Afropolitan Journals

ISSN: 2762-4585X www.afropolitanjournals.com

Forecasting the Trend of Typhoid Fever in Selected Teaching Hospital in Awka, Anambra State

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Abstract

This study looked at how to predict or forecast typhoid disease trends in selected teaching hospital in Awka, Anambra State. On Typhoid fever cases in Awka, Anambra State, four distinct trend models of time series were fitted: linear, quadratic, exponential, and s-curve trend models. For this study, secondary statistical data was taken from survey information on typhoid fever cases conducted selected teaching hospital in Awka, Anambra state, from the records department of monthly typhoid fever recorded cases covering a period of twelve years (2000-2021). Model accuracy measures of MAPE, MAD, and MSD were used to find the best fitted trend model. The results demonstrated that the quadratic and s-curve trend models compete favourably in all the three model accuracy approaches assessed. The quadratic trend model, on the other hand, exhibited the best fit to the data and had the lowest MAD and MSD. For a period of 12 months, the quadratic trend model was employed to forecast typhoid fever in Awka. Between January 2022 and December 2022, the number of typhoid fever cases in Awka, Anambra state, is expected to grow. Clean water, toilet facilities, sanitation infrastructure, good hygiene practices, health education, and illness awareness initiatives were all recommended.

Keywords: Performance, Construction projects, Determinants, Contractors, Professionals.

Introduction

Typhoid fever is a bacterial infection that is a major health concern in many low- and middle-income nations (LMICs). It is only transmitted to humans via the fecal-oral route and ingestion of water or food contaminated by faces from a newly infected person or an asymptomatic carrier (Kabwama et al., 2017; Polonsky et al., 2014). The disease is more common in communities and informal squatter settlements that practice open defecation and have insufficient access to water, sanitation, and hygiene (Akullian et al., 2015; Greenwell et al., 2013; Mogasale et al., 2016).

Typhoid fever's frequency, incidence, and burden have continued to raise worldwide, particularly in African countries, with an estimated 21 million new cases and 222,000 fatalities every year (Pach, et al., 2016; Polonsky, et al., 2014; Steele, et al., 2016; World Health Organization [WHO], 2108). The disease is common in Nigeria, a West African country, and most citizens lack basic utilities such as drinkable water and working toilet facilities (Enabuele & Awunor, 2016). Because typhoid fever is a serious, life-threatening illness, this issue puts them prone to infection, posing a significant public health risk (Enabuele & Awunor, 2016; Mogasale, et al., 2014).

According to Alba et al (2016), understanding the risk factors for typhoid fever, as well as inadequate hand washing and the intake of polluted street food and drinks, is critical for preventing the disease. Although Akullian, et al (2015) and Keddy, et al (2016) focused on sanitation and hygienic habits that lead to disease, I discovered no literature that particularly addressed the population of Awka, Nigeria, a West African country, in terms of environmental behavior and living conditions. I attempted to examine and identify the indications and determinants, as well as the experiences and needs of the community's typhoid disease victims. The findings of this study may help to develop typhoid fever prevention education and awareness that is personalized to the people, allowing them to make the necessary behavioural adjustments that will enhance their lives by reducing disease incidence in the area.

A health agency such as the WHO has stepped up its efforts to manage the disease by campaigning for typhoid vaccine programs and health education, as well as improvements in safe water or water quality, sanitation, and health practitioner training in diagnosis and treatment (Mogasale, et al., 2016; WHO, 2018). However, it appears that WHO's efforts have not yielded much fruit. Pach, et al. (2016), for example, stated that typhoid fever causes around 21.7 million new cases and 217,000 deaths per year around the world. According to Antillon et al. (2017), 17.8 million instances of the disease occur each year in LMICs.

For the prevention of typhoid fever, health education, awareness, and knowledge of risk factors are crucial (Alba et al., 2016; WHO, 2018). To address the disease's increasing spread in African countries, a number of studies focusing on ecological and environmental factors, such as a lack of proper sanitation and water contamination, have been conducted. The majority of these studies recommended that additional measures or inventions be implemented (Akullian, et al., 2105, Alba, et al., 2106; Jung-Seok, et al., Kabwama, et al., 2107, Mogasale, et al., 2016; Shukla, et al., 2014).

Despite all of these far-reaching research investigations, typhoid fever remains a prominent disease in Africa, according to Keddy et al. (2016). According to the literature reviewed to date, the majority of these intervention approaches to combat the spread of the infection have been used in the region, but have been ineffective (Akullisn, et al., 2015; Alba, et al., 2016; Greenwell, McCool, Kool, & Salusalu, 2013; Shukla, et al., 2014). Environmental variables or transmission, ecological factors, and poor awareness of the risk factors of typhoid fever infection are among the reasons why these interventions are ineffective in certain places, according to Alba, et al. (2016) and Akullian, et al. (2015). This study looked at the gaps in already suggested or implemented typhoid fever control strategies by public health practitioners and WHO in the effort to reduce typhoid infection or control the disease in Awka, Nigeria, based on people's personal experiences.

Previous studies focused on sanitation and sanitary circumstances that contribute to the disease, such as household hygiene and food and water contamination, as well as food and water handling behaviors (Akullian, et al., 2015; Alba et al., 2016; Mogasale, et al., 2016). The lack of knowledge of these risk factors, as well as the paucity of literature on them, may raise the illness burden in the population. These conditions, or risk factors, constitute the chasm that I attempted to close by asking villagers about disease and hygiene practices that influence their behavior.

A time series is a set of data points that represent a sequence of measurements taken over a period of time. Time series are used in statistics, communication, and other fields. We utilize time series for often plotting via line chart and time series are used in statistics, communication, and other fields. A time series is defined mathematically by the functional relationship Y = F(t), where Y is the value of the variable being studied at time t.

A mathematical model could aid in the country's reaction to the growing threat of malaria. Sir Roland Ross, the guy who initially discovered that malaria is spread by mosquitoes, devised the first mathematical model for malaria transmission in 1911. "The mathematical approach of treatment is basically nothing but the application of careful reasoning to the problem at hand," Ross said when introducing his model.

Time series models come in a variety of shapes and sizes to reflect various stochastic processes. There are three types of models that can be used to simulate variations in the level of a process: autoregressive (AR) models, integrated I models, and moving average (MA) models. Combining this principle, these three classes are linearly dependent on preceding data points. It generates a moving average that is autoregressive. We also have autoregressive fractionally integrated moving average (ARMA) and autoregressive integrated moving average (ARIMA) models (ARFIMA). These models represent conditional heleroske dastcity that is autoregressive (ARCH). A Hidden Markor Model (HMM) is a statistically Markor model in which the represented system is considered to be a Markor process with hidden states that are unobserved.

The AR, MA, ARMA, and ARIMA models are some of the most basic time series forecasting models. The model's autoregressive (AR) component tries to forecast times series values based on historical data. The correlated error terms are modelled by the moving average components. By differencing the series with a certain time lag, non-stationary can be reduced.

On Nigeria's gross domestic product, Eke et al., (2015) compared three time series trend models. This study fitted three time series trend models on Nigeria's Gross Domestic Product: a linear trend model, a quadratic trend model, and an exponential trend model, using annual data from 1982 to 2012. The exponential trend model was found to have the lowest MAPE and best fit the data. The exponential trend model was used to construct a five-year forecast for Nigeria's Gross Domestic Product, revealing that the country's GDP will grow over the following five years.

Lin et al., (2009) used time series analysis to study the link between falciparum malaria in endemic provinces and imported malaria in non-endemic regions of China. An autoregressive integrated moving average model was used to fit the predictor variable at first. According to AIC and goodness-of-fit criteria, the seasonal ARIMA (1, 1, 1) and (0, 1, 1) models for malaria incidence matched the data the best of all the models examined.

Briet et al. (2008) created a short-term malaria prediction model for Sri Lanka. The ability of exponential moving average models, autoregressive integrated moving average models with seasonal components, and seasonal multiplicative autoregressive integrated moving average (ARIMA) models to predict the number of malaria cases one to four months ahead was compared using monthly time series of district malaria cases. The best model for forecasting and forecasting error differed significantly between districts. For example, in Ampara, the best model for predicting horizon was an ARIMA (2, 1, 1) with seasonality via a harmonic with a one-year period and a harmonic with a six-month length for a one-month period. The ARIMA (0, 1, 2) model with seasonality through a first order seasonal autoregressive and a first order seasonal moving average component proved optimal for the district of Ampara over longer forecasting horizons. Using an ARIMA model, Contreras et al. (2003) created a model for forecasting next-day power prices in mainland Spain and California markets. Their program was able to predict the 24 market clearing prices for the following day. The ARIMA model is a useful tool for forecasting time series.

The application of time series analysis in the forecasting of malaria epidemic outbreaks in Nigeria was examined by Nkpordee and Nduka (2018). The Nigerian National Bureau of Statistics (nbs), Social Statistics, provided secondary data for the study. The study work used the Box-Jenkins (1976) approach to develop a suitable mathematical model by taking into account the ACF and PACF correlograms. With a 16-month lead, the ARIMA (1, 0, 1) model was used to forecast monthly reported cases of malaria, resulting in a series with a progressive rise and decline. The study also looked at the monthly average of malaria cases recorded. The government should ensure that treated bed mosquito nets, pesticides, anti-malaria drugs, and other products are available in Nigeria's rural communities, according to the report.

Problem Statement

Birth, migration, and death are some of the processes that cause population size shifts. Death is a crucial element that can result in a considerable decline in a country's population number. Typhoid fever, according to the World Health Organization (WHO), is a life-threatening sickness caused by the bacterium Salmonella typhoid. It is mainly spread through contaminated food, drink, and infected materials, causing 11-20 million people to become ill with typhoid each year, with between 128,000 and 161,000 people dying from the disease. The standard of living in industrialized countries, as well as access to health care, has made life easier for the general public. However, in developing and underdeveloped countries, access to basic health care facilities is limited, resulting in lower life expectancy among the population. Due to ignorance and a lack of basic health care facilities, several common diseases that are easily treated cause death in such areas.

According to the European Annual Epidemiological Report from the European Center for Disease Prevention and Control (ECDPC, 2017), 1098 cases of typhoid fever and above are reported annually, with 90.9 percent of people contracting the disease while traveling or by consuming contaminated food or water. Typhoid fever, which is produced by poor living conditions, especially among low-income earners, is one of the diseases or causes of mortality in developing and under-developed countries.

According to Kabini et al. (2018), who reviewed the American Journal of Tropical Medicine and Hygiene, typhoid poses a severe health threat in developing and underdeveloped countries. As a result, many people in the region are unaware of the disease's dangers due to ignorance or lack of exposure. In order to bridge this vacuum and raise awareness about the dangers of this terrible disease, researchers plan to evaluate the trend, design a suitable time series model, and forecast the rate of typhoid fever in Awka, Anambra State, Nigeria.

Purpose of the Study

The primary goal of this research is to forecast the typhoid fever behaviours in selected teaching hospital in Awka, Anambra State, Nigeria from January 2022 to December 2022. The time series model (trend models) is utilized to attain this purpose. The following are the study's particular objectives:

1. To obtain the estimates of the parameters (β_0, β_1, and β_2) in the respective trend models.
2. To obtain the accuracy measures (MAPE, MAD and MSD) for the individual trend model.
3. To obtain the trend analysis plot for the typhoid fever cases in selected teaching hospital in Awka, Anambra State from 2000 to 2021 for each of the individual model.
4. To compare the result of the four trend models and identify the one with the least MAPE, MAD and MSD as the best fitted model which will determine the type of trend the typhoid fever in the selected teaching hospital in Awka, Anambra State cases followed.
5. To forecast the trend of Nigerians with typhoid fever admitted in selected teaching hospital in Awka, Anambra State using the best fitted trend model that will be identified in objective 4 above.

Significance of the Study

The relevance of this study is that it aims to fill a vacuum in the literature by increasing public awareness of typhoid fever and its specific risk factors among Awka residents.

1. Medical institutes will benefit from this research because it will allow them to identify typhoid fever indications. This would also allow them to provide proper care to patients by administering effective drugs, implementing a health-awareness program, and maintaining regular typhoid fever disease surveillance.
2. Indigenes of the Awka region will benefit from the study since it will show how contaminated food and water, an unsanitary environment, and a lack of hygienic habits can lead to typhoid disease.
3. This study will be significant to public health centers as it will prompt them to maintain constant monitoring or surveillance against typhoid fever and as well regularized health campaign programme against typhoid fever in both low and middle income earners region.
4. The government will benefit from the study since it will allow them to identify problems that impede or deprive individuals of a good level of living. It will also allow them to examine policies and programs relating to standard health care and administration.
5. Finally, researchers will benefit from the study because it will offer them with literature for empirical reviews in future studies.

Scope and Limitations of the Study

This research focuses on typhoid fever cases in selected teaching hospital in Awka, Anambra State. In order to find the best fit model that will be used to predict the trend of the typhoid fever data under this study, specifically, annual typhoid fever cases in the selected teaching hospital in Awka, Anambra State, matching the data length of 144 based on monthly records from January 2000 to December 2021, and a period of twelve years was used.

However, due to a lack of time, data, and related literature, the researchers focus their attention on the annual cases of typhoid fever cases in selected teaching hospital in Awka, Anambra State, using secondary records from the record department of the selected teaching hospital under study, Average Number of Hospital Admissions (ANHA). This research paper focuses on finding the best fitted trend models among the Linear, Quadratic, Exponential, and S-Curve models of Time Series Analysis.

Methods and Materials

Research Design: This study used a cross-sectional research approach that focused on the prediction of typhoid fever trend in selected teaching hospital in Awka, Anambra State.

Nature and Source of Study Data: The secondary statistical data used for this study were extracted from survey information on typhoid fever cases conducted in selected teaching hospital in Awka, Anambra State, from the records department of monthly typhoid fever cases matching the data length of 144 based on monthly records from January 2000 to December 2021 covering a period of twelve years.

Data Analysis Tools: The parameters for the models are obtained using the MINITAB (version 18.0) and Microsoft Excel (2010) programs. The researchers used these programs to estimate the parameters for Linear, Quadratic, Exponential, and S-cure models to make records evaluation easier.

The MINITAB (version 18.0) program was used to forecast the trend of typhoid fever cases in the selected teaching hospital in Awka, Anambra State after establishing the trend model with the best fit.

Method of Data Analysis

Model Specification

The linear trend model, quadratic trend model, exponential trend model, and S-cure model will be used in this study.

The Linear Trend Model

The linear trend model is used by default in trend analysis:

$$Z_t = \alpha_0 + \alpha_1 X_t + \mu_t \quad (1)$$

In this model, α_1 represents the average change from one period to the next.

Linear forecasting model:

$$Z_t = \alpha_0 + \alpha_1 X_t \quad (2)$$

The Quadratic Trend Model:

$$Z_t = \alpha_0 + \alpha_1 X_t + \alpha_2 X_t^{\,2} + \mu_t \quad (3)$$

Quadratic forecasting model:

$$Z_t = \alpha_0 + \alpha_1 X_t + \alpha_2 X_t^{\,2} \quad (4)$$

The Exponential Trend Model:

$$Z_t = \alpha_0 \alpha_1^{\,x} \mu_t \quad (5)$$

Exponential forecasting model:

$$Z_t = \alpha_0 \alpha_1^{\,x} \quad (6)$$

The S-curve Trend Model:

The Pearl-Reed logistic trend model fits the S-curve model. The case where the series follows an S-shaped curve is explained in this way. The model is:

$$Z_t = \frac{10^a}{\left(\alpha_0 + \alpha_1 \alpha_2^{\,X}\right)} \quad (7)$$

Where

α_0 = Estimated Z intercept

α_1 = Estimated linear effect on Z

α_2 = Estimated quadratic effect on Z

Models Accuracy Measures

To find the best fit, the model with the fewest accuracy measurements will be used (MAPE, MAD and MSD). The best model is one that reduces the criterion to the bare minimum. Several criteria for selecting various models, such as Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), and Mean Squared Deviation (MSD), have been proposed in recent years (MSD). A couple of these standards are listed below:

Mean Absolute Percentage Error (MAPE)

Because this figure is a percentage, it expresses accuracy as a percentage of the error, and it measures the correctness of fitted time series values.

$$MAPE = \frac{\Sigma\left|(Z_t - \hat{Z}_t) / Z_t\right|}{n} \text{X100} \qquad (Z_t \neq 0) \qquad (8)$$

Where Z_t is the fitted value, is the actual value at time *t*, $\hat{Z}_t$ and n is the number of observations.

Mean Absolute Deviation (MAD)

This metric assesses the precision of time series values that have been fitted. It expresses accuracy in the same as the data. This helps to theorize the error also.

$$MAD = \frac{\sum_{t=1}^{n}\left|(Z_t - \hat{Z}_t)\right|}{n} \qquad (9)$$

Where Z_t is the observed value at time *t*, and $\hat{Z}_t$ is the fitted value and *n* is the number of observations.

Mean Squared Deviation (MSD)

This is calculated using the same denominator, n, regardless of the model. This allows MSD values to be compared across models. As a result, MSD is more sensitive than MAD to the biggest forecast inaccuracy.

$$MSD = \frac{\sum_{t=1}^{n}\left|(Z_t - \hat{Z}_t)\right|^2}{n} \qquad (10)$$

Where Z_t equals the actual value at time *t*, $\hat{Z}_t$ equals the fitted value, and *n* equals the number of observations.

Results

The Scatterplot of the Actual Data for the Typhoid Fever Cases in Selected Teaching Hospital in Awka, Anambra State

In the graphs below, the cases of Typhoid fever at selected teaching hospital in Awka, Anambra State from 2000 to 2021 are shown in a scatterplot. Seasonal variation in the early era (seasonality of order 4) with fluctuating (upward and down) trend movement is depicted in fig. 1. The month with the most cases of Typhoid fever (566 cases) was January, and the month with the least cases was July (402 cases).

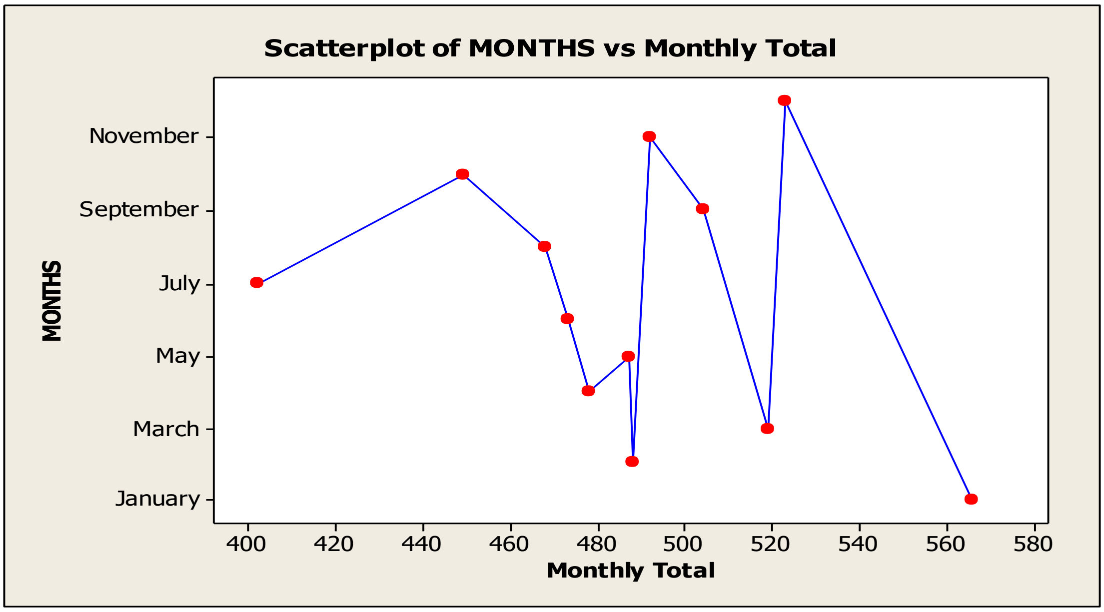

Fig.1 Scatterplot of the total monthly Typhoid fever cases

Sources: Author's Work (2020)

Figure 2 depicts early-period seasonal variation (seasonality of order 7) with fluctuating (upward and down) trend movement. The year with the most cases of Typhoid fever (347 cases) was 2015, and the year with the fewest cases was 2006 (193 cases).

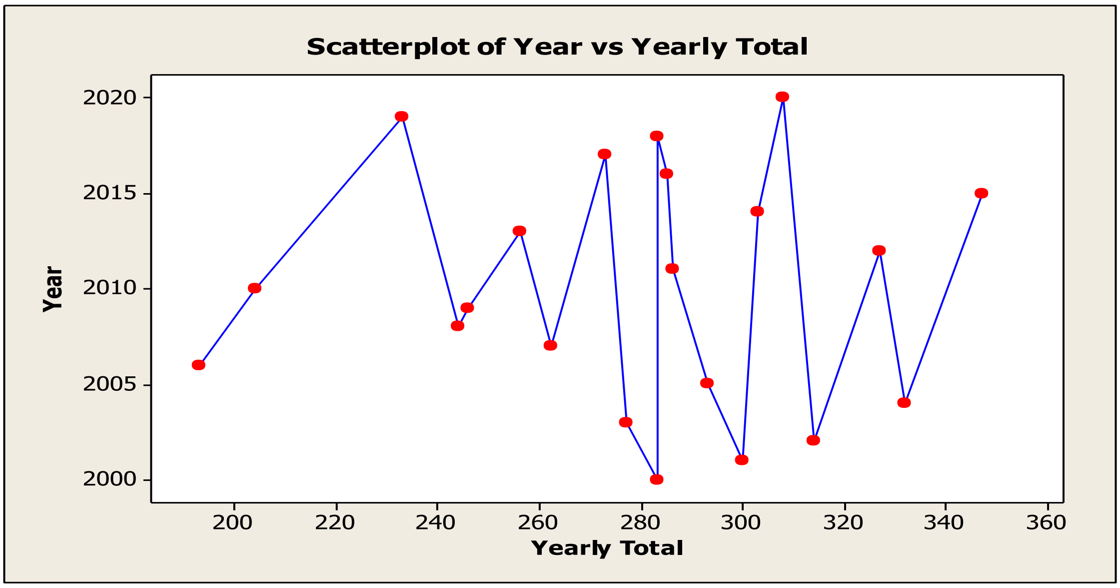

Fig.2 Scatterplot of the total yearly Typhoid fever cases

Sources: Author's Work (2020)

The Time Series Plot of the Actual Data for the Typhoid Fever Cases in Selected Teaching Hospital in Awka, Anambra State

A time series plot of Typhoid fever patients in selected teaching hospital in Awka, Anambra State (2000–2021) is shown in fig. 3. The graph showed seasonal fluctuation in the early period (seasonality with many orders) and trend movement that was fluctuated (upward and down). This means we'll fit general time series trend models to the data to see which model fits the data set best for forecasts.

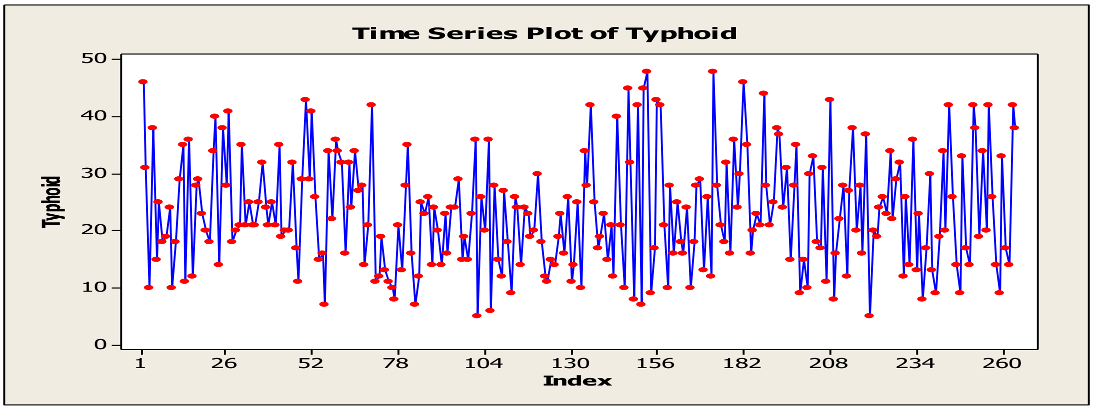

Fig.3 Time series plot of the Typhoid fever cases

Sources: Author's Work (2020)

Model Identification and Parameter Estimate

The Linear Trend Model

Equation (2)'s predicted linear trend model is written as $Z_t = 23.05 + 0.00206X_t$.

The linear trend model does not fit the data, as shown by the graphic in fig.4.

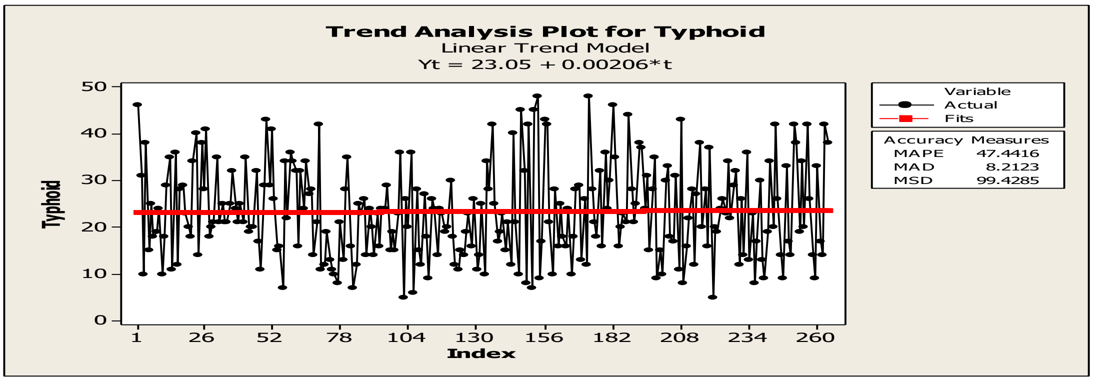

Fig. 4 Trend analysis plot of the Linear Trend Model

Sources: Author's Work (2020)

Table 1: Accuracy Measures of Linear Trend Model

Accuracy Measures	
MAPE	47.4416
MAD	8.2123
MSD	99.4285

Sources: Author's Work (2020)

Data in Table 1 shows that MAD has a lower value of 8.2123 in the linear trend model's accuracy metrics, while other values are relatively large.

The Quadratic Trend Model

The estimated quadratic trend model of equation (4) is given as $Z_t = 25.32 - 0.0491X_t + 0.000193X_t^{\ 2}$ .The quadratic trend model matches the data with slight variance, as seen in Figure 5.

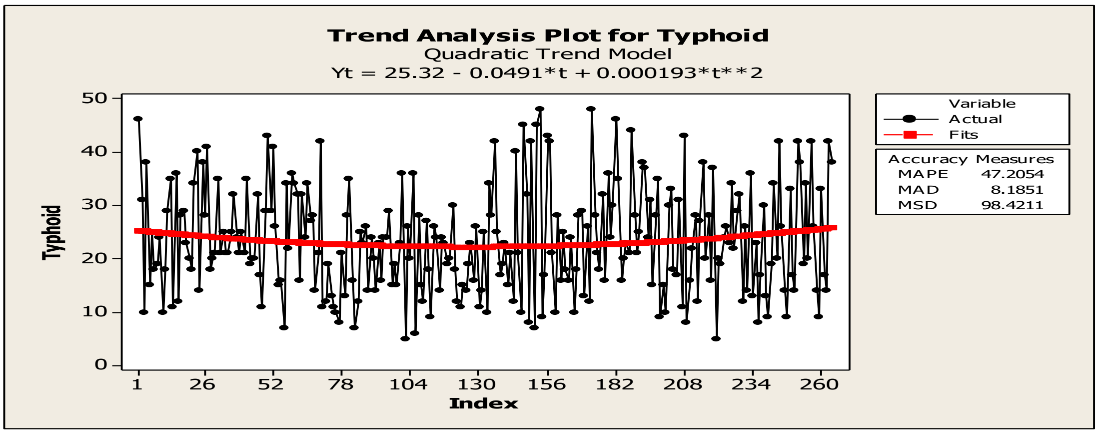

Fig. 5 Trend analysis plot of the Quadratic Trend Model

Sources: Author's Work (2020)

Table 2: Accuracy Measures of Quadratic Trend Model

Accuracy Measures	
MAPE	47.2054
MAD	8.1851
MSD	98.4211

Sources: Author's Work (2020)

Data in Table 2 shows that MAD has a lower value of 8.1851 in the quadratic trend model's accuracy metrics, while other values are relatively large.

The Exponential Trend Model

Equation (6)'s predicted exponential trend model is written as $Z_t = 21.1850(0.999960)^x$ .The exponential trend model does not fit the data, as shown by the graphic in fig.6.

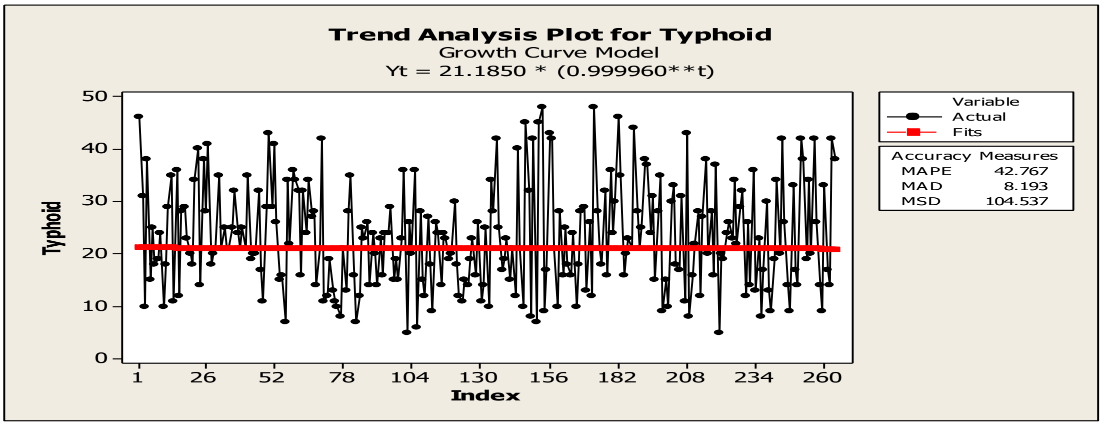

Fig. 6 Trend analysis plot of the Exponential Trend Model

Sources: Author's Work (2020)

Table 3: Accuracy Measures of Exponential Trend Model

Accuracy Measures	
MAPE	42.767
MAD	8.193
MSD	104.537

Sources: Author's Work (2020)

Data in Table 3 shows that MAD has a lower value of 8.193 in the exponential trend model's accuracy metrics, while other values are relatively large.

The S-curve Trend Model

Equation (7)'s predicted S-curve trend model is written as $Z_t = \frac{10^a}{\left(\alpha_0 + \alpha_1 \alpha_2{}^X\right)}$. The results and figure of the S-curve model data could not be fit; indicating that S-curve trend model does not fit the data.

Comparing the Accuracy Measures

Table 4: Comparative Accuracy Measures

Model	MAPE	MAD	MSD
Linear	47.4416	8.2123	99.4285
Quadratic	**47.2054**	**8.1851**	**98.4211**
Exponential	42.767	8.193	104.537
S-curve	*	*	*

Sources: Author's Work (2020)

When comparing the accuracy measurements of these four models in Table 4, the MAPE and MSD for all of them are relatively large. However, when compared to other models, the quadratic model has the smallest MAD and MSD measures of 8.1851 and 98.4211, respectively, when using MAD, which is a more effective measure of the four accuracy measures. This shows that Typhoid fever cases in selected teaching hospital in Awka, Anambra State do not follow a linear trend model; rather, they follow a quadratic trend model pattern. To this purpose, the quadratic trend model was used to calculate a 12-month projection of the reported Typhoid fever cases in selected teaching hospital in Awka, Anambra State.

12 Monthly Forecast of the reported Typhoid fever cases in Selected Teaching Hospital in Awka, Anambra State

Table 5: Forecast of Typhoid Cases

Period	Forecast	Period	Forecast
Jan, 2022	25.8650	July, 2022	26.1915
Feb, 2022	25.9185	Aug, 2022	26.2473
March, 2022	25.9723	Sep, 2022	26.3035
April, 2022	26.0265	Oct, 2022	26.360
May, 2022	26.0811	Nov, 2022	26.4169
June, 2022	26.1361	Dec, 2022	26.4743

Sources: Author's Work (2020)

The quadratic trend model forecast of reported cases of Typhoid fever in selected teaching hospital in Awka, Anambra State is shown in Table 5. Typhoid fever cases are expected to rise during the next 12 months, from January to December 2022, according to the findings.

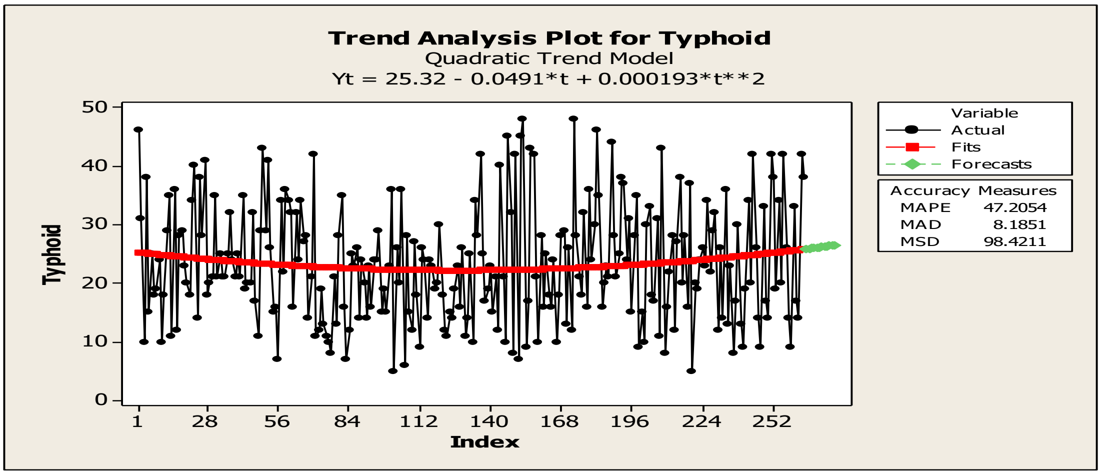

Fig. 7: Trend Analysis plot of the Quadratic Trend Model with Forecasted Values
Sources: Author's Work (2020)

Discussion of Finding

Four time series models were evaluated in this study to analyze the growth behavior of Typhoid fever cases recorded in selected teaching hospital in Awka, Anambra State. The four models encompassing Linear, Quadratic, Exponential, and S-curve were not all assumed to be able to reflect the long term trend of reported Typhoid fever cases in selected teaching hospital in Awka, Anambra State, after comparing and analysing the model accuracy metrics of MAPE, MAD, and MSD values of each model. The quadratic trend model, however, was in the best agreement with the actual long-term reported Typhoid fever cases in selected teaching hospital in Awka, Anambra State, based on model accuracy criteria such as MAPE, MAD, and MSD values. The reported cases of Typhoid fever in selected teaching hospital in Awka, Anambra State, were shown to follow a quadratic trend model characterized by MAD and MSD values. The quadratic trend model outperformed the other models, and it was used to generate 12-month forecasts. The projection reveals that the trend of reported Typhoid fever cases in selected teaching hospital in Awka, Anambra State, is increasing. This means that starting in January 2022, if suitable measures are not taken, typhoid fever will be on the rise.

Conclusion

The purpose of this study was to add to the body of knowledge in the field of public health and community health education by investigation into forecasting the trend of typhoid fever in selected teaching hospital in Awka, Anambra State. The study findings demonstrated health disparities within the community as a result of terrible settings, insufficient understanding of the risk factors for typhoid fever, inadequate hygiene practices, and necessary supplies such as water, based on data obtained from the participants.

The quadratic trend model, which had the lowest MAD and MSD values, was found to be the best fit for the data when fitting relevant trend models to typhoid fever cases in Awka, Anambra state. The quadratic trend model was the best fit for assessing the progression of the typhoid fever outbreak in selected teaching hospital in Awka, Anambra state. It has been persuasively proved that Typhoid fever cases are expected to rise during the next 12 months, from January to December 2022, according to the findings.

Recommendation

1. We urge that the government, in partnership with the public health agency and local schools, implement a community-driven health educational outreach awareness campaign.
2. We advocate for improved sanitation infrastructure, which includes efficient trash disposal and human excrement disposal, as well as improved environmental conditions both inside and outside of homes.
3. Further research or investigation is recommended that will fairly represent the four quarters of the population in terms of the amount of their knowledge and the elements that contribute to the sickness. Residents would benefit from the research.
4. Improved or clean water, toilet facilities, sanitation infrastructure, and good hygiene practices are all required for typhoid fever prevention, but they also stated that health education and awareness programs on the disease are also necessary.

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