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SPATIO-TEMPORAL ANALYSIS OF TYPHOID FEVER MORTALITY IN KANO STATE, NIGERIA

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ABSTRACT

Typhoid fever has become a significant health problem causing an estimated 21.7 million cases per year and over 200,000 deaths annually. This study analysed typhoid fever mortality spatially and temporally in Kano State over the period of 10 years (2006-2015). Hospital records obtained from all General hospital (31) and Aminu Kano Teaching Hospital were used. These facilities were purposively selected because of the availability of doctors and diagnostic laboratories. Coordinate of wards in the state were also generated and imported into Arc GIS environment. Variables used include age, sex, number of days spent on admission, condition on discharge and Typhoid fever mortality cases. Descriptive statistics (Tables) was used to show age and sex distribution of deaths while bar graphs were used to show case fatality. The results showed case fatality rate for the state is at 6% with Kunchi in the extreme north east having the highest case fatality rate greater than 10% and the lowest rates of 0-3% were observed around Doguwa Tudun Wada and Takai. Furthermore, results revealed that more females died of the disease than males with 6.3% and 5.6% respectively, while the monthly distribution of mortality in the state for all the years showed that it was high in months of March and December with over 6% and about 7% case fatality respectively. The study recommends frequent vaccination and hygienic eating and drinking habits as well as hygienic practices at home and outside home as remedies for addressing the problem.

Keywords: *Distribution, trend, death, case fatality*

INTRODUCTION

Infectious diseases are the most endemic diseases in developing societies including Nigeria. These diseases are caused due to poor water supply and sanitation which is usually associated with poverty and underdevelopment resulting to high morbidity and mortality. Among the infectious diseases typhoid fever is a major cause of ill health in the world (Brooks, *et al.*, 2005), a common disease worldwide transmitted by the ingestion of food and/or water contaminated with the feces of an infected person (Ifeanyi, 2014; Modebe *et al*. 2014),especially in crowded and impoverished populations (Crump and Mintz, 2010). It continues to be a significant cause of illness and death particularly among children and adolescents in developing countries as a result of poor sanitation, and consumption of unsafe food and contaminated water (Okafor, 2007; Crump and Mintz, 2010) so also the consumption of raw milk products, flavored drinks and ice-creams (Marathe, *et al.*, 2012).Up to 1.5 million people die from water, sanitation and hygiene-related diseases each year and millions more suffer from preventable diseases such as diarrhea, intestinal worms, *schistosomiasis* and trachoma (WHO, 2014) including Typhoid fever. Nigeria is one of the countries in the world that has unsafe water supplies due to the uncoordinated efforts of various federal, state and local agencies, and given the low quality of drinking water, making them susceptible to waterborne illnesses (Yusuff, John and Olorutoba 2014).Typhoid fever was found to be endemic in Kano State infecting all age groups with the bulk of infection within the youthful age groups. It is prevalence throughout the year with high prevalence recorded in the hot dry season and the warm wet seasons, and also endemic in both urban and rural Kano (Abdulkarim and Adamu, 2018).

Typhoid fever is endemic through- out the African and Asian continents, causing an estimated 21.7 million cases per year and over 200,000 deaths annually (Crump and Mintz, 2010). However, the true magnitude is difficult to quantify because the clinical picture is confused with many other febrile illnesses and most typhoid endemic areas lack facilities to confirm the diagnosis (Parry 2005).Illness and death rates as a result of typhoid fever may upsurge more due to increased antimicrobial resistance (AMR), (Pieters, *et al.*, 2018).Epidemiologic studies also show the rise of multi-drug resistant (MDR) organisms (Walia *et al* 2005). In a study of 1100 hospitalized children in

Pakistan, the mortality rate of 1.6% was found to be related to younger age and MDR infection (Bhutta, 1996). Traditionally the age range considered to be at greatest risk was 5-25 years. However this has been questioned in a study from a private laboratory in Bangladesh, which found that the 57% of S. typhi isolates were in children less than 5 years of age and 27% less than 2 years (Saha *et al*., 2001).

To attack the core cause of typhoid fever including poor sanitation, unsafe water due to poor management of infrastructures has thrown large population in endemic areas away from achieving good sanitation and safe water consumption (Pieters *et al*, 2018). Hygienic measures such as hand washing, boiling water before consumption can be help reduce susceptibility to the disease. Vaccination especially of populations that are in high-risk is seen as the most hopeful approach for the control of typhoid fever (Kanungo *et al*., 2008).Most of the early studies in Kano are clinically based studies, including Diagnostic Value of Widal Test in Febrile Children (Adeleke and Nwokedi, 2008), leukocyte count of Typhoid fever patients (Sarkinfada and Abubakar, 2001), prevalent and Multiple Antibiotic Resistance (Mas'ud and Tijjani, 2015), Typhoid enteric perforation, (Edino, *et al.,* 2004) and incidence of Salmonella species, (Abdullahi, 2010). Few studies attempted analyzing the spatial and temporal distribution in part of the study area (see Benjamin, 2002, Abubakar 2015, Abdulkarim and Mohammed, 2017). However, these studies only looked at the prevalence with their unit of analysis only within the metropolis and with data from very few health facilities. This study investigated the distribution and trend of typhoid fever mortality in Kano State.

METHODS

Description of the Study Area

Kano State is located between latitude 10º30'N to 12º30'N and Longitude 7º30'E to 9º25'E. It is bordered by Jigawa State in the north and east, Kaduna and Katsina States in the West, and Bauchi and Kaduna States in the South (Figure 1). The state is located within the Sudan savannah, and bordered in the south by the guinea savannah. The climate is the tropical wet and dry type coded as AW based on the Koppen's classification of climate (Achugbu and Anugwo, 2016) with the believe that changes have occurred in the past, recording high temperature throughout the year (Mustapha *et al.,* 2014) and determined by the movement of the Inter Tropical Discontinuity (ITD) zone (Abdulhamid *et al.,* 2014). Three main seasons are identified base on temperature regimes: the cool and dry season, the hot and dry season and the wet season. The cool dry season starts in November and ends in February. It has a mean monthly temperature between 21º and 23º with a diurnal range of 12º-14^{0}C (Olofin, *et al.,* 2008). Mean annual rainfall in a normal year ranges from 800mm in around the Urban Kano, and 1000m in the southern part of the state. Rainfall amount received vary between Central Kano/metropolis and the extreme northern and southern parts based on factors such as latitude and continentality. Annual amount of rainfall in the southern Kano may reach about 1000 mm (part of Doguwa and Tudun-Wada local governments), and lower than 800mm in the northern extreme as you approach the desert (Mustapha *et al.,* 2014). The state is drained with two major rivers (River Kano and River Chalawa) with the former originating from the southern Kano highland (the foot slope of the Jos plateau), and the later emerging from western Kano, (Barau, 2008).The Kano River flows down to Kano central making a confluence at Tamburawa with River Chalawa.

DATA COLLECTION

First, an application letter was submitted to the Kano State Ministry of Health and the Research and Ethics Department of Aminu Kano Teaching Hospital requesting for data on reported Typhoid fever cases. Attached to the application letter sent was a copy of the research proposal which was subjected to scrutiny by the ethics committee of both the Kano State Hospital Management Board and Aminu Kano Teaching Hospital before approval was given to have access to the records.

Purposive sampling was used in the choice of healthcare facilities in the state. Major secondary healthcare facilities that are publicly owned were selected because of the availability of doctors and diagnostic laboratories in these facilities. The only tertiary healthcare facility that is not specialized was also chosen for the study because the services it provide. The choice of these facilities was also tied to the fact that they are economically accessible to an average member of the state and the most patronized by the populace.

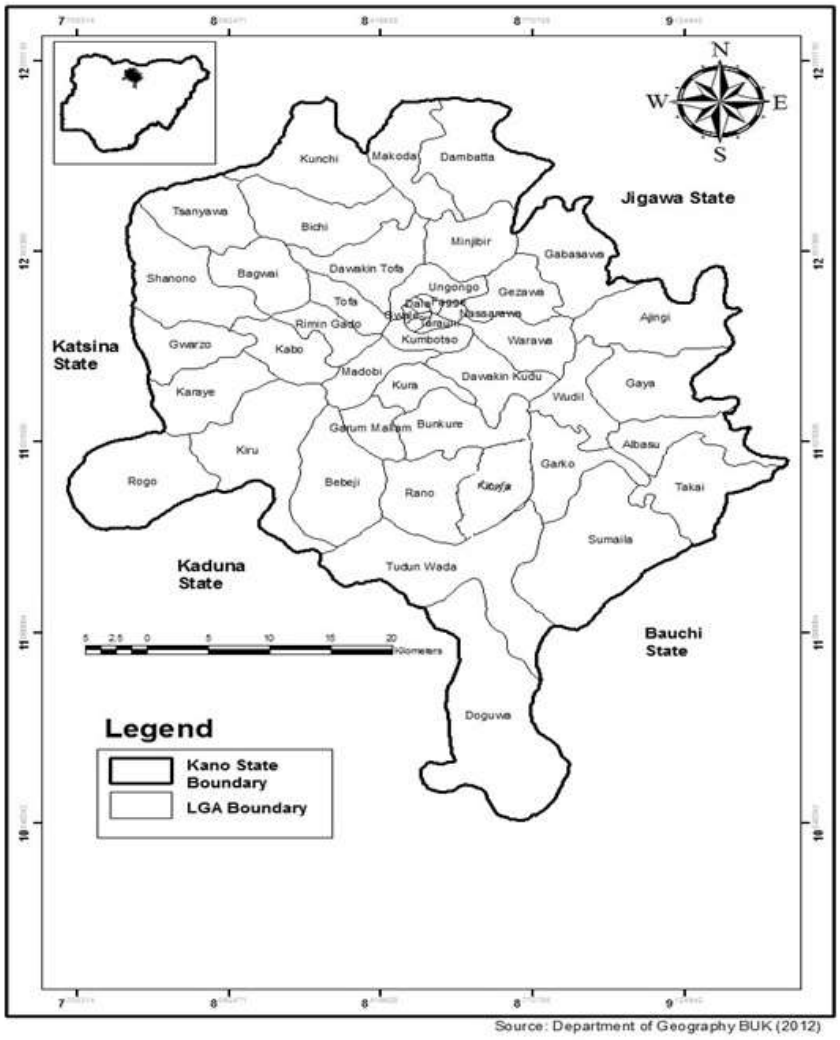

Fig. 1: Map of Study Area

A template for entering the data was created with nine columns including date, address (Ward and LGA), age and sex of infected patients, number of days spent on admission, and the condition on discharge after being diagnosed with the disease (whether recovered absconded or dead). Four research assistants were trained on how to collect the data from the records department of all the sampled hospital. The data on typhoid fever deaths was generated from the register obtained from the records department of the health facilities. The hospitals are provided with records books the management of AKTH and KSHMB which is used for taking records of reported health problem for each day. Typhoid fever cases were extracted from the records and dully verified and signed the head of the record department. On the other hand, the coordinates of all settlements as identified in the hospital records was generated from the data base of all settlements in Nigeria created by E-Health. Briefly report how the hospitals collect the data. How often the data is documented in the hospital. What about quality assurance and quality control followed during the process of collecting the data? The sample size is not reported in this study. The coverage of the data in this study is missing.

Data obtained from the Hospital records was first entered into Excel Microsoft (2007) application to create a simple database. Columns were used as field to store information on typhoid cases. These are the date; location; age; sex; number of day spent on admission, Status of the patients (whether recovered or not); and coordinates (Generated from the database of E-Health). The data was saved in a project folder (created in C drive) and then imported to ArcMap environment of ArcGIS 10.2 (Mohammed, 2015). The data was converted to shape file and used to perform all the analysis. In addition, bar and line graphs were produced for the analysis using Microsoft Excel. The population of the state was obtained from the National Population Commission (NPC, 2006 Census) and projected yearly using the growth for

the state as provided by the commission. The following formula was used for the projection:

$$P_i=P_{2006}(1+X)^n \quad 1$$

where, P_i is population for year of interest, P_{2006} is the population of 2006, X is the annual growth rate of the state and n is the number of years between 2006 and the year of interest. The projected population data were used as the denominators to calculate the typhoid prevalence rate for each year (Dewan *et al*, 2013). This was used to generate the population for each local government area since population at each community was not available.

This was used to calculate Case fatality for each month, year, age, sex, and for locations to avoid misrepresentation of the prevalence since the population of the state is not evenly distributed.

DATA ANALYSIS

Mapping

The Local Government Area map of Kano State was sourced from the department of Geography, (Bayero University, Kano) scanned georeferenced and digitized in the GIS environment. The typhoid fever record was imported into the GIS environment and merged forming the database for the analysis. Choropleth map was generated from the database using prevalence rates at local government level. This has the advantage of showing rates per local government per year, with a fair presentation of the actual scenario of typhoid prevalence in the state. Four level of categorization (High, low-high, low, and insignificant as used by Wang, *et al.*, 2103). The range of categorization for each year and for the combined 10 years data was determined by the total number of deaths per year and for the whole years. This explains the reason for the variations in range of deaths for the various years.

Statistical Analysis

Variables used here include age, sex, number of days spent on admission, condition on discharge and typhoid fever mortality cases. Descriptive statistics (Tables) in the SPSS software 20.0 were used to perform this analysis. Case fatality was also calculated for each month, year, age, sex, and for locations using the following:

$$\text{Case fatality} = \frac{\text{Total Typhoid fever prevalence}}{\text{Total Population}} \times 100 \quad 2$$

The results for monthly, yearly, age and sex was presented in line graphs using Excel Microsoft (2007) applications, and map was used to present those for locations.

RESULTS AND DISCUSSIONS

The study investigated mortality of patients infected with typhoid fever and the result indicates that over the study period, a total of 1384 deaths were recorded of which54.3% are female and 45.7% are male. The high deaths recorded by the female might be attributed to their domestic activities including handling children excreta which without proper hand washing will make them more vulnerable to the infection and where cases are not quickly identified and reported, it could develop to complications and eventually death. Also, one of the major factor apart from economic identified to influence women health is cultural factor where husbands might not allow their wives to patronize orthodox health facility, and as such lead to maternal mortality (Adamu, 2003).

Table 1: Sex Distribution of Typhoid Fever Mortality in Kano State

			Mortality
	F	F	752
		%	54.3
	M	F	632
		%	45.7
Total		F	1384
		%	100.0

Source: Medical Records of Sampled Health Facilities (2016)

The age distribution typhoid fever mortality in the state shows that children less than 5 years of age are the most that died of the disease, (Table 2).

Age (Year)			Total
			Dead
	Not Indicated	F	1
		%	0.1
	<5	F	241
		%	17.4
	5-9	F	135
		%	9.8
	10-14	F	158
		%	11.4
	15-19	F	211
		%	15.2
	20-24	F	125
		%	9.0
	25-29	F	129
		%	9.3
	30-34	F	102
		%	7.4
	35-39	F	59
		%	4.3
	40-44	F	74
		%	5.3
	45-49	F	35
		%	2.5
	50-54	F	43
		%	3.1
	55-59	F	7
		%	0.5
	60 & Above	F	64
		%	4.6
Total		F	1384
		%	100.0

Source: Medical Records of Sampled Health Facilities (2016)

The high mortality in this age group might be attributed to poor hygiene practices at homes and the fact that children within the group are vulnerable where they play anywhere and eat and drink anything that comes their way without precaution making

them more susceptible not only to typhoid fever but other infectious diseases. The study however showed that patients between ages 5-19 (school going) account for the majority of those who lost their lives to the disease. The implication of this is the structure of the population might be affected as the young age group that is supposed to replace the older ones is dying. The high death in this group might be because they spend most of their time outside their homes, as such they become vulnerable to the disease especially due to eating and drinking outside. It might also be as result of late reporting of the disease in healthcare facilities. It also shows that from the age of 20 death decreases with increase age, however, there was a slight rise in death in ages 60 and above. This might be as a result of age and possibly other underlying problems associated with ageing. This finding corroborates the work of Crump (2017) who reported the high deaths among children and a decrease in death with increase of people who died of typhoid fever.

The temporal trend of typhoid fever mortality a rising situation from 2006 -2015 with few exceptions implying that the disease is endemic throughout the period of study and on the increase (Table 3).This study corroborates the work of Benjamin (2002) who observed a gradual rise in the disease prevalence from 1997-2000.

Table 3: Typhoid fever Deaths by year

Year	Dead
2006	82
2007	94
2008	111
2009	126
2010	137
2011	152
2012	119
2013	161
2014	204
2015	198
Total	1384

Source: Medical Records of Sampled Health Facilities (2016)

However, there was a slight drop in the number that died in 2012. This might be as a result of maintenance services done on the existing Water Works across the state, particularly, the Challawa and Tamburawa Water Treatment Plants immediately the new administration took over spending.5.6 billion naira on water supply in the state within11 months (weircentreforafrica. 2012).

Sex Distribution of Case Fatality Rates

The study showed that more females died of the disease than males with 6.3% and 5.6% respectively as shown in Figure 2.

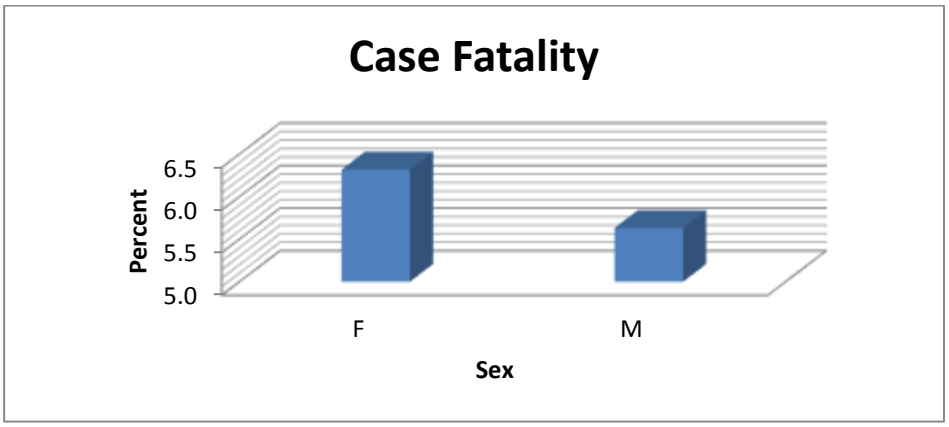

Fig. 2: Sex Distribution of Case fatality Rates of Typhoid fever in Kano State

This might not be unconnected to the fact that more female were infected by the disease than males and the fact that they are more vulnerable especially because they are the food handlers in majority of homes in this part of the country. It might also be as a result some social, economic and cultural problems attached to maternal health where husbands might not allow their wives to patronize orthodox health facility, and as such lead to maternal mortality (Adamu, 2003).

Age Distribution of Case Fatality Rates

The result of the analysis showed high fatality rate in age group below five with rate of 9.8% and continues to drop with increase in age up to ages 20-24 with case fatality rate of 4.%. However, the fatality begin to rise with increase in age to ages 45-49 with case rate of 6.3%, and the dropped as the increased to 3.4% at ages 55-59, and surprise rise in ages 60 and above with case fatality rate of 5.1%.

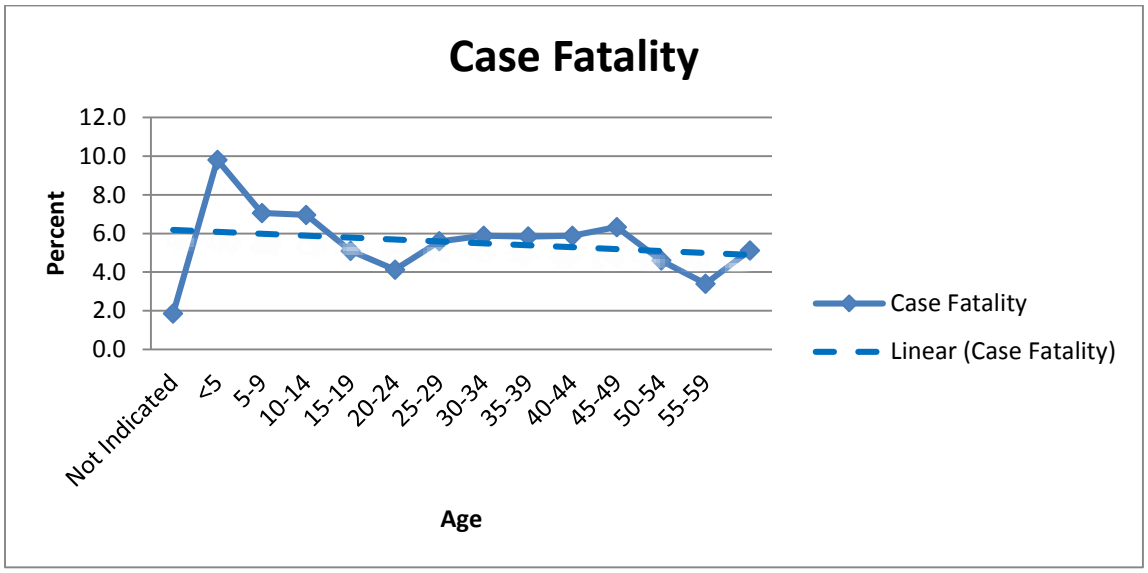

Fig. 3: Age Distribution of Case Fatality Rates of Typhoid fever in Kano State

The general trend of the case fatality showed a decrease in with increase in age as shown in Figure 3. This might be as a result of age and possibly other underlying problems associated with ageing. This finding corroborates the work of Crump (2017) who reported the high deaths among children and a decrease in death with increase of people who died of typhoid fever.

The age group 25-49 is the very active and productive population in the state. The age groups are mostly out either working on farms, industries, government offices, institutions and businesses and markets, as such most them eat and drink outside. This could make them vulnerable to the disease in the state. Mohan *et al*. reported 0.47% of the food handlers they studied are carriers of *S. Typhi*and which was attributable to their poor personal hygiene. As such they can shed the bacteria in the process posing serious danger to those patronise their food.

Spatial Distribution Typhoid mortality in Kano State

The case fatality rate for the state showed high rates in both metropolitan and non-metropolitan Kano. Kunchi in the extreme north east had the highest case fatality rate with greater than 10%. Some parts of the western axis such as Shanono, Gwarzo, and Rogo, eastern axis around Albasu and Gaya, metropolitan areas of Gwale and Kumbotso, and areas around Rano, Madobi, Garko, Gezawa and Kunchi had case fatality rates of between 7-10% (Figure 4)

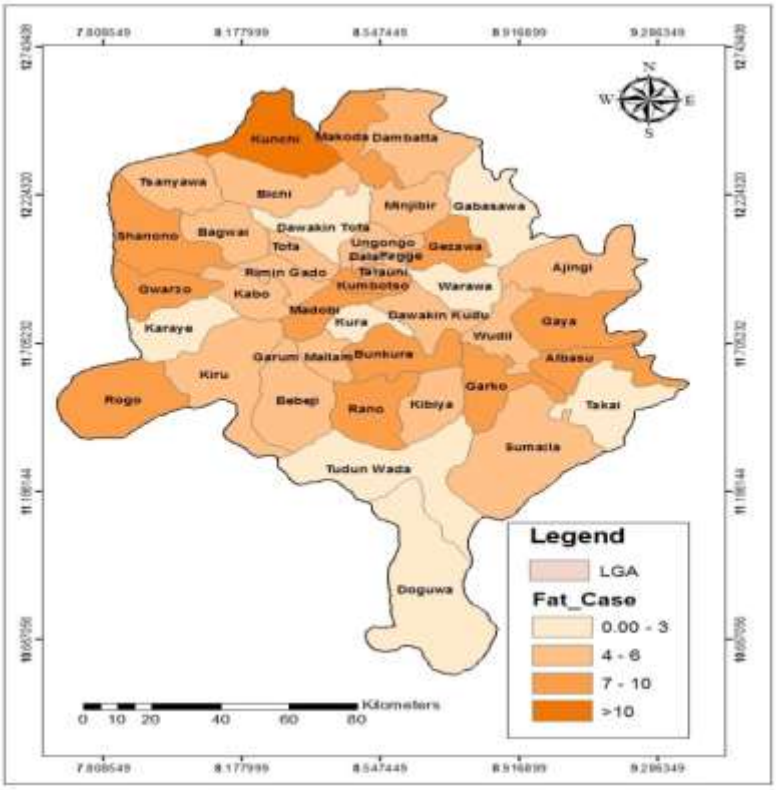

Fig. 4: Case Fatality Rates of Typhoid fever in Kano State

Most part of the state had rates of between 4-6% while southern parts of the state around Doguwa and Tudun Wada, Takai axis in the east, Gabasawa in the north east, Karaye in the west, and Warawa, Kura, and Dawakin Tofa in the central parts of the state had rates of between 0-3%. Only Kunchi LGA had case fatality rate that is greater than 10%. The Low case fatality rate in urban Kano might be as a result of the presence of General Hospitals and AKTH where infected patients can easily referred to and given effective treatment. The high rate of case fatality in Kunchi LGA might be because there is no General Hospital in the LGA where cases can easily be diagnosed and proper treatment proffered to avoid fatality. This might support the assertion of Burkle *et al.,* (2012), that where proper treatment is not given, the case-fatality rate of typhoid fever is 10–30%. Furthermore, the high rate of the typhoid fever mortality in rural Kano might also be associated with use of surface water for domestic purposes especially in southern parts of the state as reported by Yalwa *et al.,* (2016).

Monthly Analysis of Case Fatality Rates

The monthly distribution of death from Typhoid Fever in the state for all the years showed that high in months of March with over 6% case fatality. The month of March coincides with one of the hottest month in the state. The rate falls to below 6% in months of April, May, and June, and a subsequent rise in the months of July, September, October and November with a peak in the month of December with about 7% case fatality.

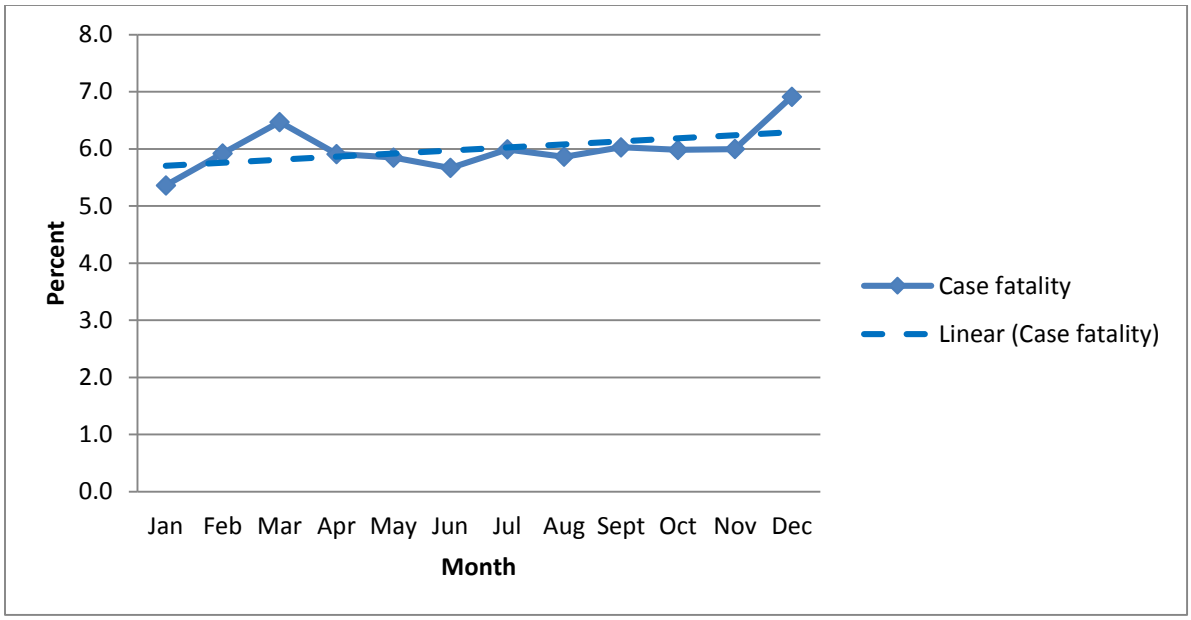

Fig. 5: Monthly Distribution of Case Fatality Rates of Typhoid fever in Kano State

The two peaks (March and December) coincide with one of the hottest and coldest months in the state respectively (Figure 5). The hottest month is a month when a lot water intake is high, and as such, the proliferation of water vending businesses everywhere especially in the urban areas. The month of December which is one of the coldest in the state coincides with the dry season when the rain has seized and a period that water levels in the rivers have gone down. In areas where there is water supply problem and they rely on rainwater and the river, challenges ensue as they will have to compete for the little water available in the rivers with that animals reared. This could contaminate water and make the people in the areas more vulnerable to the disease. In general there is a rise in case fatality from January to December as shown in the trend line. This is consistent with the work of Soomro *et al.*, (2014) who reported typhoid fever endemicity in a tertiary healthcare in Karachi throughout the months of February 2012 to May 2014.

Annual Distribution of Case Fatality

The annual distribution of the case fatality showed a rise in from 2006 to 2015. The rates are above 5% in the year 2006, 2007, 2009, 2010 and 20011. The year 2008, 2013, had rates of 6% while 2014 and 2015 had rates of 7%. However, the year 2012 was the year that had the lowest with rate 5% as shown in Figure 6.

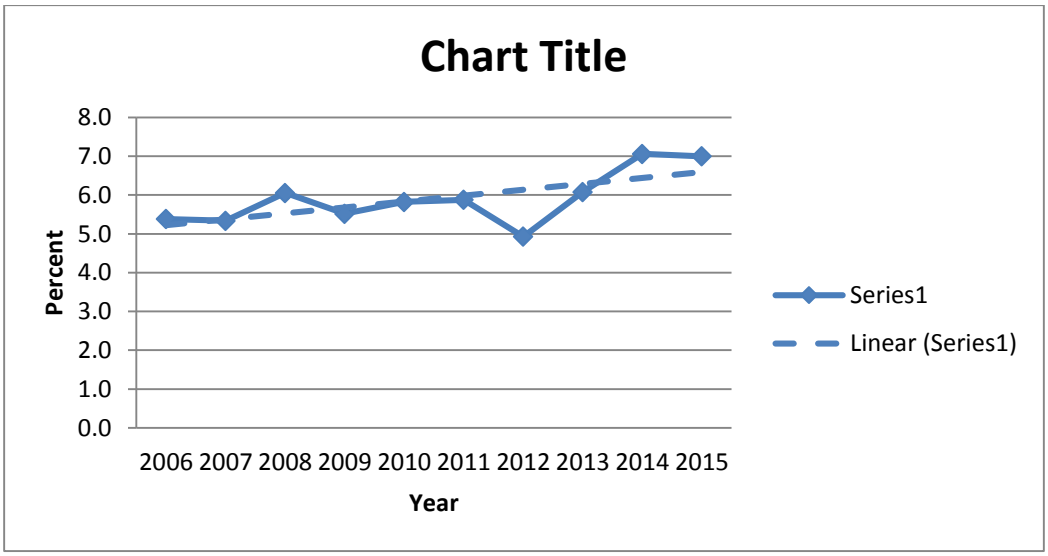

Fig. 6: Yearly Distribution of Case Fatality Rates of Typhoid Fever in Kano State

The general trend showed a serious rise in the case fatality from 2006 to 2015 from a little above 5% over 6%. The rise in the case fatality may be explained by general increase in the prevalence rate of the disease in the state. The average rate for the state is 6%, which is lower than the findings of Benjamin(2002) whose study showed 13.2% of the patients did not recover from the disease representing a case fatality of 13.2% or 132 per 1000 cases.

CONCLUSION

Conclusively, it is evident that typhoid fever is endemic in Kano State throughout the period of this study, and infects all age groups with the bulk of infection within the youthful age groups. High prevalence was recorded in the hot dry season and the warm wet seasons. The result shows that the disease prevalence has been on increase from 2006-2015, in both metropolitan and non-metropolitan areas of the state. The case fatality rate is at 6% with Kunchi Local Government Area in the extreme north east having the highest case fatality rate greater than 10% and the lowest rates of 0-3%were observed around Doguwa Tudun Wada and Takai axis in the east, Gabasawa in the north east, Karaye in the west, and Warawa, Kura, and Dawakin Tofa in the central part of the State. More females died of the disease than males with 6.3% and 5.6% respectively, and high fatality rate in age group below five with rate of 9.8% that continues to drop with increase in age up to ages 20-24 with case fatality rate of 4.%. However, there was a rise with increase in age from 45-49 with case fatality rate reaching 6.3%.

The findings of this study would enhance the understanding of spatial variability of the burden of disease at the Local Government level and may be useful to policy makers especially on vaccination. Public health officials can make use of the information to classify the areas having higher disease prevalence and arrange for interventions. For example, immunization can be targeted on children as well as other measures such as improvement of water supply and sanitation required, which would be a huge investment for a resource-poor community.

RECOMMENDATIONS

Prevention is based on ensuring access to safe water and by promoting safe food handling practices. Health education is paramount to raise public awareness and induce behavior change especially the poor hand washing habits. The people should imbibe the culture of boiling water before drinking which is essential in killing the bacteria that cause the disease. This will reduce vulnerability to the infection especially with regards to consumption of water. Typhoid fever vaccination should be introduced in the state which will help in the prevention of the disease in the state. Government should make the provision in all health facilities and make it affordable to all.

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