# Relationship between Water Quality and Public Health

*A.O. Ibeje, H.U. Nwoke and O. Ibearugbulem

**Abstract**— Many people in developing world rely on commercial water boreholes for potable water supply and it is believed to have caused water-borne diseases to the people. This study is focused on identifying the relationship between quality of water borehole and health of residents of the Owerri in Imo state, Nigeria. Ten water samples from randomly selected commercial boreholes are analyzed for biochemical oxygen demand (BOD), total coliform and E. coli count. The result indicates mean and standard deviation of (1.13, 0.37); (13, 12.2) and (1.2, 1.48) for BOD, total coliform and E. coli count respectively. Valid and reliable questionnaires indicate that 68%, 4% and 10% of respondents drank sachet and bottled water, commercial water boreholes and pipe-borne water respectively. Prevalence of typhoid fever, deduced from out-patients records of randomly selected 10 hospitals in Owerri, has mean and standard deviation of 62.81% and 8.50% respectively; which represents high prevalence of typhoid fever in all the selected hospitals in Owerri. None of the biological water quality parameters analyzed in this study had statistically significant relationship with % prevalence of typhoid fever, an indicator of health status, but it decreases with increase in BOD but increases with the increase in total coli and E. coli. The most important multiple regression variable is E. coli. There is need to enlighten people on typhoid fever and to improve sanitation and personal hygiene.

**Index Terms**— Typhoid fever, Water borehole, Water quality, Hospital.

## 1 Introduction

Water plays essential roles in supporting human life. If contaminated, water also has great potential for transmitting a wide variety of diseases and illness. Water-related diseases are rare in the developed world because of the presence of efficient water supply and wastewater disposal systems. This is not the case in the developing world because many people lack access to safe water supply and adequate sanitation [1]. As a result of this, the number of water-related diseases in these areas is frightening. In these areas, the principal microbial water-borne diseases are typhoid and paratyphoid fevers (salmonellosis), cholera, bacillary dysentery (shigellosis), infectious hepatitis, dracontiasis and schistosomiasis [2]. Others are food poisoning, amoebic dysentery, giardiasis, gastro enteritis, hepatitis A and poliomyelitis. Typhoid is a microbial water-borne disease contracted by the intake of water or food contaminated with the S. typhii bacterium. Typhoid fever is characterized by fever, headache, constipation, malaise, chills, and myalgia with few clinical features that distinguish it from a variety of other infectious diseases, but diarrhea is uncommon and vomiting is not usually severe [3]. Water quality is those physical, chemical or biological characteristics of water by which the user evaluates the acceptability of water. The quality of many commercial water boreholes in Owerri is not often analyzed before consumption.

Yet many people in Owerri in Imo state, Nigeria, rely on waterboles for potable water supply. Although many studies ([4]; [5] & [6]) on the quality of sources of drinking water in Owerri have been conducted, the records of frequent infections of water-borne diseases are still hypothesized to be linked to the unwholesomeness of the water boreholes. This study is focused on identifying the statistical relationship between water borehole quality and health of residents of the Owerri.

## 2 Materials and Methods

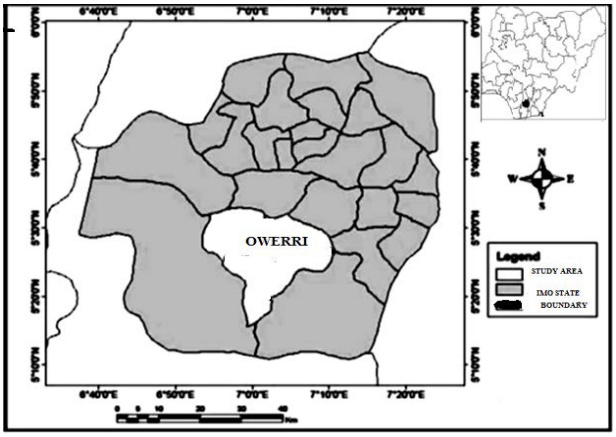


Fig.1. Location Major Towns in Owerri, Nigeria (Adapted from Onyekuru et al. [7]).

The study area is the urban area of Owerri, Imo State. Owerri is the capital city of Imo State, South East Nigeria. Owerri with a population of about 150,000 situates between 50 20'N, 6055'E in the south-western corner and 50 34'N, 70 08'E in the north-eastern corner [1]. It falls within the rainforest zone of 2290mm per annum rainfall, relative humidity of 55-85% and

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temperature of 270C. It has a subequatorial climate. The two prevalent seasons, the dry and rainy seasons occur from October to March and April to September respectively [1]. Owerri covers a land mass of 5200km$^2$ and lies entirely within coastal plain sand stones. The study proceeded with the use of laboratory procedures to ascertain the quality of some commercial water boreholes in Owerri. The water quality parameters of interest were biochemical oxygen demand (BOD) and E. coli count. Borehole water samples were collected from randomly selected water boreholes in Owerri and standard methods [8] was used to determine the BOD while membrane filtration and pour plate count were used to determine total bacterial and E. Coli counts. To ascertain the health status of some residents of the Owerri, data from some randomly selected hospitals in Owerri were collected and collated for the study. To calculate prevalence of typhoid fever, the total number of persons who came to the hospitals with various medical complaints was used as the number of persons examined, while the number of those diagnosed with typhoid fever by the doctors was used as the number of positives. Furthermore, to ensure that the persons who were examined in these hospitals consumed borehole water, a simple random of 200 persons from the study area were administered valid and reliable questionnaires of 0.72 Cronbach's alpha value. Multiple coefficient of determination $R^2$and Pearson correlation coefficient, r were used to analyze the correlational relationship between prevalence of typhoid fever and BOD, total bacterial count and E. Coli count of the borehole water samples. Also attempt was made to fit a multiple regression model to the variables at 0.05 level of significance. The assumptions of regression model were tested using Durbin-Watson test for independence of residuals and skewness test for normality of errors. Significance test of regression model was conducted using F-test and t-test for model regression coefficients. The confidence interval on the regression coefficient was also calculated. The selected hospitals were designated as shown in Table 1.

TABLE 1
DESIGNATION OF HOSPITALS IN OWERRI

| *Hospital Designation* | *Name of Hospital* | *Location* |
|---|---|---|
| *1* | *Pamela Hospital* | *Akwakoma, Owerri North L. G. A.* |
| *2* | *Amanda Hospital* | *Works Layout, Owerri Municipal L. G. A* |
| *3* | *Umezurike Hospital* | *Sam Mbakwe Road, Owerri Municipal L. G. A* |
| *3* | *Cottage Hospital* | *Amakohia, Owerri North L. G. A.* |
| *4* | *Chapel Group Specialists Hospital* | *Works Layout, Owerri Municipal L. G. A* |
| *5* | *Imo State Specialist Hospital* | *Port Harcourt road, Owerri Municipal L. G. A* |
| *6* | *Zenia Hospital* | *World bank Housing Estate, Owerri Municipal L. G. A* |
| *7* | *Federal Medical Centre, Owerri* | *Owerri Municipal L. G. A* |
| *8* | *Life Spring Hospital* | *Okigwe Road,* |
| *9* | *Umuguma General Hospital* | *Owerri west L. G. A* |

## 3 RESULTS

Generally, prevalence among the various hospitals ranged from: 53.5% in hospital 1 to 49.2% in the hospital 2, 66.7% in the hospital 3 to 58.6% in hospital 4, 66.6% in the hospital 5 to 73.9% hospital 9, 53.0% in hospital 10 to 68.3% in hospital 8. Hospital 6 as well as hospital 7 has prevalence above 66.6% (two-third of persons with positive cases). Only hospital 1 has prevalence below 50% (Fig. 2).

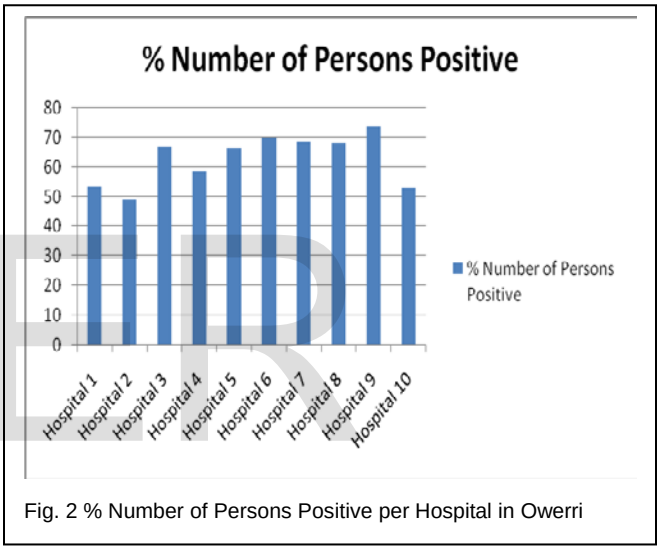


Fig. 2 % Number of Persons Positive per Hospital in Owerri

From questionnaires collected, 4% of respondents indicated that they drank sachet and bottled water, 68% indicated that they consumed water from commercial water boreholes and 10% of respondents reportedly drank form pipe-borne water.
The mean concentration of biochemical oxygen demand (BOD) in the private borehole water samples was 1.13 mg/l. Total coliform count in the water samples ranged from 4 x100 to 3.4 x101 cfu/100ml. The range of E. coli was found to be 1x100 to 4 x100 (Fig. 3).

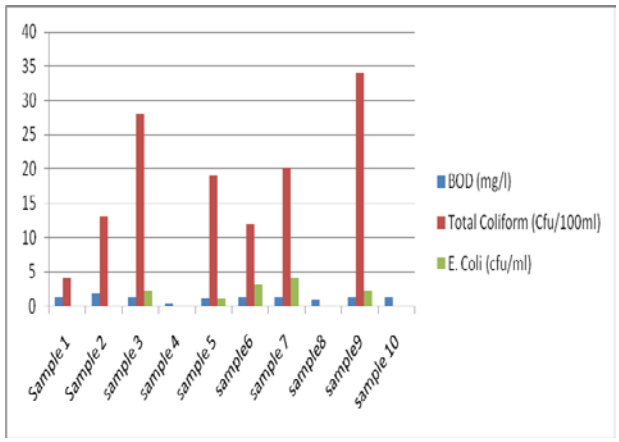


Fig. 3 Biological Analysis of Commercial Water Boreholes in Owerri

The regression equation obtained is given by

$$\%\ Typhoid\ positive\ persons = 68.7 - 12.2BOD + 0.338Total\ Coli. + 2.94E.Coli.$$

At 0.05 level of significance, the overall model significance is acceptable (0.038<0.05). The model can explain 73.2% of variation in %persons positive with typhoid fever at a standard error of 5.39256. The result of t-test of regression coefficients shown in Table indicates that neither BOD nor total coliform nor E.coli had a significant relationship with the % number of persons infected with typhoid fever as their respective p-values were greater than 0.05. However the chemical parameter, BOD apparently had more influence in the model than the other water biological parameters. Durbin-Watson statistic gave a value of 1.99762 < 2.0, the assumption of independence in residuals in the model was fulfilled.

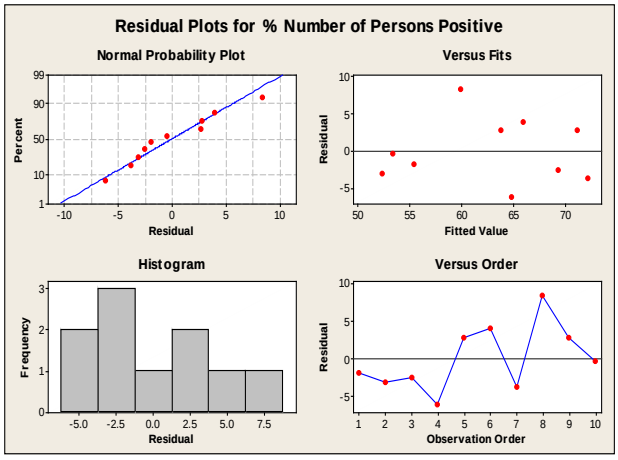


Fig. 4. Plots of Assumptions of Regression Model

TABLE 3
RESULT OF T-TEST OF MODEL COEFFICIENTS

| *Predictor* | *Model Co-efficient* | *Significance level (p-value)* |
|---|---|---|
| *Constant* | *68.714* | *0.000* |
| *BOD (mg/l)* | *-12.233* | *0.065* |
| *Total Coli-form (cfu/100ml)* | *0.3376* | *0.151* |
| *E.Coli (cfu/ml)* | *2.941* | *0.112* |

## 4 DISCUSSIONS

Results from the present study indicate high prevalence of typhoid fever in all the selected hospitals in Owerri. The prevalence recorded in this study was higher than 39.4% recorded in Nassarawa State in middle belt of Nigeria [9]. High prevalence of typhoid fever is widespread in Nigeria [10]. High incidence of typhoid in Nigeria occurs when communal water supplies are few and people congregate at few sources left. Similar finding of sudden upswing in typhoid fever occurred in some provinces in China in 1991 and was attributed to poor quality of drinking water [10]. The inhabitants of Owerri depend mostly on water from commercial boreholes for general use. There is no evidence that the World Health Organization minimum permissible limits for drinking water [11] are adhered to. Consequently, in Owerri the major water source available to the people is contaminated. This could be as a result of drinking contaminated water in homes and the use of same for domestic activities. This high incidence was sustained by the paucity of potable water, and the proliferation of unsupervised commercial boreholes that produced non-potable water used by inhabitants for domestic activities.

TABLE 2
ESTIMATED PARAMETERS OF VARIABLES

| Statistic | Percentage Prevalence | BOD (mg/l) | Total Coli-form (cfu/100ml) | E. Coli (cfu/100ml) |
|---|---|---|---|---|
| Mean | 62.81 | 1.13 | 13 | 1.2 |
| Standard Deviation | 8.498425 | 0.367726 | 12.202 | 1.47573 |

## 5 CONCLUSION

This study is focused on identifying the statistical relationship between water borehole quality and health of residents of the

Owerri. Results from the present study indicate high prevalence of typhoid fever in all the selected hospitals in Owerri. Borehole water supply is the popular source of drinking water supply in Owerri. Borehole water supply is biologically contaminated. None of the biological water quality parameters analyzed in this study had statistically significant relationship with % prevalence of typhoid fever, an indicator of health status of Owerri residence. This high incidence was sustained by the paucity of potable water, and the proliferation of unsupervised commercial boreholes that produced non-potable water used by inhabitants for domestic activities. There is need for detailed protocols for monitoring boreholes in the area to ensure that the quality of water sold to the people meet the minimum permissible standard. The need for awareness campaign to enlighten people on the epidemiology of typhoid fever cannot be over-emphasized, so also the need to regularly wash all water-storing containers and utensils on a regular basis and to improve sanitation and personal hygiene.

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