EFFECTS OF ENVIRONMENTAL CONDITIONS ON DIARRHOEA DISEASE IN SOUTH EAST, NIGERIA: A CASE OF ENUGU STATE, NIGERIA

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Abstract

This study examined the effects of weather conditions on diarrhoea occurrence in South Eastern states with emphasis on Enugu State. The aim was to establish if there is a significant relationship between temperature, relative humidity, and rainfall and diarrhoea occurrence in the state. Tables were designed for collecting data on temperature, relative humidity, rainfall and diarrhoea from 2006 to 2016 and also number of children between 0-4 years that were affected with diarrhoea in the Primary Health Centers of the State. Through the administration of questionnaire to nursing mothers, the perception of mothers on the relationships between the predictors and diarrhoea

spread were obtained. Data collected were presented in tables, percentages and charts. The hypotheses were tested using correlations, regression and ANOVA. The results obtained showed that there were no significant relationships between temperature, relative humidity, and diarrhoea in Enugu State, but there is a significant difference in the occurrence of diarrhoea in the dry season and rainy season from 2006 to 2016. Also, the relationship between the predictors and diarrhoea differs significantly between the Primary Health Centers. Recommendations include public enlightenment campaign on diarrhoea epidemic at the beginning of dry season, the need for adequate water supply and sanitation in dry season, giving enabling environment for prevention and control of diarrhoea, improvement in environmental hygiene, infant nutrition, and education of mothers.

Introduction

The World Health Organization (WHO, 2012) noted that diarrhoea infections are associated with high death rate among the children (WHO 2012: UNICEF 2012), causing over three million cases each year, with recorded deaths in low and middle-income countries. Akari, Michio and Yukik (2002) noted high mortality and morbidity of occurrences in developing countries with about 4 billion episodes. According to WHO (2006), several weather parameters affect diarrhoeal diseases either from bacterial, parasites and viruses, arising from high temperature as recorded from these disease replication rates and survival duration. They noted also that other factors such as humidity and rainfall also influence diarrhoea. For instance, extremely low rainfall can force people in developing countries to make more use of polluted waters, while too much rain can contaminate sources of water supply by flooding (Peter, 2009). This goes to prove that weather conditions may have effect on diarrhoea. Therefore, it is necessary to clarify the potential role of weather elements (temperature, humidity and rainfall by determining their impacts on of diarrhoea cases in various localities in the study area.

Other socio-demographic factors associated with increased diarrhoea in the study area according to Mayelsi (2010), include low maternal education, low economic status, and poor quality of housing, diminished access to clean water, poor sanitation facilities and overcrowding in the family household. Norquist (2012) published in Medical News Today (MNT) that symptoms range from slightly watery stools, brief episodes of stomach ache, with severe stomach cramping. He enumerated; abdominal cramps, and pain, vomiting, nausea, fever, headache, loss of appetite, fatigue, loose watery stool and sometimes blood in stool.

Other causes, according to Fieldsman and Brandt (2010), include flu (viral gastroenteritis), certain types of bacteria or parasites, certain medications including certain antibiotics, chemotherapy drug for cancer and laxatives containing magnesium. Dupont (2013) said that diarrhoea of any duration may cause dehydration which means the body lacks enough fluid and electrolyte chemicals in salts, including sodium and chloride. The National Institute of Health (2012) in one of their publications outlined the most common causes of diarrhoea as: bacterial infections, viral infections, parasites, functional bowel disorder, intestinal disease, food intolerance and sensitivities, and reaction to medicines.

WHO, through its department of research and control for diarrhoea disease (CDD), introduced Oral Rehydration Therapy (ORT) in 1979 which speedily became the special control of diarrhoea. It is estimated that ORT is accessible now to more than 60% of children, and is used in about 20% of all diarrhoea episodes (WHO, 2008). This is true of Nigeria, (Okoni, 1998) and Enugu State (Ayogu, 2010).

Diarrhoea is one of the principal causes of mortality and morbidity especially in developing countries of the world (WHO 2OO8). In Nigeria, a tropical and also developing country in which Enugu State is located, prevalence of diarrhoea disease is a serious problem of public health (Ayogu. 2010). According to record by UNICEF (2012) diarrhoea kill about 194,000 children under five annually in Nigeria and there has been increase in recent years. The

increase in diarrhoea patients in Nigeria and thus Enugu state are also attributed to the association with the global warming and thus weather impact on diarrhoea. This work intends to study the effects of weather conditions on diarrhoea in Enugu State, Nigeria by examining the impact of rainfall, temperature and humidity on the disease in order to recommend environmental management strategies that could address the issues relating to the identified effects. Data relating to weather conditions in respect of rainfall, temperature and humidity from 2006 to 2016 were sourced from the agro-meteorological data of Ministry of Agriculture Enugu and Enugu Air Port**.** The relationship between diarrhoea and weather conditions needs to be established using the number of diarrhoea cases among children between 0-4 years the vulnerable group. The study involved mothers of child bearing age within the localities who provided information on their perception in respect of the causes of diarrhoea in the study area.

Rainfall cessation can force people to drink from pounds, rivers and other contaminated sources as a response to water scarcity in a developing country such as Nigeria where Enugu State is located. Also Excessive rainfall could lead to flooding and surface runs offs that can pollute and contaminate wells and other sources of water supply. This may also eventually affect the rate of contracting diarrhea (Gugu, 1999). Temperature can also affect the range and reproductive rates of disease organisms, disease vectors, and extending transmission seasons and increase the incidence of food and water borne diseases (International Panel on Climate Change (IPCC, 2007). In the present study, weather conditions are independent variable in respect of diarrhoea while diarrhoea may be dependent on weather conditions. Thus if weather conditions is proved to affect diarrhoea in Enugu State, rational plans and actions to break the link between the two, needs to be established.

Literature Review

Weather and Seasonal Effects on Diarrhoea; Water, Sanitation and Hygiene in Relation to Diarrhoea Disease; Socio-economic and

demographic Factors' Associated with Diarrhoea have been reviewed in this section. Akari, Michio and Yukiko (2002) made a statistical investigation for the effect of the climate on the epidemic diseases using the time series of meteorological elements and the number of patients elements in Bangladesh, using Correlation and Empirical Orthogonal Function EOF analysis method. Higher maximum temperature and more sunshine in the pre monsoon period are found to have a tendency to enhance the first peak of the diarrhoea occurrence.

Bhandari and Gurung (2012) carried study in Nepal to assess the relationship between climatic variables and diarrhoea and to find out the range of non-climatic factors that can confound the relationship of climate change and human health. They found out that the trend of yearly cases of diarrhoea has been increasing from 1998 to 2001 after which the cases remain constant till 2006.

Trowbridge and Newton (2009) studied the seasonal changes in malnutrition and diarrhoea disease among pre-school children in EL Salvador which was assessed quarterly for I year using height, weight and arm circumference measurements.Result indicated a similar seasonal increase in both measured malnutrition and diarrhoea disease occurring at the onset of the rainy season. The work gave similar result with the one conducted by Tyun (2000) in Southwest Nigeria.

Bandyopadhyay, Kanyi and Wang (2011) quantified the impact of variation in precipitation and temperature on the prevalence of diarrhoea in under-age children in Sub- Sahara Africa. The results show that shortage of rainfall in the dry season increases the prevalence of diarrhoea across Sub-Sahara Africa. This is similar to Enugu Urban area where shortage of rainfall decreases prevalence of malaria in 2011 (Okoye, Nwachukwu and Ewiurn, 2011).

Teshrima and Hayashi (2004) studied the impact of improved water supplies and excreta disposal facilities on diarrhoea morbidity, growth and mortality among children. They found out that excreta disposal facilities were more effective than improved water supplies for lowering diarrhoea morbidity and mortality rates and improving child growth.

Barwick (2006) reported that in the United States, 14 outbreaks of infectious etiology associated with drinking water were reported for the two period 1997-1998. Hque, (2003) stated that in Bangladesh, hand washing is universally promoted in health interventions, indicating 14-40% reduction of diarrhoea diseases with hand washing. WHO, (2009) posits that children under the age of 5 in developing countries bear the greatest burden and account for the majority of the 1.5 million deaths attributed to diarrhoea annually. This implies that diarrhoea is a major burden of childhood disease in low and middle incomes countries thus the poorer socioeconomic groups has been considered a priority in diarrhoeal control. Stanton and Clemens (1997) worked in an urban setting on socio - economic variables and rates of diarrhoea disease in urban Bangladesh. They found out that Socio-economic factor including low maternal education, low economic status, and inferior quality of housing, diminished access to water and sanitation facilities, and overcrowding in the household.

Birger, Forberg, Goran and Peter (2009) carried out a study aimed to determine the role of socio-economic inequalities in the management and control of childhood diarrhoea. They collected data on children aged 0-4 years from 93 Demographic Health Survey (DHS) in 55 countries in 1990-2005. Data were analyzed by wealth quintiles while socio-economic disparities and trends in inequalities were assessed. Their findings were that the households in the poorest socio-economic group consistently showed higher morbidity attributable to diarrhoea and less frequent use of oral rehydration therapy (ORT) when compared with households in the richest socio-economic group. Ogbu, Agumadu, Uneke and Amadi (2008) conducted an assessment of antibiotic sensitivity and microbiological profile of enteric pathogens in pediatric stool specimens for infantile diarrhoea in in Abakaliki, the South East. Of the 150 children diagnosed with diarrhoea (controls) 4 (8.0%) had enteric pathogen. Rotavirus was detected in 35 (23.3%) cases but none in the controls.

Regina, John, Martin and Julia (2009) published their work on "Hand washing for preventing diarrhoea". The objective was to

evaluate the effects of interventions to promote hand washing on diarrhoeal episodes in children and adults. Trial eligibility and risk of bias were employed. They stratified the analysis for cluster adjusted and no-adjusted trials. Incidence rate ratio (IRK) was pooled using the generic inverse variance method and random-effects model with 95% confidence interval (CI). Only trial results gave a 39% reduction in diarrhoea episodes in children in high-income countries. (IRR 0.61, 95% CI 0.40 to 0.92; 2 trials) and a 32% reduction in children living in communities in low-or middle income countries (IRR 0.68, 95% CI 0.52 to 0.90; 4 trials). They concluded that interventions that promote hand- washing can reduce diarrhoea episodes by about one-third.

Marzia and Luca (2013) tried to evaluate oral zinc supplementation for treating children with acute or persistent diarrhoea. Both authors assessed trail eligibility and risk of bias, extracted and analyzed data, and drafted the review. Diarrhoea duration and severity were the primary outcomes. They summarized dichotomous outcomes using risk ratios (RR) and continuous outcomes using mean difference (MD) with 95% confidence intervals (CI). Twenty-four trials, enrolling 9128 children, met inclusion criteria. The main results are that in children aged greater than six months with acute diarrhoea, zinc supplementation may shorten the duration of diarrhoea by around 10 hours

Location and Weather Conditions of the Study Area

Enugu State is one of the states in southeastern Nigeria. Its capital is Enugu. Enugu State is located within latitude 7°00'N and 10°.00'N and longitude 6°.00'E and 14.00'E. The state shares borders with Abia State and Imo State to the south, Ebonyi State to the east, Benue State to the northeast, Kogi State to the northwest and Anambra State to the west. The State is made up of 17 local government areas. These include Igbo Eze North, Igbo Eze South, Udenu, Nssuka, isi Uzo, Uzo Uwani, Igbo Etiti, Udi, Enugu East, Enugu North, Enugu South, Ezeagu, Nkanu West, Nkanu East, Oji-River, Awgu and Aninri local government areas. The State possesses two seasons; rainy season and

dry season. The average annual rainfall in Enugu is around 2,000 mm (79 in) which arrives intermittently and becomes heavy during the rainy season. Rainfall is of two major types; conventional which occurs from the month of May to September and frontal rainfall which occurs in March/April and October/November. (Anyadike, 2002). Temperatures throughout Enugu are generally high. Highest temperatures occur during the dry season. Rains moderate afternoon temperature during the wet season. Average high and low temperatures for the Enugu are 31°c and 23°c in January and 28°c and 23°c in June (NIMET, 2010).

Methodology

Climatic data from seven (7) different zones which are district health boards were collected. Questionnaire was designed for collection of data relating to the perception of mothers on the causes of diarrhoea in children between 0-4 years. Tables were designed for collection of secondary data on rainfall, temperature and humidity of Enugu State and for collection of number of children who attended the district hospitals (diarrhoea cases and non-diarrhoea cases) on monthly basis for a period of 10 years (2006-2016).

The district health boards where data on diarrhoea were generated include; (a) Enugu Ezike district health board with district hospital locates at Igbo-Eze North L. G. A. (b) Nsukka district health board with district hospital located at Nsukka.(c) Isi-uzo district health board with district hospital located at Ikem; (d) Udi district health board located at Udi; (e) Enugu district health board located at Uwani;(f) Agbani district health board located at Agbani; (g) Awgu district health board located at Awgu. The period of the study is ten years, from 2006 to 2016 and the data relating to diarrhoea cases were sourced from the seven district health boards covering the seventeen Local Government Areas in the state. The population of the study is made up the nursing mothers that attend the seven district hospitals in Enugu state. Based on the survey, an average of 2800 nursing mothers

attends immunization sessions in a month in all the district hospitals and as shown in Table 9.2.1.

Table 9.2.1: Monthly attendance of district hospital by nursing mothers

S/No	Location of district hospital	No. of nursing mothers	Total (%)
1	Igboeze-North	400	14.29
2	Nsukka	450	16.10
3	Isi-Uzo	370	13.21
4	Udi	350	12.50
5	Enugu-South	460	16.42
6	Agbani	430	15.36
7	Awgu	340	12.14
	Total	**2800**	**100**

Source: Field survey June 2017

The method employed is non probability purposive sampling methods. The population is divided into seven district areas (district boards) based on the geographical coverage of the hospital. Each division is a stratum and all the strata are to be selected. The strata are: Enugu Ezike district health hoard, Nsukka district health board, Isi-uzo district health board, Udi district health board, Enugu district health board, Agbani district health board, Awgu district health board.

Taro Yamane's formula was used to determine the sample size stated as follows:

$$n = \frac{N}{1+N\,(e)^2}$$

Where n = the sample size
N = No of population (Nursing mothers that attended immunization session)
e = limit of tolerance error (0.05)
1 = is the constant.
Therefore,

$$n = \frac{I + 2800\,(0.05)2}{\dfrac{2800}{1 + 2800\,(0.0025)}}$$

$$\frac{}{2800}$$

$$n = 350$$

Therefore, the sample size needed is 350 nursing mothers.

Primary data were obtained through administration of questionnaire on 350 nursing mothers whose child or children had suffered from diarrhoea. The Validity/Reliability of the questionnaire was tested using Cronbach's alpha, and designed in a 5-point Likert scale measuring the degree to which mothers 'agree or disagree to causes of diarrhoea. The data after presentation were analyzed using various techniques such as analysis of variance ANOVA and multiple regressions. ANOVA was employed to test the hypothesis. Here the assumption is that each of the two seasons dry or rainy season is an independent random sample from a normal population in which there are equal variances. The equation for simple ANOVA is stated as follows:

$$SST = \sum(x^2) - (\sum x^2)$$

$$SSB = \frac{(\sum x_1)^2}{N} + \frac{(\sum x_2)^2}{N} + \frac{(\sum x_3)^2}{N}$$

$$SSW = SST - SSB$$

Where SST = total sum of squares occurrence of diarrhoea during the period).

SSB = between sum of squares (occurrence in different seasons i.e. rainy and dry season of the state) SSW within sum of squares (occurrence in different months within each season).

Degree of freedom (df), df(total) = number of cases in total N minus 1 (N - 1).

df(between groups) = number of groups K minus 1 (K - 1).

df (within groups.) = sum of the number of cases within each group n minus 1 (n-1)
Mean Squares: MSB (mean square for between groups) SSB divided by df (between groups)

$$F = \frac{\text{MSB (mean square for between groups)}}{\text{MSW (mean square for within groups)}}$$

Mean squares are calc1ated by dividing each sum of squares by its degree of freedom. The F ratio for testing equality of group means is F mean square between, mean square within BSSMWSSM. The significance level is obtained from the F distribution with numerator and denominator degree of freedom.

ANOVA was also employed to test this hypothesis. Here the assumption is that each district health area is an independent random sample from a normal population in which there are equal variances. The equation for simple ANOVA is stated as follows:

$$SST = \sum(x^2) - (\sum x^2)$$

$$SSB = \frac{(\sum x_1)^2}{N} + \frac{(\sum x_2)^2}{N} + \frac{(\sum x_3)^2}{N}$$

SSWSSY—SSB
Where SST total sum of squares (perception of mothers on causes of diarrhoea).
SSB between sum of squares perception from different study locations i.e. district areas in the state) SSW = within sum of squares (perception from different locations within district areas).
Degree of freedom (df)
df(total) = number of cases in total N minus 1 (N - 1).
df(between groups) number of groups K minus 1 (K - 1).
df (within groups) sum of the number of cases within each group n minus I(n-1)

Mean Squares: MSB (mean square for between groups) SSB divided by df (between groups)

$$F = \frac{\text{MSB (mean square for between groups}}{\text{MSW (mean square for within groups)}}$$

Mean squares are calculated by dividing each sum of squares by its degree of freedom.

The significance level is obtained from the F distribution with numerator and denominator degree of freedom.

Table 9.2.2: Maximum, Average and Minimum Temperature, Relative Humidity, and Rainfall for 2006

S/N	Month	Temperature			Relative Humidity			Rainfall		
		Max.	Average	Min.	Max.	Average	Min	Max.	Average	Min.
1	Jan.	35.9	26.0	18.1	93	52	10	0.0	0.0	0.0
2	Feb.	37.2	29.1	21.1	91	50	09	9.4	4.7	7.2
3	March	37.8	29.9	22.0	100	54	08	41.8	24.2	0.2
4	April	34.5	28.2	22.0	100	72	45	59.4	29.8	1.0
5	May	33.8	27.9	22.0	100	76	53	49.8	25.1	2.1
6	June	32.8	26.6	20.5	100	78	55	60.2	30.4	0.2
7	July	31.5	26.5	21.5	100	80	60	90.0	45.2	0.6
8	Aug.	31.5	24.4	21.4	100	78	57	49.3	24.8	1.0
9	Sept.	32.1	26	21.0	100	78	56	61.1	30.6	0.6
10	Oct.	32.3	26.4	20.5	100	78	56	50.7	25.4	0.4
11	Nov.	33.6	27.2	20.9	100	72	45	24.9	13.4	0.0
12	Dec.	34.2	25.4	16.5	88	50	12	0.0	0.0	00

Source: Meteorologcal data, Akanu Ibiam International Airport, Enugu, 2016

Table 9.2.3: Maximum, Average and Minimum Temperature, Relative Humidity, and Rainfall for 2008.

S/N	Months	Max.	Temperature Average	Min.	Relative Humidity			Rainfall		
					Max.	Average	Min.	Max.	Average	Min.
1	Jan.	34.2	25.9	17.6	98	56	14	1.2	0.0	0.0
2	Feb.	36.4	27.6	22.8	88	50	11	0.0	7.2	0.0
3	March	27.6	30.6	21.7	97	61	25	39.3	1.9	0.1
4	April	30.3	283	21.6	98	74	50	46.6	23	0.1
5	may	28.3	27.4	20.7	98	76	53	42.8	23	4.1
6	June	27.4	26.5	20.7	100	78	57	43.2	21	0.6
7	July	26.5	25.8	20.2	98	76	54	52.0	26	0.2
8	Aug.	26.5	26.8	220	99	78	58	78.3	39	0.8
9	Sept.	27.2	27.8	21.7	98	79	60	66.4	33	1.0
10	Oct.	27.8	27.8	22.2	97	74	50	23.0	1.2	0.8
11	Nov.	28.0	28.0	21.1	97	67	37	0.0	00	00
12	Dec.	26.6	26.6	18.4	96	58	19	29.7	0.0	

Source: Meteorogical data, Akanu Ibiam International Airport, Enugu, 2016

Table 9.2.4: Maximum, Average and Minimum Temperature, Relative Humidity, and Rainfall for 2010

S/N	Months	Max.	Temperature Average	Min.	Relative Humidity			Rainfall		
					Max.	Average	Min.	Max.	Average	Min.
1	Jan.	34.4	25.6	18.8	92	54	16	1.0	0.5	0.0
2	Feb.	37.7	29.0	20.5	90	54	18		3.6	0.0
3	March	39.0	31.2	23.3	91	52	14	2.2	1.1	
4	April	38.3	30.4	22.5	97	68	40	56.9	30.0	1.0
5	may	34.2	27.8	21.5	98	77	56	30.0	15.6	0.1
6	June	32.5	27.1	21.7	99	80	60	81.2	41.2	1.1
7	July	31.8	26.5	21.2	98	80	59	26.3	13.4	0.4
8	Aug.	26.5	26.9	21.5	98	80	62	38.7	19.4	0.1
9	Sept.	31.6	26.6	21.3	98	80	62	72.1	36.6	1.1
10	Oct.	33.5	27.4	22.5	97	76	56	51.2	26.3	1.4
11	Nov.	34.6	28.6	21.1	97	72	37	1.0	0.5	00
12	Dec.	35.5	29.0	22.5	96	60	19	0.0	0.0	00

Source: Meteorogical data, Akanu Ibiam International Airport, Enugu, 2016

Table 9.2.5: Maximum, Average and Minimum Temperature, Relative Humidity, and Rainfall for 2012

S/N	Months	Max.	Temperature Average	Min.	Relative Humidity			Rainfall		
					Max.	Average	Min.	Max.	Average	Min.
1	Jan.	35.1	26.6	18.0	8	57	16	32.2	19.5	6.8
2	Feb.	35.4	28.6	21.8	96	69	42	97	49.2	1.4
3	March	38.0	31.1	24.2	92	56	20			
4	April	37.1	29.6	22.0	97	71	44	47.3	46.6	1.9
5	may	34.3	27	20.6	100	75	56	49.9	25.3	0.2
6	June	32.7	28.8	21.0	100	78	55	48.8	24.7	0.6
7	July	31.6	26.6	2.17	100	80	59	62.8	31.7	0.6
8	Aug.	31.2	26.6	22.0	100	80	59	61.7	3.10	0.3
9	Sept.	31.8	26.7	21.6	98	78	56	7.36	3.0.7	0.4
10	Oct.	32.7	26.6	20.5	98	79	55	37.0	18.8	0.6
11	Nov.	33.8	27.9	22.0	98	77	54	18.0	29.4	5.6
12	Dec.	34.5	26.0	17.4	99	58	19	00	0.0	00

Source: Meteorogical data, Akanu Ibiam International Air Port, Enugu, 2016

Table 9.2.6: Maximum, Average and Minimum Temperature, Relative Humidity, and Rainfall for 2014

S/N	Months	Max.	Temperature Average	Min.	Relative Humidity			Rainfall		
					Max.	Average	Min.	Max.	Average	Min
1	Jan.	36.3	26.6	18.0	8	57	16	32.2	19.5	6.8
2	Feb.	37.3	28.6	21.8	96	69	42	97	49.2	1.4
3	March	35.6	31.1	24.2	92	56	20			
4	April	35.5	29.6	22.0	97	71	44	47.3	46.6	1.9
5	may	34.3	27.4	20.6	100	75	56	49.9	25.3	0.2
6	June	33.1	28.8	21.0	100	78	55	48.8	24.7	0.6
7	July	32.4	26.6	2.17	100	80	59	62.8	31.7	0.6
8	Aug.	30.4	26.6	22.0	100	80	59	61.7	3.10	0.3
9	Sept.	32.0	26.7	21.6	98	78	56	7.36	3.0.7	0.4
10	Oct.	33.0	26.6	20.5	98	79	55	37.0	18.8	0.6
11	Nov.	33.8	27.9	22.0	98	77	54	18.0	29.4	5.6
12	Dec.	34.6	26.0	17.4	99	58	19	00	0.0	00

Source: Meteorogical data, Akanu Ibiam International Airport, Enugu, 2016

Table 9.2.7: Maximum, Average and Minimum Temperature, Relative Humidity, and Rainfall for 2016

S/N	Year	Annual Average for Tempeeature	Annual Average for Relative Humidity	Annual Average for Rainfall
1	2006	27.34	68.92	22.68
2	2007	27.18	68.92	21.13
3	2008	27.35	68.92	16.70
4	2009	27.57	72.00	22.12
5	2010	28.18	69.42	15.68
6	2011	22.83	71.25	21.16
7	2012	27.71	67.92	24.27
8	2013	25.90	71.25	20.46
9	2014	27/71	71.25	24.27
10	2015	27.07	69.58	27.88
	Overall Average in 10 years	26.88	69.96	21.64

Source: Computations

Table 9.2.8: Percentage of Respondents in District Health Boards

District health Boad	Frequency	Percent	Valid percent respondents	Cumulative percent
Igboeze North	49	14.3	14.3	14.3
Nsukka	54	15.7	15.7	30.0
Isi-uzo	46	13.4	13.4	43.4
Udi	46	13.4	13.4	56.9
Enugu	53	15.5	15.5	87.8
Agbani	53	15.5	15.5	87.8
Awgu	42	12.2	12.2	100.0
Total	343	100.0	100.0	

Source: Field work June, 2016

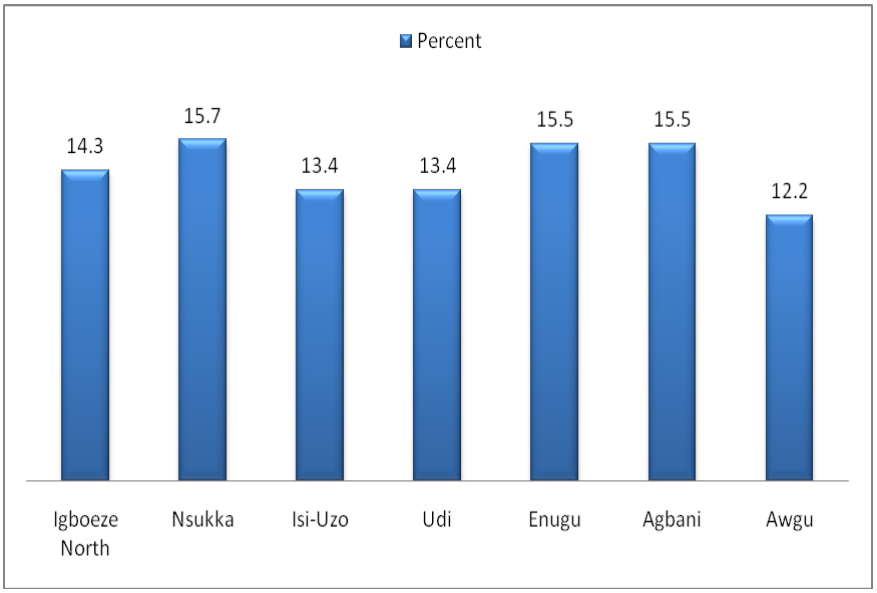

Figure 9.2.1: Bar Chart Showing the Percentage of Respondents in District Health Boards
Source: Field work, June 2016

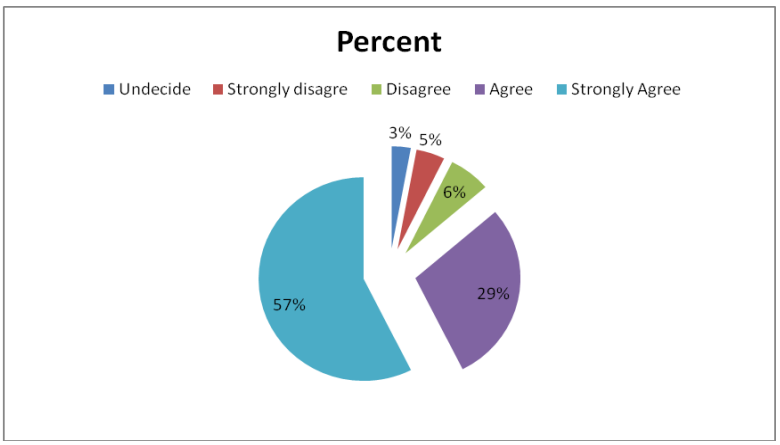

Figure 9.2.2: Diarrhoea and Rainfall relationship
Source: Field work, June 2016

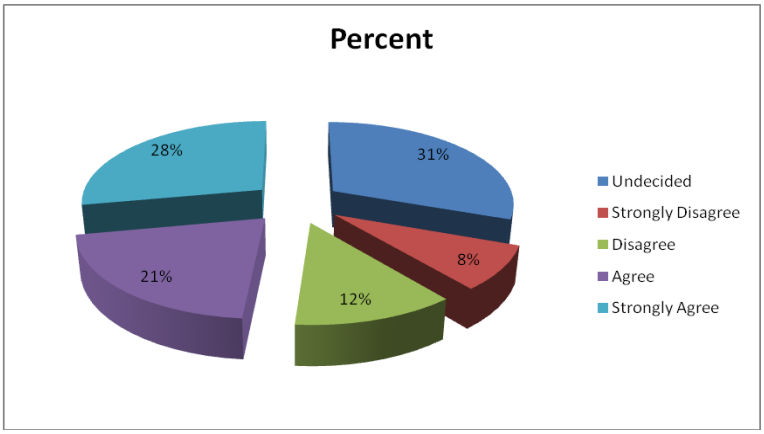

Figure 9.2.3: Diarrhoea and temperature relationship
Source: Field work, June 2016

Figure 9.2.3 reveals that greater number of the respondents (57%) strongly agree on diarrhoea and rainfall relationship. Figure 9.2.3 reveals that greater number of the respondents (31%) disagree whether temperature has any relationship with diarrhoea.

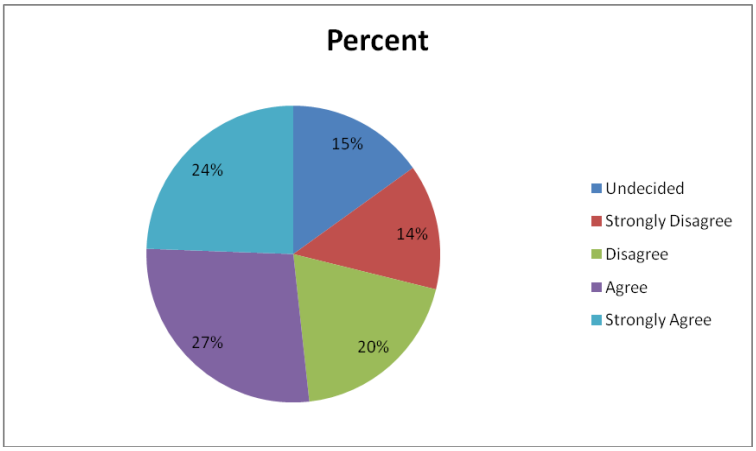

Figure 9.2.4: Opinios of respondents on whether people drink contaminated water that may cause diarrhoea in dry season than in rainy season
Sources: Field Work, 2016.

Figure 9.2.4 reveals that greater number (39%) of the respondents strongly disagree that people drink contaminated water that may cause diarrhoea in dry season than in rainy season

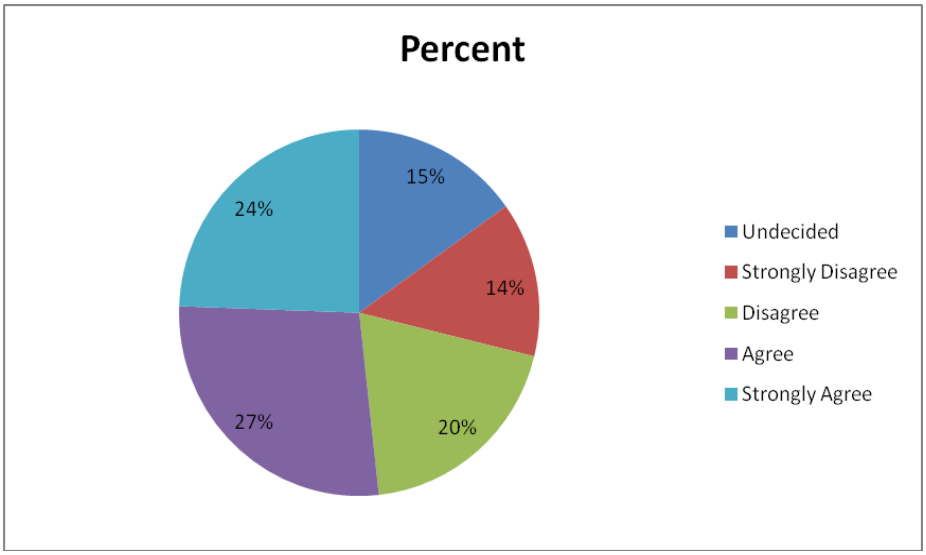

Figure 9.2.5 Diarrhoea incidence in children between November and March
Source: Field Work, June 2016.

Figure 9.2.5 discloses that greater number (27%) of the respondents agree that children always suffer from diarrhea between November to March.

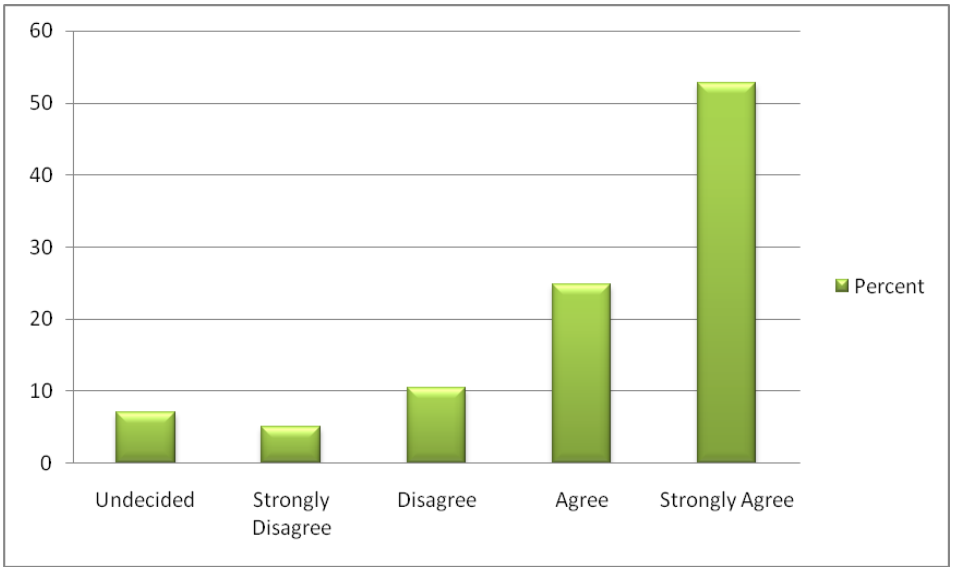

Figure 9.2.6: Diarrhoea incidence in children between April and September
Source: Field Work, June 2016

Figure 9.2.6 gave the percentage responses of (52%) that strongly agree that children always suffer from diarrhoea between April to September

Table 9.2.9: Diarrhoea is common at the onset of rainy season than onset of dry season

Diarrhoea is common at the onset of rain season than onset of dry season	Frequency	Percent	Valid percent respondents	Cumulative percent
Don't know	18	5.2	5.2	5.2
Strongly disagree	24	7.0	7.0	12.2
Disagree	34	9.9	9.9	22.2
Agree	103	30.0	30.0	52.2
Strongly agree	164	47.8	47.8	100.0
Total	343	100.0	100.0	

Sources: Field Work, June 2016

Table 9.2.10 reveals that greater number of the respondents (48%) strongly agree that diarrhoea is common at the onset of rainy season than onset of dry season**.**

Table Table 9.2.11: Diarrhoea incidence in rainy and dry seasons

There are more cases of diarrhoea in rainy season than dry season	Frequency	Percent	Valid percent respondents	Cumulative percent
Undecided	25	7.3	7.3	7.3
Strongly disagree	13	3.8	3.8	11.1
Disagree	15	4.4	4.4	15.5
Agree	89	25.9	25.9	41.4
Strongly agree	201	58.6	58.6	100.0
Total	**343**	**100.0**	**100.0**	

Sources: Field Work, June 2016

Table 9.2.11 expressed that greater number of the respondents 58% strongly agree that there are more cases of diarrhoea in rainy season than dry season. Yearly occurrence of diarrhoea with both averages in temperature, humidity and rainfall can be predicted as follows:

$Y= a +b_1 x_1+ b_2 x_2+ b_3 x_3+ e$ …… (I)
OD const. + (vaat) aat + (vaah) aah + (vaar) aar + e…….. (2)
Where: OD = occurrence of diarrhea,
const. = value or constant,
vaat = value by which occurrence of diarrhoea will change as a result of a change in temperature,
vaah = value by which occurrence of diarrhoea will change as a result of a unit change in humidity,
vaar = value by which o occurrence of diarrhoea will change as a result of a unit change in rainfall,
aat = annual average temperature,
aah = annual average humidity,
nar = annual average rainfall,
e = error.

Yearly occurrence of diarrhoea
= 14.229 + (-0.0 14) 26.88 + (0,003) 69.9(r (0.053)21.64+1.901
= l422Q+ (0.38) +0.2l + 1.147+1.901
= 17.105 => 17.

This implies that both annual average in temperature, humidity and rainfall only contributes to 17 cases of diarrhoea in a year in the whole of Enugu state.

Results

The correlation between occurrence of diarrhoea and temperature in Enugu state is -0.034. This means that there is a negative correlation between occurrence of diarrhoea and temperature in Enugu State. This implies that as one of the variables goes up, the other goes down. Correlation between occurrence of diarrhoea and humidity in Enugu state is 0.127. This implies there is a weak positive correlation between occurrence of diarrhoea and humidity in Enugu State. The correlation between occurrence of diarrhoea and rainfall in Enugu state is 0.072. This means that there is a weak positive correlation between occurrence of diarrhoea and rainfall in Enugu state. The significant value of 2 tailed gives the P value of 0,354, 0.03 and 0.217. These are greater than the alpha level (0.05). The null hypothesis was retained since P values were greater than the alpha level. The following conclusions can be drawn; there is no enough evidence to say that there is a statistical significant relationship between temperature, humidity, rainfall and diarrhoea in Enugu State.

Summary of Findings

1. The correlation between occurrence of diarrhoea and temperature, humidity and rainfall are -0.034, 0.127 and 0.072 respectively. This means that diarrhoea has a weak positive correlation with humidity and rainfall but negative correlation with temperature.

2. The annual average temperature, humidity and rainfall contribute to 17 cases of diarrhoea only in a year. Translated into percentage, the predictor account only for 2.5 percent of variation in occurrence of diarrhoea in the state, the other 97.5 percent is explained by other factors.
3. The null hypothesis that "there is no significant relationship between temperature, humidity, rainfall and diarrhoea" was retained.
4. There is a significant difference between occurrence of diarrhoea in the rainy season and dry season in Enugu State.
5. In different study locations compared, there were significant difference in Nsukka versus Igboeze North, Isi-uzo, Udi, Enugu, Agbani and Awgu. There is also significant difference in Isiuzo versus Igboeze North and Agbani, Awgu versus Igboeze North, Isi-uzo and Agbani.
6. There is no significant difference in Isi-uzo versus Ighoeze North and Agbani, Udi versus Igboeze North, Isi-uzo and Agbani, Enugu versus Igboeze North, Isi-uzo and Udi, Agbani versus Awgu, Udi and Enugu.
7. The mean comparison of diarrhoea occurrence in rainy and dry season indicates that there were more cases of diarrhoea in dry season than rainy season in all District Health Boards except in Agbani and Enugu.
8. The findings therefore indicate that the null hypothesis "there is no significant difference between the occurrence of diarrhoea in rainy and dry seasons in Enugu State" was not accepted. From the result of the analysis, there is a significant difference in the perception of mothers on the relationship between temperatures, humidity, rainfall and diarrhoea in the different study locations of Enugu State.
9. There is a correlation between temperature, humidity, and rainfall and diarrhoea occurrence. While the temperature has a negative correlation, humidity and rainfall have weak positive correlation. The annual average in temperature, humidity and

rainfall could only contribute to 17 cases of diarrhoea per year between 2006 and 2016 in Enugu State. This translates to 2.5% of all the cases recorded from 2006 to 2016 in the district hospitals. The implication of this is that 97.5% cases are attributed to other factors. Factors such as were identified in the literature include level of education, nutrition, water supply, environmental hygiene, socio-economic status, and infections.

Discussion of Findings

The result in Enugu State that the average temperature has negative correlation to diarrhoea while average rainfall has weak positive correlation did not totally correspond with that of Taiwan. Poisson regression model by Chou, Wu, Wang and Chuang (2010) results indicated that the maximum temperature and extreme rainfall were strongly related to diarrhoea associated morbidity. Pinfold, Horan and Mara, (2002) works in Thailand showed that reported incidence of diarrhoea appears to be inversely related to a sharp decrease in temperature for the period 1982 to 1987, around January each year. This is in line with Enugu's result where temperature and diarrhoea cases have a negative correlation in the State. Also, their result indicated acute reduction of diarrhoea during July to August in Thailand which tallies with Enugu's result that shows a reduction in the rainy season. The increase of diarrhoea cases in the dry season may be attributed to use of contaminated water due to water scarcity, forcing people to drink from ponds, rivers (Gugu, 1999) invariably, poor hygiene generally. The mean Comparison showed that there are more cases of diarrhoea in Nsukka and Awgu District Health Boards while, Enugu District Board has the least cases of diarrhoea both in dry season and rainy seasons, due to better education, nutrition, environmental hygiene, health facilities in Enugu urban than in rural areas.

Recommendations and Conclusions

This work studied the effects of weather conditions of temperature, relative humidity, and rainfall on diarrhoea cases in seven District Health Boards (DHB) in Enugu State. Various literatures were reviewed to explore available perspective of others on related problems in various places. Both primary and secondary data were collected and presented in various tables, percentages and charts and finally the data were analyzed and hypothesis tested using correlations, regressions and analysis of variance (ANOVA). The analysis showed that there is a correlation between temperature, relative humidity, rainfall and diarrhoea in Enugu State between 2006 and 2016. While, temperature showed strong negative correlation, relative humidity and rainfall showed weak positive correlation. The regression analysis predicted the rate at which the independent variables contributed to diarrhoea between 2006 and 2016 and showed that they contribute to 2.5% every year. The contribution of these weather factors is too small to prove that there is a significant relationship between them and diarrhoea. The analysis also showed that there is a significant difference in the occurrence of diarrhoea in rainy and dry season. The analysis of variance (ANOVA) indicated this significant difference in various study locations, It was concluded that there are more cases of diarrhoea in dry season than in the rainy season, Furthermore, the analysis established the perception of mothers on the relationship between the weather elements and diarrhoea occurrence at the study locations differs significantly. That there are more cases of diarrhoea in dry season than rainy season will enable the state government to alert the public at the onset of the dry season as a method of prevention and control in the state. The study also has identified certain parts of the state that have more cases of diarrhoea for government attention The significant relationship which differs between temperature, relative humidity, rainfall and diarrhoea was brought into limelight and will be useful in health education.

Recommendations

Though the research proved that only 2.5% of diarrhoea cases in a year were attributed to temperature, relative humidity and rainfall in Enugu

State, it is recommended that Enugu State should develop an early warning system based on the weather information for diarrhoea control management at the onset of the dry season. It is necessary that issues of water sanitation and use of good sources in dry season be emphasized. To this effect, government should highlight in the education of mothers to avoid use of contaminated water. Adequate water supply is recommended in dry season to reduce the use of contaminated water in order to reduce the diarrhoea cases in the State. Areas identified with more cases of diarrhoea should be given priority on matters of diarrhoea prevention and control. Also efforts should be geared towards improvement in environmental hygiene, infant nutrition, education of mothers, early diagnosis and treatment of diarrhoea cases, and immunization against diarrhoea infections.

Conclusions

The work on the effects of weather conditions on diarrhoea occurrence in Enugu State was successfully concluded. The objectives slated for the study were achieved. These objectives were collapsed into three hypotheses and the hypotheses were tested. It is therefore concluded as follows:

a) There is no significant relationship between temperature relative humidity and rainfall and diarrhoea in Enugu State from 2006 to 2016. Temperature has a negative correlation with diarrhoea while relative humidity and rainfall have weak positive correlation with diarrhoea. The three predictors could only contribute to 2.5%.
b) There is a significant difference in the occurrence of diarrhoea in rainy and dry season in Enugu State; there are more cases of diarrhoea in the dry season than in the rainy season in Enugu State from 2006 to 2016.
c) The suggested recommendations if implemented will reduce child mortality resulting from diarrhoea in Enugu.

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Appendix

Supplementary data to this article can be found online at the Website (jasdevr.org) of an international academic research journal, *Journal of Applied Sciences and Development.*