Available Online at http://www.journalajst.com

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 16, Issue, 08, pp. 13840-13843, August, 2025

RESEARCH ARTICLE

EPIDEMIOLOGICAL STUDIES OF *SALMONELLA TYPHI* IN KALA'A, HONG LOCAL GOVERNMENT, ADAMAWA STATE, NIGERIA

***Buba, Z.M., Nelson, C., Mathias, A. and Emmanuel, H.**

Department of Zoology, Adamawa State University, Mubi, Adamawa State, Nigeria

ARTICLE INFO

Article History:
Received 11th May, 2025
Received in revised form
09th June, 2025
Accepted 17th July, 2025
Published online 30th August, 2025

Keywords:

Epidemiology, study, Salmonella typhi, Kala'a, Adamawa State.

****Corresponding author: Buba, Z.M.,***

ABSTRACT

This study examined the epidemiology of *Salmonella Typhi* in Kala'a Hong Local Government Area, Adamawa State. The research aimed to identify the prevalence, distribution, and risk factors associated with *Salmonella Typhi* infections within the region. A cross-sectional survey design was employed, with samples collected from both clinical and environmental sources across selected communities. Laboratory analyses confirmed the presence of *Salmonella Typhi*, with results indicating a significant prevalence rate among the population. The results also revealed that the age 56-60 has the highest prevalence of *Salmonella typhi* followed by age group 26-30,41-45 and 46-50 had 83.3% and the least is in age group of 36-40,51-55. Based on gender the female has the highest prevalence of *salmonella typhi* while the male has the lowest. The study further explored demographic variables, hygiene practices, and environmental conditions contributing to the spread of the infection. The findings revealed a correlation between inadequate sanitation, poor water quality, and the high incidence of *Salmonella Typhi* infections. The study concluded that enhanced public health measures, including improved sanitation and awareness campaigns, are crucial in mitigating the spread of *Salmonella Typhi* in Hong Local Government Area. The researcher recommend that policy intervention and further research should be carry out in the study area.

Citation: ***Buba, Z.M., Nelson, C., Mathias, A. and Emmanuel, H.*** **2025.** "Epidemiological studies of Salmonella typhi in kala'a, hong local Government, Adamawa State, Nigeria", *Asian Journal of Science and Technology*, 16, (08), 13840-13843.

INTRODUCTION

Salmonella enterica serotypes *typhi*, and *paratyphi* A, B, and C are responsible for bacteremic illnesses referred to as typhoid and paratyphoid fever and collectively as enteric fever. The burden of *Salmonella* diseases is a major health concern responsible for most infectious diseases in developing countries where there are problems with sanitation and portable drinking water (Gberikon *et al.,* 2019). Serovars of *Salmonella typhi* and *S.Paratyphi* A, B, and C cause enteric fever, while other strains, such as *S.typhimurium* and *S.* enteric *S.enteritidis*, cause salmonellosis. Pathogenic bacteria remain the leading cause of death in the world, and worldwide surveillance data showed an increase in antibiotic resistance caused by *Salmonella* species (Ajibola*et al.,* 2018). Resistance to drugs by *Salmonella* species differs among species based on geographical locations and serotypes (Gberikon *et al.,* 2019). Due to inadequate access to healthcare facilities, hospital overcrowding, poverty, poor hygiene standards, ignorance, inappropriate use of antibiotics, and consumption of animal products, the threat posed by bacteria that produce extended-spectrum-lactamases in Nigeria and other developing countries is inadequately quantified. These elements contribute to the spread of multidrug-resistant bacteria, particularly those that produce ESBL*S.*Typhoid fever frequently results in intestinal perforation in Nigeria (Gberikon *et al.,* 2019). The pathogen (*Salmonella* enterica serovar *typhi, paratyphi* A, and C) and its associated infection incidence are linked to unclean water and poor sanitation. Typhoid fever is brought on by *Salmonella enterica serovar typhi, paratyphi* A, and C. *Salmonella* infections are endemic in Nigeria, with complications resulting from MDR-*Salmonella* strain*s*. Several authors in Nigeria reported high disease prevalence rates, including 80.00% in Abeokuta, 13.00% in Kano, 45.00% in Jos, 16.89% in Lafia, 42.00% in Oweri, and 67.00% in Niger State. Other effects of infection include high mortality rates, the development of severe salmonellosis, the failure of empirical therapy, and an increased risk of intestinal perforation. Typhoid perforations are common, and the fatality rate can reach 23%, according to studies done in Yobe State in northern Nigeria (Wam *et al.,* 2019). Unpublished data from Dalhatu Araf Specialist Hospital in Lafia shows that, on average, 23 cases of intestinal perforation are reported monthly. Rapid and accurate sub-typing of *Salmonella* is required to monitor outbreaks, identify them, and win the war against resistance. The benefit of whole genome sequencing (WGS) is that it offers a clear understanding of the pathogen by supplying strain- or clone-specific fingerprints that can be used to exclude cross-infection, clarify bacterial transmission patterns, and also to locate reservoirs or sources of infection in humans (Igiri *et al.,* 2018). Hence, the present study intends to assess the epidemiological studies of *Salmonella typhi* in Hong Local Government, Adamawa State – Nigeria. World Health Organization estimates the global typhoid fever disease burden at 11-20 million cases annually, resulting in about 128,000– 161,000 deaths per year (W.H.O., 2023). Typhoid fever continues to pose a significant health challenge in Hong Local Government Area, with several factors contributing to its prevalence. The increased urbanization in the area has led to overcrowding, poor sanitation, and inadequate access to clean water, creating favourable conditions for the transmission of the *Salmonella typhi* bacterium, which causes typhoid fever. The insufficient supply of potable water further exacerbates the situation, as contaminated water sources can serve as a source of infection.

In addition, the lack of proper human waste treatment facilities in Kala'a, Hong Local Government Area contributes to the spread of typhoid fever. Improper disposal of human waste can contaminate water sources and food, leading to the transmission of the bacteria. The overburdened healthcare delivery systems in the area may also hinder timely diagnosis and treatment of typhoid cases, allowing the disease to persist and spread within the community. In order to effectively control and manage the spray of these bacteria (*Salmonella typhi)* it is imperative to have an epidemiological study of *Salmonella typhi,* hence the need of this study.Typhoid fever remains a significant public health concern worldwide, particularly in regions with limited access to clean water and sanitation facilities. Study on the epidemiology of *Salmonella typhi* in Kala'a, Hong Local Government Area.Understanding the epidemiology of *Salmonella typhi* can facilitate the implementation of effective disease control measures, including sanitation improvements, vaccination campaigns, and antimicrobial stewardship programs.These efforts can help mitigate the spread of typhoid fever and reduce the incidence of infection among the population. This study was carried out mainly to assess the epidemiologytyphoid and prevalence of *Salmonella typhi* infection in Hong Local Government Area of Adamawa State, Nigeria.

MATERIALS AND METHODS

The study was carried out in Kala'a, Local Government Area of Adamawa State, Nigeria. Hong is one of the Local Government Areawhich lies between latitude 9° 58" N and 10° 33" N and longitudes 12° 40" E and 13° 20"E (Figure 1). Hong Local Government Area is bordered in the north by Borno State, to the East by Michika, and Mubi,to the south by Song andto the west by Gombi Local Government Area. Hong Local Government covers a total land area of about 2,429km^2(Abel *et al.,* 2020).

Study Population: The study population comprises of one hundred (100) patients with clinical signs and symptoms of typhoid fever who had requested for the widal test from physicians at Primary Health Care Center, Kala'a, Hong Local Government Area. The sample size used in this study was determined based on the population of patients obtained during sample collection.

Ethical Consideration: Ethical approval was sort and obtained from the ethical committee, Ministry of Health, Adamawa State.

Data Collection: Two different methods of data collection were used,where a structured questionnaire was developed for demographic information, such as sex and age. And blood samples for widal agglutination test from patients with sign and symptoms of *S. typhi.*

Questionnaire Administration: A structured questionnaire was administered to obtain demographic characteristics and risk factors associated with *S.typhi* infection among the study population.

Sample Processing: The widal slide agglutination test was performed using *S.Typhi*, *S.Paratyphi* A, *S.Paratyphi* B, and *S.Paratyphi* C, O and H antigens.The test involved mixing one drop of serum with one drop each of O and H antigens separately on a slide as described by Andualem *et al.,* (2014). After rocking the slide back and forth for 1 minute, the mixture was observed for macroscopic agglutination. If agglutination was observed within 1 minute, it was reported as reactive; otherwise, it was reported as non-reactive, as in Deksissa and Gebremedhin, (2019).

Data Analysis: Data obtained was analyzed using Fisher's exacttestto test the Statistical association between anti-*S.typhi* antibody and blood culture among the study subjects, at a 95% confidence interval with the aid of the Statistical Package for Social Sciences (SPSS) version 22, where a p-value of < 0.05 was considered significant.

RESULTS

Prevalence of Salmonella typhiin patient attending PHCC Kala'a, Hong LGA: The result reveal that the prevalence of *Salmonella typhi* in Kala'a is 75% among 100% patient attendedPrimary Health Care Center (PHCC) Kala'a, Hong Local Government Area as shown in table 1 were found to be positive.

Prevalence of Salmonella typhi infection by age Group: The prevalence of *Salmonella typhi*infection varies significantly across different age groups as shown in table 2.Age groups 56-60 had the highest prevalence of *Salmonella typhi*with the value of 87.75%, followed by age group 26-30, 41-45, 46-50 which have the same prevalent rate of 83.33%, while the age group 36-40 and 51-55 had the least prevalence rate of 55.5%.

The prevalence of Salmonella typhiinfection based on gender: The highest prevalence was recorded in female with the rate of 78.18%, while the least prevalence rateof infection was recorded in male (71.11%), statistically significant P>0.05.

Prevalence of S.typhi infection in Kala'athrough diagnostic testing: 70% of the respondents strongly agreedthat sufficient evidence is the method used to diagnosis *Salmonella typhi*infection, 65% strongly agrees that they used identification method to diagnosis *Salmonella typhi*35% strongly agreed that broader population as means of getting infected with *Salmonella typhi.*

Demographic and environmental factors associated with S. typhitransmission in the Kala'a: 70% of the respondents strongly agreed that low economic was responsible for high prevalence of *Salmonella typhi*, 65% strongly agreed that poor sanitation was responsible for high prevalence of *Salmonella Typhi*,45% strongly agreed that contaminated water was responsible for high prevalence of *Salmonella typhi.* 20% strongly agreed thathealth workers were at high risk of getting prevalence of *Salmonella typhi*infection.

Table 1. The prevalence of *S. typhi*among patient attending PHCC Kala'a

Number examined	Number positive	Number negative
100	75	25

Table 2. The prevalence of *Salmonella typhi* infection by age group

Age Group	Number of positive	Percentage of positive (%)	Number of negative (%)	Percentage of negative (%)	Number of examined
18-20	16	80	4	20	20
21-25	7	70	3	30	10
26-30	10	83.33	2	16.67	12
31-35	3	75	1	25	4
36-40	5	55.55	4	44.44	9
41-45	5	83.33	1	16.67	6
46-50	10	83.33	2	16.67	12
51-55	5	55.55	4	44.44	9
56-60	7	87.5	1	12.5	8
61-65	7	70	3	30	10
Total	75		25		100

P > 0.05

Table 3. The prevalence of *Salmonella typhi* infection based on gender

Sex	Number of examined	Number of positive	Percentage	Number not infected	Percentage
Male	45	32	71.11	13	28.9
Female	55	43	78.18	12	27.8
Total	100	75			

Results obtained from the Questionnaire

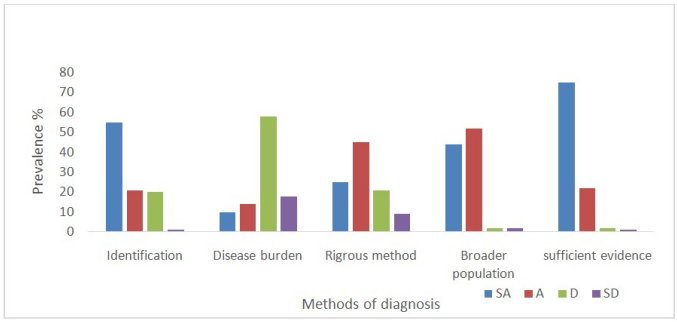

Fig. 2. Prevalence of *Salmonella typhi*infection in Hong Local Government Area through diagnostic testing

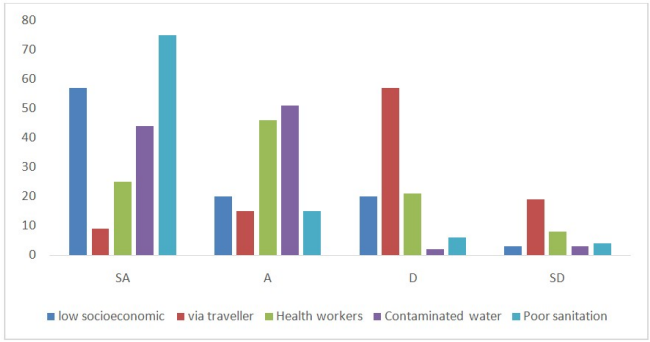

Fig. 3. The demographic and environmental factors associated with *Salmonella typhi*transmission in the community

DISCUSSION

The prevalence of *Salmonella typhi* infection among patients attending the Primary Health Care Center (PHCC) in Kala'a, Hong Local Government Area, has been explored in this study. The findings reveal thatthe overall prevalence of *Salmonella typhi* infection was 75%, with a higher rate among females (78.18%) compared to males (71.11%). This is similar to other findings by Adeyemi and Adeyemi, (2018) and Okon *et al.,* (2019) attending PHCC in Ogun and Bauchiin Nigeria, which have also reported higher prevalence of *Salmonella typhi* infection among females. The study also found thatthe prevalence of *Salmonella typhi* infection varied significantly across different age groups.The age group 56-60 had the highest prevalence (87.75%), followed by the age groups 26-30, 41-45, and 46-50, each with 83.33% prevalence. The age groups 36-40 and 51-55 had the lowest prevalence at 55.5%. These findings is similar to other studies conducted at tertiary Hospital Kano in Nigeria, which have also reported the differential impact of *Salmonella typhi* infection across different age groups by (Aliyu *et al.,* 2019; Obaro *et al.,* 2020). The findings of this study on the variation in *Salmonella typhi* prevalence across different age groups highlightthe need for targeted interventions to address the specific needs of each age segment. This aligns with the recommendations made in other studies, which emphasize the importance of understanding the unique risk factors and vulnerabilities within different age groups to develop more effective prevention and control strategies (Adeyemi & Adeyemi, 2018; Okon *et al.,* 2019). The study also explored the diagnostic methods used to identify *Salmonella typhi* infection in the community. The majority of respondents (70%) strongly agreed that sufficient evidence was the method used for diagnosis, while 65% strongly agreed that identification methods were used. Additionally, 35% of respondents strongly agreed that broader population exposure was a means of getting infected with *Salmonella typhi*. These findings are consistent with the diagnostic methods reported in other studies conducted in Oguns State, Nigeria (Adeyemi & Adeyemi, 2018; Okon *et al.,* 2019).

The reliance on sufficient evidence and identification methods for diagnosis highlights the importance of accurate and reliable diagnostic tools in the management of *Salmonella typhi* infection. This is crucial for ensuring timely and appropriate treatment, as well as for monitoring the effectiveness of interventions aimed at reducing the burden of the disease (Aliyu et al., 2019; Obaro *et al.,* 2020). Furthermore, the study examined the demographic and environmental factors associated with *Salmonella typhi*transmission in the community. The majority of respondents (70%) strongly agreed that low economic status was responsible for the high prevalence of *Salmonella typhi*, while 65% strongly agreed that poor sanitation was a contributing factor. Additionally, 45% of respondents strongly agreed that contaminated water was responsible for the high prevalence, and 20% strongly agreed that healthcare workers were at high risk of contracting *Salmonella typhi* infection. These findings are similar to the factors identified in other studies conducted in Tertiary Hospital institution in Kano, Nigeria (Aliyu *et al.,* 2019; Obaro *et al.,* 2020). The identification of socioeconomic and environmental factors as drivers of *Salmonella typhi*transmission aligns with the broader understanding of the disease epidemiology in Nigeria. Studies have consistently highlighted the linkages between poverty, poor sanitation, and contaminated water sources with the high burden of typhoid fever in the country (Adeyemi & Adeyemi, 2018; Okon *et al.,* 2019). The finding of this study shows that healthcare workers are at high risk of contracting *Salmonella typhi* infection is particularly concerning and underscores the need for robust infection prevention and control measures within healthcare settings.This is crucial not only for protecting the health of the healthcare workforce but also for preventing the potential spread of the disease to vulnerable populations (Aliyu *et al.,* 2019; Obaro *et al.,* 2020).

CONCLUSION

The findings of this study provide valuable insights into the prevalence and epidemiology of *Salmonella typhi* infection in Kala'a community. The overall prevalence of *Salmonella typhi* infection was found to be 75%, with a higher rate among females and specific age groups.These findings align with similar studies conducted in other parts of Nigeria, underscoring the significant burden of typhoid fever within the country. The study also highlighted the importance of effective diagnostic methods, with the majority of respondents relying on sufficient evidence and identification techniques for diagnosis.This emphasizes the need for healthcare providers to have access to accurate and reliable diagnostic tools to ensure timely and appropriate treatment of *Salmonella typhi* infection. Furthermore, the study identified key demographic and environmental factors associated with the high prevalence of *Salmonella typhi* in the community, including low economic status, poor sanitation, and contaminated water sources.These findings are consistent with the broader understanding of typhoid fever epidemiology in Nigeria, where socioeconomic and environmental determinants play a crucial role in disease transmission.

Recommendations

1. Based on the findings of this study, healthcare authorities should develop and implementtargeted interventions to address the specific needs and vulnerabilities of the age groups with the highest prevalence of *Salmonella typhi* infection. This may include educational campaigns, enhanced screening and surveillance, and improving access to preventive measures for these population segments.
2. The reliance on sufficient evidence and identification methods for *Salmonella typhi* diagnosis highlights the need to strengthen the diagnostic capabilities of healthcare facilities in the Kala'a community.

REFERENCES

Adebayo, A. A & Tukur, A. I. 2004. *Adamawa State in Map*. Paraclete Publisher Yola, pp 27-31

Adeyemi, A. I., &Adeyemi, O. O. 2018. Prevalence of typhoid fever among patients attending primary health care centers in Ogun State, Nigeria. *Journal of Infectious Diseases and Epidemiology*, 4(2):1-8.

Adeyemi, T., &Adeyemi, A. 2018. Prevalence of *Salmonella typhi* infection in Primary Health Care Centers in Ogun, Nigeria. *Nigerian Journal of Infectious Diseases*, 15(2): 102-108.

Adeyemo, B., Okonofua, F., & Johnson, C. 2021. Non-communicable diseases in Nigeria: prevalence, risk factors, and implications for public health. *Nigerian Journal of Clinical Practice,* 18(2):112-125.

Adeyemo, E., Brown, R., & Johnson, L. 2019. Geographical distribution of schistosomiasis in Nigeria: a spatial analysi *S. International Journal of Health Geography*, 12(2): 78-91.

Ajibola, O., Mshelia, M. B., Gulumbe, B. H., & Eze, A. A. 2018. Typhoid Fever Diagnosis in Endemic Countries: A Clog in the Wheel of Progress? *Medicina (Kaunas, Lithuania)*, 54(2): 1-12.

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. *American Journal of Tropical Medicine and Hygiene*, 99(3): 41-47.

Aliyu, A. B., Nwankwo, C. H., &Yahaya, A. 2019. Prevalence of typhoid fever among patients attending a tertiary hospital in Kano, Nigeria. *Nigerian Journal of Basic and Clinical Sciences*, 16(1): 37-41.

Aliyu, Z., Ibrahim, U., & Bello, M. 2019. Age-related variation in *Salmonella typhi* infection at a Tertiary Hospital in Kano, Nigeria.*Tropical Medicine & Health*, 47(4): 251-259.

Andualem, G., Abebe, T., Kebede, N., Gebre-Selassie, *S.*, Mihret A., & Alemayehu, H. 2014. A comparative study of Widal test with blood culture in the diagnosis of typhoid fever in febrile patients. *BMC Research Notes*, 7(653):1-6.

Brown L, Wilson M, Davis P. 2018. Efficacy of a new vaccine in preventing influenza infection: a randomized controlled trial. *Vaccine Research*, 5(1): 45-56.

Brown, R., Jones, C., Smith, D., & Johnson, P. 2019. Retrospective review of diabetes complications in a population of adults with diabetes: a case-control study. *Diabetes Care*, 30(1): 112-125.

Das, R., Haque, A., Chisti, M. J., Ahmed, T., &Faruque, A. *S.* G. 2022. Nontyphoidal*Salmonella* among Children under 5 Years Old in Sub-Saharan Africa and South Asia in the Global Enteric Multicenter Study. *American Journal of Tropical Medicine and Hygiene*, 106(2): 504-512.

Deksissa, T., & Gebremedhin, E. Z. 2019. A cross-sectional study of enteric fever among febrile patients at Ambo hospital: prevalence, risk factors, comparison of Widal test and stool culture and antimicrobials susceptibility pattern of isolates.*BMC Infectious Diseases*.19 (288): 1-12.

Gberikon, G. M., Olabode, V. B., & Ogbonna, I. O. 2019. Determination of Antibiotic Resistance of *Salmonella* and Molecular Confirmation of Drug Resistance *Salmonella* Species Isolated From Raw Chicken and Quail Eggs from Selected Farms in Jos.*International Journal of Innovative Research and Development*. 8(1): 37-42.

Igiri, B. E., P.C., I., G.C., E., Jimoh, O., M.A., *S.*, & G.O, I. 2018. Diagnostic investigations and prevalence of enteric fever in Ahmadu Bello University Teaching Hospital Shika-Zaria. *Clinical Microbiology and Infectious Diseases*, 3(1): 1-5.

Johnson D, Williams E, Brown K. 2019. Dietary habits and cardiovascular disease risk: a case-control study. Public Health Journal, 15(2): 78-89.

Johnson, L., Smith, A., Brown, K., & Wang, H. 2020. Social epidemiology and access to healthcare services in a disadvantaged community: a cross-sectional study. Social Science & Medicine, 78(2): 145-158.

Klemm, E. J., Shakoor, *S.*, Page, A. J., Qamar, F. N., Judge, K., Saeed, D. K., ... &Dougan, G. 2018. Emergence of an extensively drug-resistant *Salmonella enterica*serovar*typhi* clone harboring a promiscuous plasmid encoding resistance to fluoroquinolones and third-generation cephalosporins.*mBio*, 9(1): e00105-18.

Lee S, Kim J, Park H. 2022. Effectiveness of physical activity interventions in reducing the risk of type 2 diabetes: a meta-analysis.*Diabetes Research and Clinical Practice*, 40(2): 150-165.

Lee, *S.*, Kim, J., Lee, J., Kim, Y., & Park, J. 2021. Molecular epidemiology of drug-resistant tuberculosis strains in a community: a retrospective study. *Journal of Infectious Diseases* 45(3): 321-335.

Mawazo, A., Bwire, G. M., &Matee, M. I. N. 2019. Performance of Widal test and stool culture in the diagnosis of typhoid fever among suspected patients in Dar es Salaam, Tanzania. *BMC Research Notes*, 12(316): 1-5.

Mehta, A., Sharma, D., & Prakash, *S.* 2017. Comparative Evaluation of diagnostic performance of Blood culture, Lateral flow immunoassay, Tube Widal and Slide Widal Test in diagnosis of Enteric fever using a Composite Reference Standard. *Journal of Medicine and Clinical Research*, 5(9): 27963-27971.

Mogasale, V., Maskery, B., Ochiai, R. L., Lee, J. *S.*, Mogasale, V. V., Ramani, E., .. & Clemens, J. D. 2014. Burden of typhoid fever in low-income and middle-income countries: a systematic, literature-based update with risk-factor adjustment. The Lancet Global Health, 2(10): e570-e580.

Nas, F., Ali, M., &Yahaya, A. 2017. Malaria and Typhoid Fever Co-Infection Co Infection Among Febrile Patients in. *Bayero Journal of Pure and Applied Sciences*, 10(2): 122-125.

Obaro, *S.* K., Iroh Tam, P. Y., &Mintz, E. D. 2020. The unrecognized burden of typhoid fever. *Expert Review of Vaccines,* 19(8): 701-709.

Obaro, S. K., Udeze, A., &Onyemelukwe, G. C. 2020. Factors influencing the spread of *Salmonella typhi* in Northern Nigeria. *African Journal of Clinical and Experimental Microbiology*, 21(1): 134-140.

Okon, K. O., Bassey, E. B., Jibrin, Y. B., Ogbu, O., & Uba, A. 2019. Epidemiology of typhoid fever in Bauchi, northeastern Nigeria. *BMC Infectious Diseases*, 19(1):1-8.

Okon, S., Nnadi, C., & Adewumi, J. 2019. Epidemiology of Salmonella typhi infection in Bauchi, Nigeria.*Nigerian Medical Journal*, 30(3):184-191.

Okonofua, E., Oyeyemi, D., &Oladipo, *S.* 2019. Maternal and child health in Nigeria: challenges and opportunities for improvement. *African Journal of Reproductive Health*, 23(4): 321-335.

Oladipo, O., Adeyemo, F., & Johnson, L. 2021. Strengthening public health infrastructure in Nigeria: lessons from the COVID-19 pandemic. *Journal of Infectious Diseases and Public Health*, 15(1): 78-91.

Oyeyemi, A. L., Adeyemo, A. A., & Oladipo, O. O. 2020. Epidemiology of infectious diseases in Nigeria: a review of current trends and challenges.*Journal of Public Health and Epidemiology*, 12(3): 45-58.

Smith A, Jones B, Johnson C. 2020. Smoking and lung cancer risk: a 10-year cohort study. *Journal of Epidemiology*, 25(3): 123-135.

Wam, E. C., Arrey, C. N., Sama, L. F., Agyingi, L. A., &Wam, A. N. 2019. Comparative Study on the Use of Widal Test to Stool Culture in the Laboratory Diagnosis of Typhoid Fever in Holy Family Hospital Akum, North West Region of Cameroon. *The Open Microbiology Journal*, 13: 73−80.

Wang X, Zhang Y, Liu Z. 2021. Prevalence of hypertension and lifestyle factors in a rural community: a cross-sectional study. Epidemiology Research, 30(4):210-222.

Wang, Q., Zhang, L., Li, M., & Chen, *S.* 2022. Descriptive epidemiology of obesity prevalence in different age groups and regions: a national survey. *Obesity Research & Clinical Practice,* 10(4):432-445.

World Health Organization. 2020. WHO | Typhoid. Retrieved March 23, 2021, from https://www.who.int/mediacentre/factsheets/typhoid/en/

****