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AN ANALYSIS OF WELL WATER QUALITY AND THE INCIDENCE OF WATER BORNE DISEASES IN EMOHUA COMMUNITIES, RIVERS STATE, NIGERIA

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ABSTRACT: *This study examined well water quality and the incidence of water borne diseases especially diarrhoea in Emohua. To achieve this, health record data was obtained from the general hospital in Emohua. The laboratory procedure of physio-chemical parameters of pH, Turbidity, Total Hardness, Iron, lead and magnesium of well water samples randomly collected among the eight villages of Emohua such as Isiodu, Rumakunde, Rumuche, Mgbuitanwo, Oduoha, Mgbueto, Rumuohia and Elibrada was done and how they relate to the incidence of diarrhea. The multiple regression technique was used to examine the nature of the relationship which exists between well water quality parameters and the incidence of water borne diseases. Findings shows that the pH values of water at Mgbuitanwo is (3.87) and Oduoha (3.51) were slightly acidic, while in Rumuche (6.05)and Rumakunde (6.08), the pH value were alkaline and suitable for consumption. In terms of total hardness, Rumuche (24.024mg/l), Rumuakunde (36.036mg/l) and Rumuohia (28.028mg/l) have slightly hard water. Only Oduoha (108.101mg/l) had moderate hard water. However iron was dictated in the underground water at Mgbueto with a value of 1.621mg/l. Mgbuitanwo had the highest prevalence of diarrhea disease. This is followed by Isiodu and Rumuakunde. The r^2 statistics shows that the well water quality parameters of Total Hardness, pH, and magnesium accounted for 65.1% of the incidence of diarrhea in the study area. Specifically, well depth accounted for 39.1% of the pH values of well water and 23.1% of the total hardness of the water in the study area. Strong monitoring and evaluation of well water hygiene, proper construction of the wells as well as awareness creation among residents need due attention.*

KEYWORDS: *well water, physio-chemical parameters, acidic, diarrhea, Emohua*

INTRODUCTION

Occurrence of diarrhea and other water-borne diseases in rural areas of developing countries has been on the increase over the decades largely due to unsafe water, inadequate sanitation and poor hygiene among human population (see Esrey et al, 1991; Tumwin et al, 2002; Kumer and Harada, 2002;Verheyen et al; 2009 and Ali et al, 2011). Water is a chemical substance with the chemical formular H_2O. A water molecule contains one oxygen atom of 88.89% and two hydrogen atoms of 11.11% connected by covalent bonds. Water is a liquid at ambient conditions, but it often co-exist on earth with its solid state (ice), a combination of three molecules ($3H_2O$, tre-hydrol), gaseous state (water vapor or steam (hydrol), and in liquid crystal state near hydrophilic surfaces. The distribution of water is uneven on planet earth leading to its scarcity and thus waterborne diseases. Waterborne diseases are caused by pathogenic microorganisms that most commonly are transmitted in contaminated fresh water (Kumer and Harada, 2002; Figueras and Borrego, 2010). Infection commonly results during bathing, washing, drinking, in the preparation of food, or the consumption of food thus infected. Various forms of waterborne diarrheal disease probably are the most prominent examples, and affect mainly children in developing countries; according to the World Health Organization (2000), such diseases account for an estimated 4.1% of the total daily global burden of

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disease, and cause about 1.8 million human deaths annually. The World Health Organization estimates that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene (see WHO, 2011). About 80% of diseases in the developing countries are attributed to poor quality of water supply. A recent United Nation (UN) report says that more than three million people in the world die of water-related disease due to contaminated water, which includes 1.2 million children. The W.H.O. reported that 10 million annual deaths in India, 7.8 % are due to lack of basic health care amenities like effective sewage system, safe drinking water supply, elementary sanitary facilities and hygienic conditions. It was also reported that ground water in one-third of India's 600 districts is not fit for drinking as the concentration of fluoride, iron, salinity and arsenic exceeds the tolerance levels. The prime causes of widespread and serious health problems today in developing world is inadequate water supply, sanitation facilities, and poor hygiene (see, LeChevallier, et al, 1996; Alli et al, 2011). Similarly, WHO, (1982), documented that due to unsafe water sanitation and hygiene the lives of an estimated 1.5 million children under age of five each year are been claimed. Lack of access to water sanitation and hygiene affects the health, security, livelihood and quality of life for children, impacting women been the highly vulnerable group. In the developing countries, more than 30% of diseases are water related, with almost 2.2 million lives lost due to diarrhea diseases, and more than 4 billion diseases episodes, globally, every year (see, Tumwine, et al 2002; Kumer and Harada, 2002). These water related diseases are categorized into four groups which includes; water borne, water washed, water vectored, and water based diseases of which water borne diseases has been identified as the most killer diseases, because it plays active role in the human intestinal tract.

Well water is an important source of potable water in some rural developing areas where they are routinely dug and use today, and it typically contains more minerals in solution than surface water which may require treatment to soften the water by removing minerals like Arsenic, iron and manganese (see Kumer and Harada, 2002; Abdo et al, 2010; Figueras and Borrego, 2010). Abdo et al, (2010) described the problems of water wells to be resulting from depletion of Aquifers, poor-design, construction and usage, corrosive qualities of the water, over drawing of water, and biofouling which are caused by humans and other animal festal materials. In many part of the world today, especially in developing countries there is scarcity and unclean water supply which creates unhealthy conditions to the people. Water borne diseases prevailing in Emohua includes typhoid fever, cholera, diarrhea, hapititis, gastro-intestine and many more, which have been observed every year both in dry and wet seasons. And these diseases are prevalent to children than the adults in Emohua community, this has however, affected the economy of the local inhabitants. The inhabitants infected by these diseases are usually confronted with related costs and seldom with a huge financial burden. The financial losses are mostly caused by e.g. costs for medical treatment and medication, costs for transport, special food, and by the loss of manpower. Many families must even sell their land to pay for treatment in a proper hospital. On average, a family spends about 10% of the monthly household income per person infected. Well water usage is ubiquitous in Emohua community, and no known study has investigated the relationship between well water usage and the occurrence of diarrhea. The objective of this study therefore is to identify the relationship between the incidence of diarrhea and well water quality parameters in the study area; determine the physio-chemical parameters of well water and comparing it with the W.H.O. allowable limits with a view to recommending appropriate measures of cubing the health challenges associated with poor water quality in Emohua.

The Study Area

Geographically, Emohua Community is located in Emohua Local Government Area, of Rivers State and it lies between longitude 64^{0}` and $65^{0}5$` East and latitude $44^{0}5$` and $51^{0}5$` North. It is bounded in the North by Imo state and Ogba-Egbema Ndoni Local Government Areas, south by Degema and Asari-Toru Local Government Areas, it also shares boundaries with Ikwerre and Obio-Akpor Local Government Areas at the Eastern part. The study area was carved out of the former Ikwerre/Etche Local Government Area of the state in the then military administration of the federal republic of Nigeria, in 1989. It has a land mass of

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about 831km^2 (321 sqm^1) and it is situated on firm flat ground, 68km and away from the Atlantic Ocean on the Bonny River. The plate1below shows a typical well water supply which is ubiquitous in the study area.

Plate 1: A typical well water with fetching buckets in Emohua.

METHODOLOGY AND LABORATORY PROCEDURE

Sample were randomly collected in the water wells that are centrally located in each of the villages mentioned below and was immediately taken to the laboratory for determination of the physio-chemical parameter of the well water to avoid microbial contamination. To ensure reliability of the result one litre of plastic containers were used for collection of ground water samples for analysis. All samples were adequately labeled and the depth of water wells were measured and recorded with the aid of a measuring tape. The depth of water wells was also taken to determine the relationship between depths and ground water contamination. These communities include: Isiodu, Rumuche, Rumuakunde, Elibrada Mgbueto, Rumuohia, Oduoha, Mgbuitanwo. The water quality parameters such as ph, turbidity, Total hardness, iron, lead and magnesium used were selected because of their implications in determining the ground water quality associated with the incidence of water borne diseases. To obtain the pH (Potential Hydrogen), a digital pH meter and pH electrode were used to monitor and record the value displayed on the screen. The pH meter was inserted to stabilize for 15 minutes and set to the effluent temperature. The electrode was rinse with jet of distilled water. The pH meter was calibrated with buffer 4 and buffer 7, and the electrode was dipped into water sample and allowed to display figures to stabilize. To obtain the total hardness**,** 25ml of water samples were measured to the burret bottles, Ammonia was added to the 25ml of water samples. And Eriochrome black T were added as well to change the colour to purple and finally turned to blue colour as the end point. Finally, the values were given by the readings of the pipette. The turbidity was obtained using the spectro-photometric method, the standard turbidity solution of known concentration of 5,10,20,30,40,50,60,70,80,90,100 was read at 420nm wavelength. In a spectro-photometric standard, graph was prepared with this by plotting turbidity concentration against the corresponding absorbance. Unknown turbidity solution was read at the same wavelength and then extrapolated from the standard graph. The magnesium ion was analysed with a sample preparation, 285.2nm wavelength was selected in the instrument. Air and gas pressure flow was adjusted slit width, and other setting as recommended for this instrument was also adjusted, hallow cathode lamp was energized by allowing adequate time. Standard magnesium ion concentration was aspirated into the instrument as to effect calibration and plotting of standard graph. The sample solution was aspirated into the instrument and the concentration of the test ion was extrapolated from the standard graph in PPM or Mg/l. For iron ion analysis**,** 248.3mm wave length was selected. Air and gas flow was adjusted slit width, and the other vital setting was as recommended, instrument was also adjusted. Hallow cathode lamp was stabilized and allowed adequate time to energize. The instrument was calibrated with standard iron ion concentration to obtain a standard plot. The sample was aspirated into the instrument and the concentration of iron ion in the sample was obtained, extrapolation from the standard iron ion graph in PPM or Mg/l. Lead ion was analyzed by an atomic absorption spectrophotometer at 283.3nm wavelength. The wave length was selected with a narrow slit width, air and acetylene gas flow was adjusted, other recommended instruments employed was attended to and regulated. Hallow cathode lamp was given adequate time to stabilized before aspirating standards for equipment calibration. After calibrating the equipment with standard lead concentrations, the aspiration tubing and system were flushed with distilled water severally before aspirating the test sample solution on the sample experimental condition used for the standard. The concentration of lead ion in the sample was extrapolated from the standard graph of lead ion. The concentration was expressed in Mg/l or PPM, from the equipment; corrections were made necessarily in units of choice. The depths of well water were measured to identify if a relationship exist between depth of well and the prevalence of diarrhea disease.

Medical records of water bore diseases in Emohua General Hospital were also collected for analysis in the study area. To enable us to identify the degree and nature of relationship which exist between the well water quality parameters and the incidence of diarrhea in the study area, the multiple regression coefficient techniques was employed. The multiple regression technique is of the form.

$$y = a + B_{1x}, + B_{2x2} + B_{3x3} \ldots + Bjxj + e \qquad 1$$

Where

y = incidence of diarrhea
a = constant term
$\beta_1, \beta_{2..} \beta_j$ = Regression coefficients
$X_1, x_2, ..x_j$ = independent variables (pH, Total Hardness, magnesium etc).
e = Error term.

RESULT AND DISCUSSION OF FINDINGS

The analysis of water borne diseases in Emohua, indicates that disease like diarrhea patients has the highest number of visit in each month, with total number of 22% per year. This shows that diarrhea diseases are prevalence in the community. This is followed by Hepatitis, typhoid fever, cholera and dysentery diseases with numbers of visits of 15, 11, 6 and 4% respectively. Findings showed that children are highly vulnerable and are affected more. From the table 1, it shows that months of January, February, March and May has an equal share of diseases among adults from the age of eighteen and above, and children from the age of one to seventeen years. Only the month of October recorded adult visit while the months of April, June, July, August, September, November and December recorded the highest number of children patients that contracted water borne diseases.

Table1: The distribution of Water Borne Diseases, frequency of visits and infected age in Emohua.

Months	Disease Description	No of hospital visit	Age
January	Diarrhea	2	Adults and children
February	Typhoid fever Diarrhea Dysentery	3 2 2	Adults and children
March	Diarrhea Typhoid fever	3 2	Adults and children
April	Diarrhea Hepatitis	4 4	Children only
May	Typhoid fever Hepatitis Cholera	3 2 1	Adults and children
June	Typhoid fever Diarrhea	2	Children only
July	Hepatitis	2	Children only

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	Cholera	3	
August	Hepatitis	2	Children only
September	Dysentery Diarrhea	2 4	Children only
October	Cholera	2	Adults only
November	Hepatitis Diarrhea	3 2	Children only
December	Hepatitis Diarrhea Typhoid fever	2 3 1	Children only

Source: Medical record Office Emohua General Hospital, 2014.

Table 2: Distribution of Diseases and frequency of hospital visit

S/N	Diseases	No Of Frequency
1	Diarrhea	22
2	Hapititis	15
3	Typhoid fever	11
4	Cholera	6
5	Dysentery	4
	Total	**58**

Source: Medical record Office Emohua General Hospital, 2014.

However, it was intended in this paper to identify the diseases village by village with the highest prevalence of the diseases, but the data obtained from the medical records department of the hospital did not include such information, rather the data they had include patients within the outside the study area, such as Kalabari, Ogbakiri, Rumuji etc.

The analysis of the physio-chemical parameters of well-water in Emohua (table 3) showed that the pH ranged from 3.51 to 6.08, showing that some areas such as Oduoha & Mgbuitanwo had an acidic ground water, Isiodu is slightly acidic while Rumuohia, Mgbueto and Elibrada ranges from 5.48 to 5.56 which are close to WHO Standard. Only Rumuche and Rumuakunde were up to the WHO standard with pH 6.05 and 6.08. This shows that the areas with the lowest pH values of the groundwater can cause corrosion of pipes and other corrodible materials and effect on human health. The result of the Total Hardness for the study ranged from 3.603mg/l to 108.101mg/l, indicating differences in water hardness in the area. Areas like Mgbueto, Mgbuitanwo, Elibrada and Isiodu has soft ground water, areas like Rumuche, Rumuakunde and Rumuohia has slightly hard water, only Oduoha has moderate hard water with 108.101mg/l value. Thou, hardness of water spoils the fabrics to wastage of fuel among others effect. The result of the Turbidity ranged from 0.04NTU to 0.12NTU, indicating that the ground water in the study area has lower particulates compared to WHO standard. Almost all the villages have equal values of 0.04NTU, except Oduoha that has 0.08NTU and Rumuohia with 0.12NTU. Magnesium ion result shows that Isiodu has no magnesium content, the result ranged between 0.249mg/l to 6.0321mg/l. indicating that the amount of magnesium content in the study area are very low, only Rumuakunde recorded the highest value of 6.321mg/l, which is not up to 25mg/l of WHO standard. The result of Iron ion, indicates that the study area lacks iron content in underground water, only Mgbueto recorded 1.21mg/l while other seven villages did not detect values. Iron transports oxygen to red blood cells and other vital organs in the body, lack of it causes anemia to human health. Lead ion, from the result of the study indicates that the underground water of the study area lacks lead content.

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Table 3: Physio-Chemical Parameters of Well-Water Quality in Emohua Communities.

Samples Identification	pH	Total Hardness (Mg/l)	Turbidity (NTU)	Mg (mg/l)	Iron (mg/l)	Lead (mg/l)	Well Depth (m)
Rumuche	6.05	24.02	0.04	0.429	ND	N/L	10.10
Isiodu	4.47	12.01	0.04	N/L	ND	ND	10.66
Mgbuitanwo	3.87	3.60	0.04	1.380	ND	ND	2.85
Oduoha	3.57	108.10	0.08	0.249	NK	ND	2.90
Rumuakunde	6.08	36.03	0.04	6.321	ND	ND	6.68
Mgbueto	5.56	0.80	0.04	1.415	1.621	ND	7.52
Rumuohia	5.48	28.02	0.12	0.876	ND	ND	6.68
Elibrada	5.56	10.01	0.04	0.538	ND	ND	8.40
WHO Standard	6.5-85	17-500	5	25	50	0.01	

ND - No data,

Result showed only Oduoha village that had the highest Total hardness value of 108.101mg/l, with turbidity value of 0.08NTU and well depth of 2.90 metres, indicating that shallow well water in the study area have an impact of diarrhea disease. Specifically, given the r^2 statistics, well depth accounted for 39.1% of the pH values of well water and 23.1% of the total hardness of the water in the study area. The scater-gram of the relationship between well water depth and the water quality parameters of ph, total hardness and turbidity of the well water are shown below

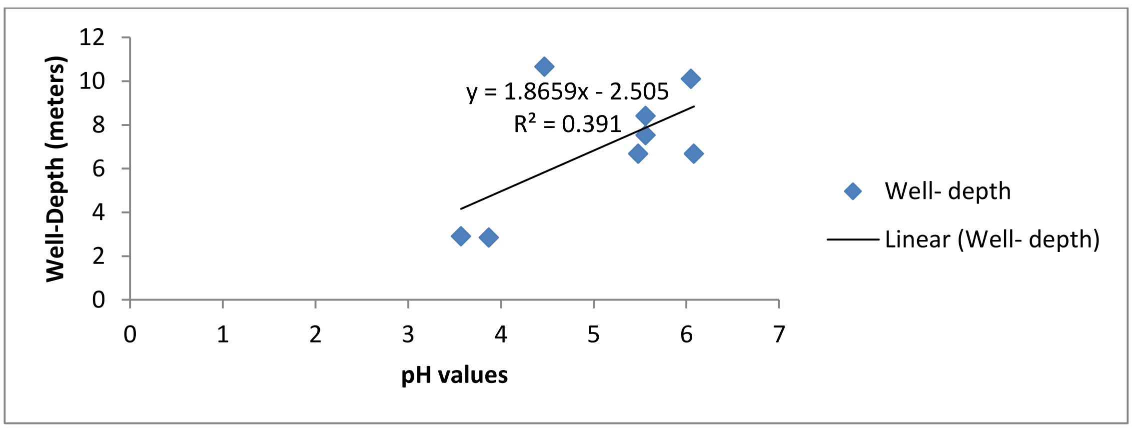

Fig1: scatter-gram of the relationship between well water depth and pH values of water

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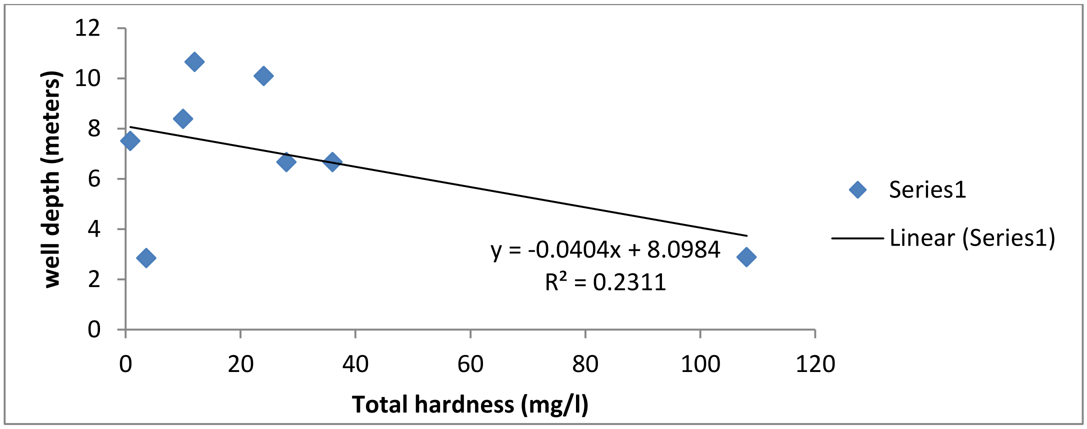

Fig. 2: Scatter-gram of the relationship between well water depth and total hardness of water.

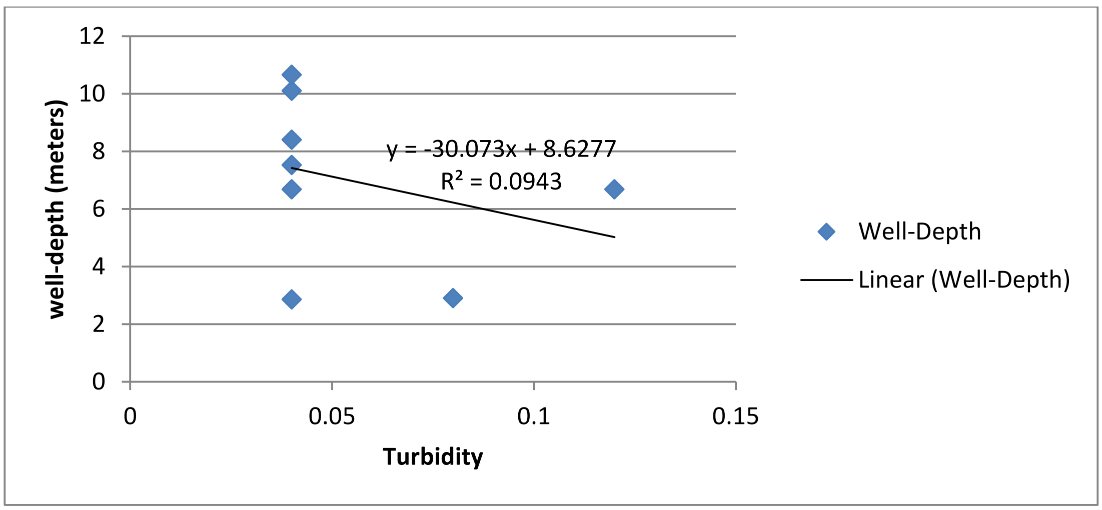

Fig. 3: Scatter-gram of the relationship between well water depth and turbidity of well water.

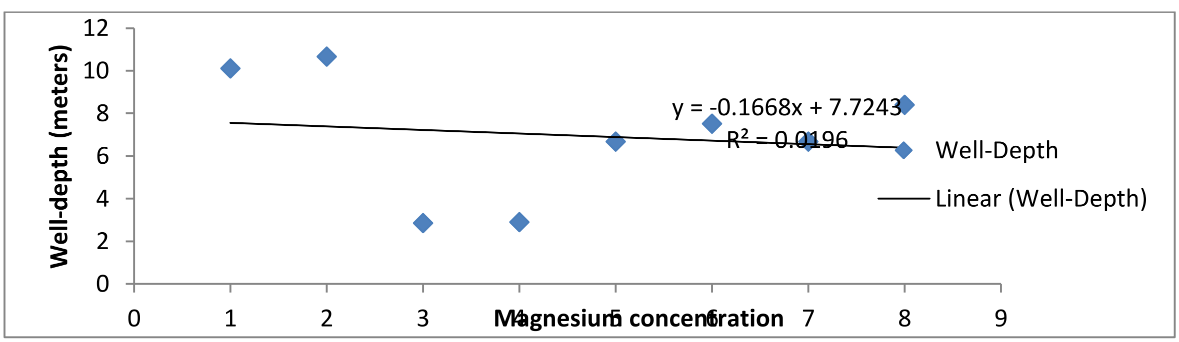

Fig. 4: Scatter-gram of the relationship between well water depth and magnesium concentration in well water.

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Table 4: Zero-order Correlation matrix of the incidence of diarrhea and well water quality parameters in Emohua.

		Diarrhea	**PH**	**TH**	**Mg**
Person correlation	Diarrhea	1. 000			.
	pH	- . 354	1. 000		
	TH	- . 167	- . 433	1.000	
	Mg	. 347	. 425	- .023	1.000

Significant at 95% level

The step wise regression result produced between the water quality parameters and the incidence of diarrhea in the study area showed that the correlation value (table 4) revealed that pH value and Total Hydrocarbon (TH) with negative correlation values of – 0.354 and – 0.167 respectively, correlated inversely to the incidence of diarrhea while magnesium (0.347) correlated directly to the concentration.

Table 5: ANOVA[s] of the incidence of diarrhea and well water quality parameters among the communities in Emohua.

	Sum of squares	**df**	**Mean square**	**F**	**Sig.**
1 Regression	10.338	3	3.446	2.489	.200[a]
Residual	5.537	4	1.384		
Total	15.875	7			

a. Predictors: (constant), Mg, TH, pH
b. Dependent variable: Diseases.

The analysis of variance (table 5) at the 95% significant level with the Snedecor's F- value of 2.489 which is greater than the F – critical value of 0.200 shows that the relationship between well water quality and the incidence of diarrhea among the communities in Emohua is very significant.

However the r^2 statistics which shows the coefficient of determination value of 65.1% revealed that the well water quality parameters of Total Hardness, pH, and magnesium accounted for 65.1% of the incidence of diarrhea in the study area. With an F-calculated value of 2.489 greater than F-critical value of 0.200, we conclude that well water quality parameters determine the incidence of diarrhea in the study area. The equation stating the relationship between the well water quality parameters and the incidence of diarrhea is shown below in table 6 and equation 2.

Table 6: Coefficient of the model of the relationship between the incidence of diarrhea and well water quality parameters.

	Unstandardized Coefficients		Standard Coefficient		
Model	**B**	**Std. Error**	**Beta**	**t**	**Sig**
1. (Constant)	9.395	2.947		3.188	.033
pH	- .351	.561	- .888	-2.407	.074
TH	- .023	.015	- .535	-1.602	.184
Mg	.523	.244	. 713	2.141	.099

Significant at 95% level.

The equation stating the relationship between the incidence of diarrhea and the well-water quality parameters is stated thus;

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$$Y = 9.395 - 0.88_{pH} - 0.53_{TH} + 0.713_{Mg} + 2.947. \quad 2$$

Finding shows that Mgbuitanwo village had the highest prevalence of diarrhea disease while Isiodu and Rumuakunde had an equal prevalence numbers of four. Rumuche, Oduoha and Elibrada had an equal numbers of two while Mgbueto and Rumuohia had the total number of one in the study area.

RECOMMENDATIONS

Based on the findings of this study, the following are the implications of the research in practical terms.

1. The inhabitants of Mgbuitanwo, Isiodu Rumuakunde and Mgbueto villages should discontinue drinking water from the hand dug wells.
2. Deep depths should be considered when drilling of boreholes in Emohua.
3. Regular testing of water quality should be encouraged to forestall the incidence of water borne diseases.
4. Aggressive public enlightenment campaigns are advocate to discourage the local inhabitants of the danger of consuming well water.
5. Well water should be treated properly before consumption.
6. Grasses growing inside the well water should be avoided in order not to attract parasitic organisms such as algal bloom.
7. Periodic medical test at most six months interval is recommended for the residents of the communities who drink well water.

CONCLUSION

In the study area, the use of well water for various purposes (food preparation, bathing etc.) without prior treatment was very common. Such practices together with relative position of the wells with pit latrines, short distance of wells from the pit latrines as well as improper protection of the wells were the major identified risk factors to result in various diseases (including typhoid fever, diarrhoea, cholera and others) related to consumption of contaminated water. The study identified closeness of well waters to latrine and their existence on equal altitude to the latrine houses along with short depth to be the major risk factors among well water users. Despite the fact that the majority of the wells water owners practice to close (cover) their wells, the practice cannot make the water safe (see Nwachuku and Gerba 2004). This was due to the fact that the covers were neither frequently properly cleaned nor effectively fit to the wells, resulting in contamination of the water and that led to various diseases related to unsafe water consumption. Water drawing methods and materials as well as additional water flow (during rainy season) were also among the major contributing factors of the observed risks. The high levels of pH and iron concentration was high in addition to high water hardness which is an indication of the presence of dissolved salt compounds renders the water unsafe for use among most of the communities in Emohua.

The physio-chemical quality of well waters used for various purposes in Emohua town was not to the acceptable level and various disease symptoms have been common among the residents. There were high levels of pH and iron in addition to the presence of dissolved salt compounds contributing to the hardness of the water in the communities. Strong monitoring and evaluation of well water hygiene, proper construction of the wells as well as awareness creation among residents need due attention.

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