University Students in Akure, Nigeria. J Infect Dis Epidemilo 6:166.doi.org/10.23937/2474-3658/1510166.

[5] Ohanu, M. E., Iroezindu, M. O., Maduakor, U., Onodugo, O. D., & Gugnani, H. C. (2019). Typhoid fever among febrile Nigerian patients: Prevalence, diagnostic performance of the Widal test, and antibiotic multi-drug resistance. Malawi Medical Journal, 31(3), 184-192.

[6] Ehidiamhen, F. E., Uneke, E. U., Ogbata, E. S., (2025). The burden of enteric fever (typhoid fever) among hospitalized febrile patients: An insight in a teaching hospital in South East Nigeria. American Journal of Pathology Research, 4(1), 1-7.

[7] Sanchez-Vargas, F. M., Abu-El-Haija, M. A., Gomez-Duarte, O. G., (2011). Typhoid fever in children: Epidemiology, clinical findings, and current therapeutic approach. Journal of Infection and Public Health, 4, 167-175.

[8] *Oghre, Emmanuel & Ako, Ignatius. (2011). A mathematical model for measles disease. Far East Journal of Mathematical Sciences.* 54 (1), 47-63, *2011*. 7, *2011*

[9] Gombe, S., Garba, U., Stephen, U., Isah, N., Aliyu, Y., Mohammed, I., & Bala, Y. (2020). Mathematical modeling of typhoid fever transmission dynamics with vaccination. Gombe Journal of Genaral Studies, 7(1), 125-138.

[10] Tilahun, Getachew Teshome& Makinde, Oluwole Daniel& Malonza, D. M. 2017. Modelling and Optimal Control of Typhoid Fever Disease with Cost-Effective Strategies. *Computational and Mathematical Methods in Medicine* Vol. 2017, no. 2017, pp.1-16.

[11] Akinyemi, K. O., Oyefolu, A. O. B., Mutiu, W. B., Iwalokun, B. A., Ayeni, E. S., Ajose, S. O., & Obaro, S. K. (2018). Typhoid fever: tracking the trend in Nigeria. The American journal of tropical medicine and hygiene, 99(3), 41.

[12] Enabulele O, Awunor SN. (2016). Typhoid fever in a Tertiary Hospital in Nigeria: Another look at the Widal agglutination test as a preferred option for diagnosis. Niger Med J 57:145-9.

[13] Adesegun, O.A, Adeyemi, O.O, Ehioghae, O. Rabor, O.F. Binuyo, T.O. Alafin, B.A. Nagha, O.B. Idowu, A.O. & Osunuga, A. (2020). Current Trends in the Epidemiology of Typhoid fever in Africa: A Literature Review. Asian Pacific Journal of Tropical Medicine. 13(5) 204-213.