



Effects of Antibiotics on *Escherichia coli* Strains Isolated from Diarrhoeal Stool of Children (0-5) Years Attending Various Hospitals in Niger State, Nigeria

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ABSTRACT

Diarrhoea remains a common complaint among children attending various hospitals in Niger state for medical attention. A cross-sectional study was performed to determine the prevalence and antibiotic susceptibility pattern of *E. coli* strains isolated from diarrhoeal stool of children less than five years attending various hospitals in Niger state from February to October, 2014. The hospitals include Etsu Umaru Sanda General Hospital, Bida, General Hospital, Minna and General Hospital, Kontagora. A total of 480 samples were collected from diarrhoeal cases (450) and non-diarrhoeal cases (30). The samples were analyzed using MacConkey and Eosin Methylene blue agar. The isolates were Gram-stained, identified and serotype using biochemical tests and *E. coli* strain kits. Antibiotic susceptibility test was carried out on each of the *E. coli* strain using disc diffusion method. Out of the 480 patients sampled, 2 (53.13%) were males and 225 (46.87%) were females. The presences of *Escherichia coli* were observed in 81 (16.88%) samples, while 399 (83.12%) were *E. coli* negative. Different strains of *Escherichia coli* associated with diarrhoeagenic patients that were isolated includes Enteroaggregative *Escherichia coli* 16 (19.75%), Enterohemorrhagic *E. coli* 13 (16.05%), Enteroinvasive *E. coli* 8 (9.88%), Enteropathogenic *E. coli* 27 (33.33%) and Enterotoxigenic *E. coli* 17 (20.99%). All the tested *Escherichia coli* strains were susceptible to Ciprofloxacin, Nalidixic acid, Streptomycin and Tarivid, while all isolates were resistant to Ampicillin and Augmentin. Therefore, this study revealed that Ciprofloxacin, Nalidixic acid, Streptomycin and Tarivid can be used as drug of choice for the treatment of diarrhoea due to *E. coli* strains. Statistical analysis revealed that age, source of water, appearance of stool, area of domicile, occupation and education status of parents are statistically significant ($P < 0.05$), while gender is statistically in significant ($P > 0.05$).

Keywords: Diarrhoea, *Escherichia coli*. Antibiotic, Susceptibility

INTRODUCTION

Diarrhoea can be defined as the passing out of three or more loose watery stool and or one bloody loosed stool for a period of 24-hours (Guarrant *et al.*, 2001). Medically, diarrhoea is defined in terms of frequency, consistency and either weight or volume of faces (Baba *et al.*, 2016). Therefore, any liquid stool with frequency of more than three times per day and weighing more than 200 grams in total is referred to as diarrhea (Forbes, 2003). Also, diarrhoea is defined as decrease in the consistency of the stool from that which is normal for the patient (WHO, 1991).

Diarrhoea is basically classified into three major forms namely acute watery diarrhoea, acute bloody diarrhoea and persistent diarrhoea (Guarrant *et al.*, 2001). Acute watery

diarrhoea is that type of diarrhoea with high volume of watery stool occurring over a period of less than fourteen days. It usually results in severe dehydration if intervention measures are not sought. Acute bloody diarrhoea is that type of diarrhoea that manifested by loose or watery stools with the shedding of red blood cells. Persistent diarrhoea is usually associated with loose or watery stools with or without visible blood occurring over a period of fourteen days (Guarrant *et al.*, 2001).

Among the bacterial pathogen of diarrhoeal diseases, the most commonly implicated is the endemic form of childhood diarrhoea on a

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global scale are strains of *Escherichia coli* (Okeke *et al.*, 1999). *Campylobacter*, *Shigella*, *Salmonella*, *Yersinia* and *Vibrio* species (Iruka *et al.*, 2003). *Escherichia coli* are the common pathogens responsible for a wide spectrum of diseases. The spectrum could range from diarrhoea, dysentery, urinary tract infection, wound infection, peritonitis, neonate's meningitis to hemolytic uremic syndrome (Nataro *et al.*, 1998). Infectious diarrhoea is one of the world's leading causes of morbidity, resulting in about two million deaths per year (Alikhan *et al.*, 2006). However, majority of cases of serious diarrhoea occur among children in developing countries (WHO, 2000). World Health Organization (WHO) (1991) reported that diarrhoeal disease accounts for about 1.5 million deaths among diarrhoeal patient in the world annually. Also, according to Ifenyi *et al.* (2010), due to low socio-economic status and poor hygienic condition of the people, intestinal parasitic and bacterial infections constitute a major cause of morbidity which leads to several epidemics each year (Guarrant *et al.*, 2001).

Fecal-oral transmission from person to person in area with poor sanitation and contaminated or non-chlorinated water is the route of diarrhoea (Feachem, 1986). Sixty percent of *E. coli* infections are food and water borne by faecal contamination (Nataro *et al.*, 1998). *E. coli*, *Salmonella*, *Campylobacter* and *Vibrio* species are common bacterial pathogens found in stool culture recovered from patient present with gastroenteritis or severe diarrhoea (Feachem, 1986). Diarrhoeal disease is the major cause of morbidity, with attack rates ranging from 2-12 or more episodes per person yearly especial in developing countries (Guarrant *et al.*, 1990). In addition, diarrhoeal illness account for an estimated 12,600 deaths each day in children less than five years of age in Asia, Africa and Latin America (Adejuyigbae *et al.*, 2004). The impact of diarrhoeal illness is more severely felt in sub-Saharan Africa where of the 25 million children born each year, 4.3 million are expected to die by the age of five years and about 20% of these deaths will be from diarrhoea (Cuniliffe *et al.*, 1998).

Diarrhoeagenic *E. coli* is the important cause of endemic and epidemic diarrhea worldwide (Keskimaki *et al.*, 2000). Diarrhoeagenic *E. coli* has been described on the basis of distinct

epidemiological and clinical features, specific virulence determinants, and association with certain serotypes (Levine, 1987). These include Enteroaggregative *E. coli*, Enterohemorrhagic *E. coli*, Enteroinvasive *E. coli*, Enteropathogenic *E. coli* and Enterotoxigenic *E. coli* (Toledo *et al.*, 2002; Afset *et al.*, 2004). Bellin *et al.* (2001) reported that Enterotoxigenic *E. coli* causes watery diarrhoea due to production of plasmid mediated toxin (LT, ST) in infants and adult popularly called traveler diarrhoea. Enteropathogenic *E. coli* causes vomiting, fever and prolonged diarrhoea mainly in infants less than two years in most developing countries (Chessbrough, 2006). Enteroinvasive *E. coli* cause dysentery similar to shigellosis, fever, colitis with blood, mucous and many pus cells in stool (Nataro, 1998). Enterohaemorrhagic *E. coli* cause life threatening hemorrhagic diarrhoea (colitis) in all ages without pus cells and fever, while Enteroaggregative *E. coli* cause chronic watery diarrhoea and vomiting in children (Bellin *et al.*, 2001).

Enteropathogenic *E. coli* is the major cause of child hood diarrhoea among children less than two years in developing and developed countries (Donnenberg and Kaper, 1992). According to Levine *et al.* (1997), epidemiological studies indicated that series of O: H serotypes of *E. coli* were incriminated in the period of 1945 to 1960 as a cause of epidemic diarrhoea in infant's nurseries.

The epidemiological significance of each *E. coli* serotype in childhood diarrhoea varies with geographical area (Iliyasu *et al.*, 2016). Very few studies have investigated the microbiology of childhood diarrhoea in Nigeria in particular and in West African in general. In Nigeria, especially Niger state in North central have been many cases of acute childhood diarrhoea popularly called (*Foro be Atui*) in Nupe language. The aim of this study is to isolate and characterize *Escherichia coli* serotypes associated with childhood diarrhoea, and determines the prevalence and antibiotic susceptibility pattern of *E. coli* serotypes.

METHODOLOGY

Study Area

The study was conducted in Bida, Minna and Kontagora metropolis respectively in Niger state between the periods of February to

October, 2014 using diarrhea out patients attending the said hospitals. The study populations include diarrhoeagenic patients attending the outpatient (OPD) of Umaru Sanda General Hospital, Bida; General Hospital, Minna and General Hospital, Kontagora, while non diarrhoeagenic patients serve as control. The study approval was obtained from the ethical committee of the hospitals. A single fecal specimen was collected from each patient with diarrhea on presenting at the hospitals and also from control subjects. The relevant clinical data were recorded in a profoma.

Research Design

A cross-sectional study that entail sample collection from both male and female (infant and young children) patients. These comprise of patients (infants and young children) aged 0-5years presenting with diarrhoea or without diarrhoea, those without diarrhoea service as control. Inclusion criteria: patients (infants and young children) aged 0-5 years of both sexes having diarrhoea and those without diarrhoea in 2-4 weeks proceeding on before sample collection. Exclusion criteria: patients aged above 5-years of both sexes and lack of consent. Children who had been on antimicrobial drugs are excluded from this study.

Stool Sample Collection

A total of four hundred eighty (480) stool specimens were collected into wide mouth sterile screw cap bottles from three selected hospitals in Niger state, one from each senatorial zone. A total of 450 samples were collected from diarrhoeal cases (150 diarrhoeal stool samples from each hospital) and 30 non-diarrhoeal stool samples from control (10 non-diarrhoeal stool samples from each hospital). Each sample was clearly labeled and registered with patient's sex, age and sample appearance.

Sample Processing

Each sample was homogenized with sterile swab stick and about 0.5ml was introduced into macConkey agar and then incubated at 37°C for 24 hours (Chessbrough, 2002). Sub-culturing was done from the agar plate in order to obtain a pure culture of isolates on to Eosin-methylene blue agar for selective isolation of *Escherichia coli* at 18-24 hour at 37°C. The pure, sub culture isolates were subjected to series of biochemical tests that includes Gram

stain, Indole, Methyl red, Vogues Proskauer and Citrate utilization tests..

Serotyping

Species identified as *Escherichia coli* biochemically were serotype by slide agglutination tests using O specific antisera (Biotech., UK) as described by Chart, (2003). A loopful of 4% physiological saline was dropped on a sterile glass slide. A small amount of growth of culture was then picked, emulsified and mixed by titling the slide to and fro for about 30 seconds. The result from the mixture was observed or examined for agglutination against dark background in which those strains without agglutination or refused to agglutinate with saline was considered for serotyping. However, a loopful of the specific test antiserum was added and mixed, then examined for agglutination within one to two minute.

Antibiotic Susceptibility Testing

Muller-Hinton agar was prepared, dispensed into sterile petri dishes and then allowed to solidify. The isolates were diluted to a standard of 0.5McFarland's standard (approximately 1×10^6 to 2×10^8 colony forming units per mile) were then streaked on the surface of the solidified Muller-Hinton agar using sterile swab sticks. Commercially prepared antibiotic discs were picked using sterile forceps and placed on the surface of the agar already streaked with the test isolates, and then pressed lightly with the forceps. The plates were incubated at 37°C for 24 hours and zone of inhibition were measured to the nearest millimeters (mm) (Chessbrough, 2002). The antibiotics used for isolates include Ampicillin (15ug), Augmentin (30ug), Ceporex (25ug), Ciprofloxacin (30ug), Gentamicin (10ug), Nalidixic acid (30ug), Reflacine (10ug), Streptomycin (10ug), Septrin (30ug) and Tarivid (20ug). However, the percentage susceptibility was determined by dividing the number of isolates susceptible to a particular antibiotic by the total number of isolates considered and then multiplies by one hundred.

Statistical Analysis

The results were expressed using Chi-square test of association between socio-demographic factors of diarrhoeagenic patients and the occurrence of *E. coli* serotype in the patients.

RESULTS

Table 1 indicates the total number and the corresponding percentage of stool samples collected from diarrhoea and non-diarrhoea patients. Out of four hundred and eighty (480) patients aged 0-5 years investigated, four hundred and fifty (450) were diarrhoea

patients representing 93.75%, while thirty (30) with non-diarrhoeal cases serve as control, representing 6.25%. The highest samples 165 (34.37%) were obtained within children of age group of 13-24 months, while the lowest stool sample 47 (9.79%) was collected from children within the age group of 49-60 months.

Table 1: Distribution of stool samples obtained from both diarrhoea and non-diarrhoeal patients attending various Hospitals in Niger State.

Age group (Months)	Number of children with diarrhea (%)	Number of children without diarrhea (%)	Total (%)
0-12	128(26.67)	7(1.46)	135(28.13)
13-24	154(32.08)	11(2.29)	165(34.37)
25-36	67(13.96)	7(1.46)	74(15.42)
37-48	56(11.67)	3(0.62)	59(12.29)
49-60	45(9.38)	2(0.41)	47(9.79)
Total	450(93.75)	30(6.25)	480(100.00)

Table 2: Distribution of positive isolates (*E. coli*) among both diarrhoea and non-diarrhoea patients attending various hospitals in Niger State.

Age group Months	Number of positive isolate (%)	Number of negative isolates (%)	Total (%)
0-12	22 (04.58)	113 (23.55)	135 (23.55)
13-24	26 (05.41)	139 (28.95)	139 (28.95)
25-36	13 (02.71)	61 (12.71)	61 (12.71)
37-48	10 (02.08)	49 (10.21)	49 (10.21)
49-60	10 (02.08)	37 (07.71)	37 (07.71)
Total	81 (16.88)	399 (83.12)	480 (100)

Table 3: Distribution of *E. coli* related to gender of children stool.

Age group (Months)	Positive isolates from male children (%)	Positive isolates from female children (%)	Total (%)
0-12	10 (15.35)	12 (11.81)	22 (27.16)
13-24	11 (13.58)	15 (18.52)	26 (32.10)
25-36	08 (09.88)	05 (06.16)	13 (16.04)
37-48	04 (04.94)	06 (07.41)	10 (12.35)
49-60	06 (07.41)	04 (04.94)	10 (12.35)
Total	39 (48.15)	42 (51.85)	81 (100)

Table 2 indicates distribution pattern of *E. coli* isolated from the stool of diarrhoeal and non-diarrhoeal patients. Out of 480 sampled, 81 (16.88%) were positive isolates (*E. coli*), while 399 (83.12%) were negative isolates. Twenty-six (26) positive isolates, representing 5.4%

were found among age group of 13-24 months, followed by 22 isolates representing 4.58% were found among age group of 0-12 months. Thirteen (13) isolates, representing 2.71% were found among age group of 25-36 month, while ten (10) isolates representing 2.08%

were found among age group of 37-48 and 49-60 months respectively.

The table 3 indicates the number of positive isolates related to their gender. Out of eight one isolates confirmed, thirty-nine (39) *Escherichia coli* isolates representing 48.15% occurred among the male patients, while forty-two (42) *Escherichia coli* isolates representing 51.85% occurred among female patients.

Table 4 indicates different strains of *E. coli* isolated from stool samples of both diarrhoea and non-diarrhoeal patients which includes Enteroaggregative *E. coli* 16(19.75%),

Enterohemorrhagic *E. coli* 13(16.05%), Enteroinvasive *E. coli* 8(9.88%), Enteropathogenic *E. coli* 27(33.33%) and Enterotoxigenic *E. coli* 17(20.98%).

Table 5 indicates the percentage susceptibility of the *E. coli* strains to some antibiotics. The highest activity against EPEC was shown by Ciprofloxacin, followed by Tarivid and the least by Gentamicin and Nalidixic acid respectively. All the test isolates showed resistant to Ampicillin and Augmentin, while EAEC and EIEC also showed resistance to Gentamicin and Pefloxacin respectively.

Table 4: Distribution of *E. coli* according to frequency of serotype identified

Diarrheagenic <i>E. coli</i> strains	No of isolates from children with diarrhoea n=74	No of isolates from children without diarrhoea n=7	Total (%)
EAEC	15 (18.51)	01 (01.24)	16 (19.75)
EHEC	12 (14.81)	01 (01.24)	13 (16.05)
EIEC	06 (07.41)	02 (02.47)	08 (09.88)
EPEC	25 (30.86)	02 (02.47)	27 (33.33)
ETEC	16 (19.75)	01 (01.24)	17 (20.99)
Total	74 (91.36)	07 (08.64)	81 (100)

Table 5: Percentage susceptibility of *Escherichia coli* strains to antibiotics

Antibiotics	Disc potency (ug)	EAEC n=16	EHEC n=13	EIEC n=8	EPEC n=27	ETEC n=17
Ampicillin	30ug	00	00	00	00	00
Augmentin	30ug	00	00	00	00	00
Ceporex	10ug	06	00	00	07	12
Ciprofloxacin	10ug	13	15	13	33	18
Gentamycin	10ug	00	07	00	07	12
Nalidixic acid	30ug	06	07	13	07	12
Pefloxacin	10ug	00	35	00	15	18
Streptomycin	30ug	13	15	38	19	00
Tarivid	30ug	19	15	25	26	12

Key: 00= No zone of inhibition

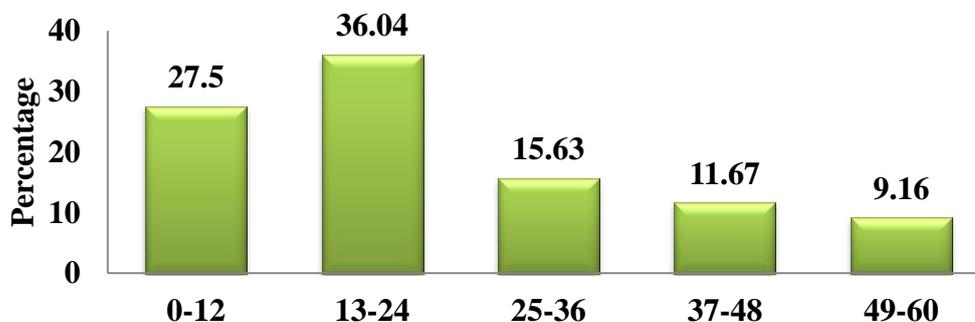


Figure 1: Occurrence of *E. coli* strain by age of the diarrhoeal patients.

Chi-square (χ^2) test of association in order to assess the association between the different variables indicated that the presence of *E. coli* strain in the diarrhoeal stool of the patients has an association with the ages of patients as shown by the distribution in the curve $P < 0.05$ (Fig 1).

Chi-square (χ^2) test of association in order to assess the association between the different variables indicated that the presence of *E. coli* strain in the diarrhoeal stool of the patients has no association with the ages of patients as shown by the distribution in the curve $P > 0.05$ (Fig 2).

Chi-square (χ^2) test of association in order to assess the association between the different variables indicated that the presence of *E. coli* strain in the diarrhoeal stool of the patients has an association with the appearance of stool of patients as shown by the distribution in the curve $P < 0.05$ (Fig 3).

Chi-square (χ^2) test of association in order to assess the association between the different variables indicated that the presence of *E. coli* strain in the diarrhoeal stool of the patients has an association with the source of water of patients as shown by the distribution in the curve $P < 0.05$ (Fig 4).

Chi-square (χ^2) test of association in order to assess the association between the different variables indicated that the presence of *E. coli* strain in the diarrhoeal stool of the patients has

an association with the area of domicile of patients as shown by the distribution in the curve $P < 0.05$ (Fig 5).

Chi-square (χ^2) test of association in order to assess the association between the different variables indicated that the presence of *E. coli* strain in the diarrhoeal stool of the patients has an association with the mother's occupation of patients as shown by the distribution in the curve $P < 0.05$ (Fig 6.1).

Chi-square (χ^2) test of association in order to assess the association between the different variables indicated that the presence of *E. coli* strain in the diarrhoeal stool of the patients has an association with the father's occupation of the patients as shown by the distribution in the curve $P < 0.05$ (Fig 6.2).

Chi-square (χ^2) test of association in order to assess the association between the different variables indicated that the presence of *E. coli* strain in the diarrhoeal stool of the patients has an association with the mother educational status of patients as shown by the distribution in the curve $P < 0.05$ (Fig 7.1).

Chi-square (χ^2) test of association in order to assess the association between the different variables indicated that the presence of *E. coli* strain in the diarrhoeal stool of the patients has an association with the father educational status of patients as shown by the distribution in the curve $P < 0.05$ (Fig 7.2).

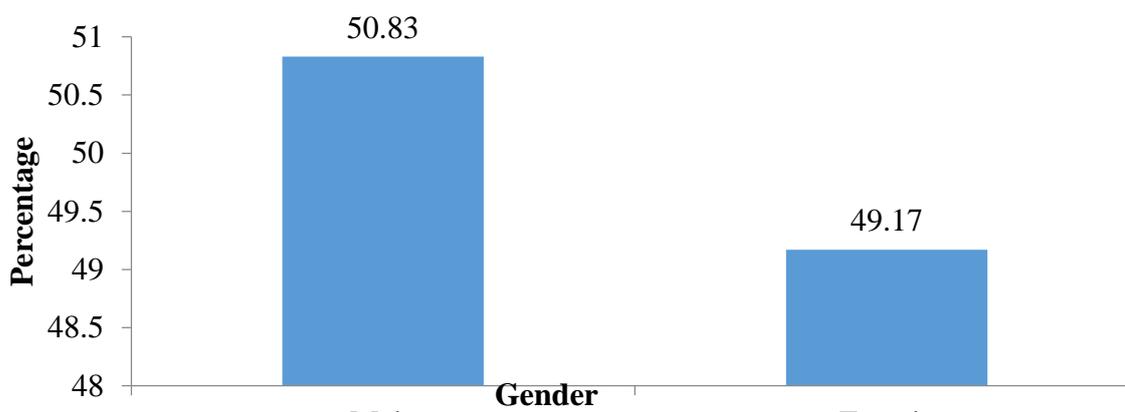


Figure 2: Occurrence of *E. coli* strain by gender of the diarrhoeal patients

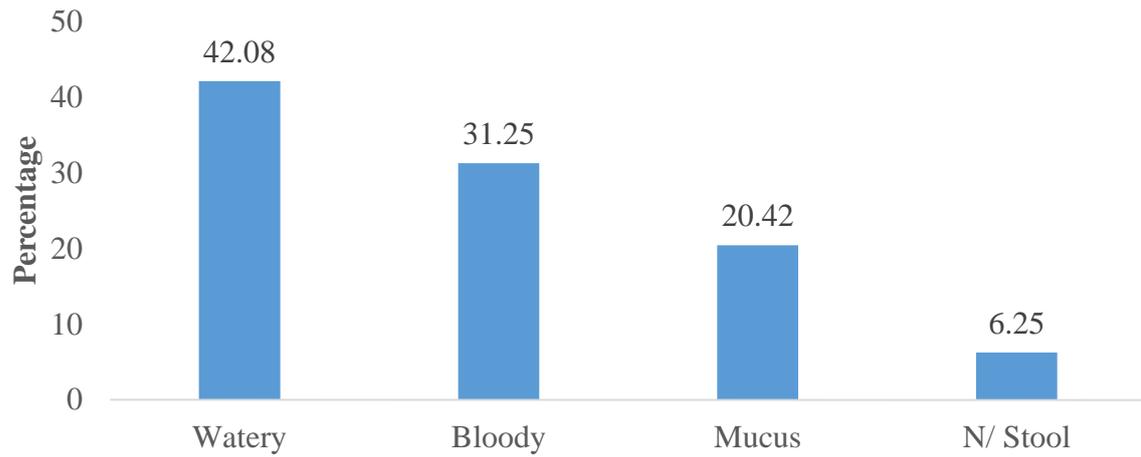


Figure 3: Occurrence of *E. coli* strain by patient's stool appearance

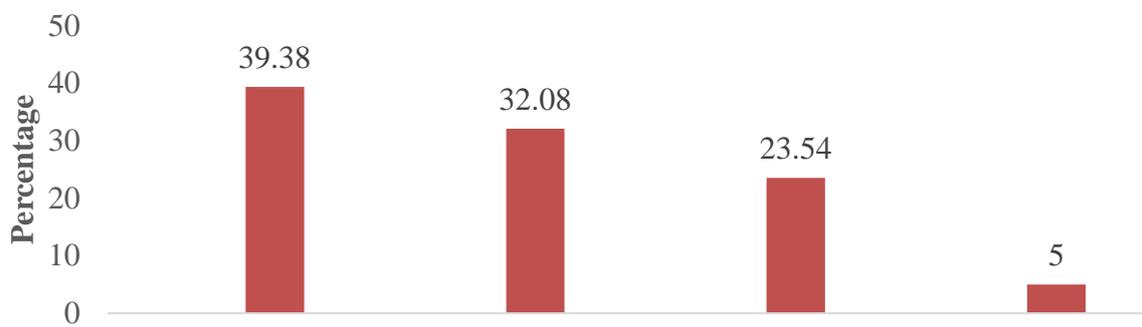


Figure 4: Occurrence of *E. coli* strain by source of water of patients.

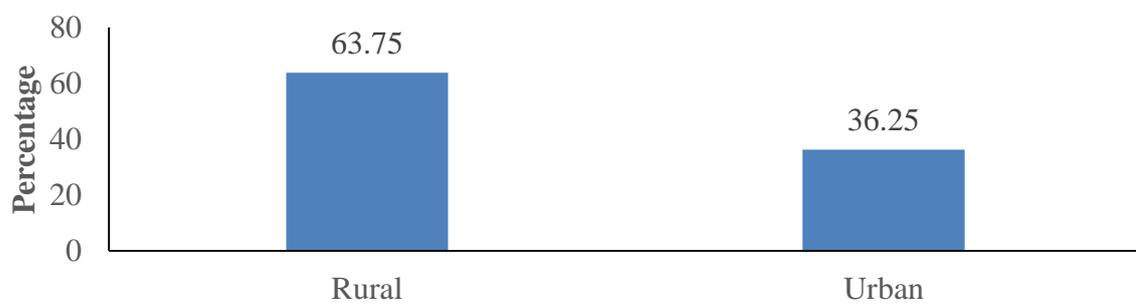


Figure 5: Occurrence of *E. coli* by area of domicile of patient

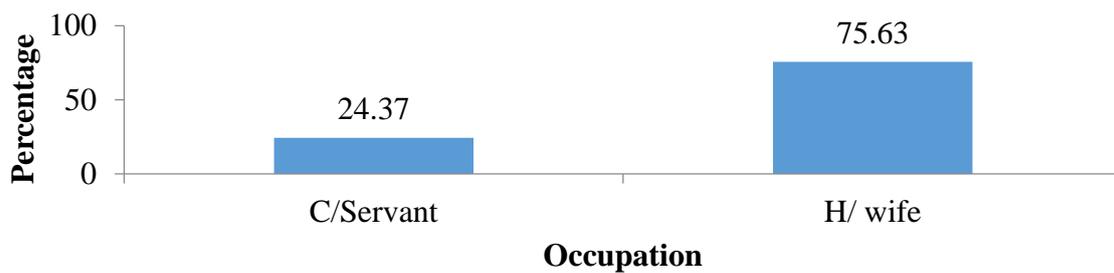


Figure 6.1: Occurrence of *E. coli* by Mother’s occupation of diarrhoeagenic patient.

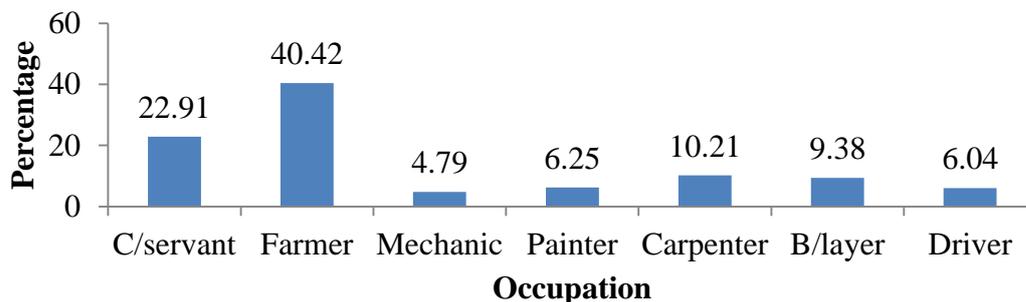


Figure 6.2: Occurrence of *E. coli* by Father’s occupation of patients.

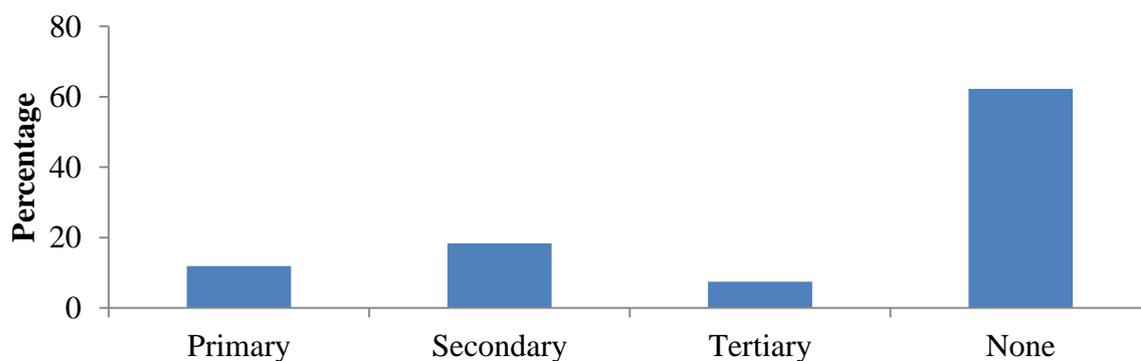


Figure 7.1: Occurrence of *E. coli* by Mother’s educational status

DISCUSSIONS

Diarrhoea may be contracted through ingestion of contaminated food or drinking of untreated water (Iruka and Okeke, 2009). These contaminants are mostly bacteria; virus and protozoa, and are capable of causing inflammation of the gut resulting into diarrhoea. Out of total sample collected, 135 (28.13%) children were younger than 12 months, while 165 (34.37%) sample obtained were from children between 13 and 24 months. This is contrary to the findings of Iliyasu *et al.* (2016) who reported that 247 (49.4%) of sample were collected from children less than 12 months, while 135 (27.0%) of sample were collected from children between 13 and 24 months. From this work, the least sample 47(9.79%) obtained were from children between 49 and 60 months. The results agree with the findings of Iliyasu *et al.* (2016) who reported the least sample obtained 14 (2.8%) between 49 and 60 months. The overall sex distribution of children was 255 (53.12%) males and 225(46.88%) females. This shows

that gastroenteritis or gastrointestinal episode is more frequent in male children than females and more prevalent in children between 0 month and 24 months. This is in conformity with the work of Vilchez *et al.* (2009), where of the 526 children involved in their studies on the prevalence of diarrhoeagenic *E. coli* in children, 280 (53.2%) were children between zero and twenty-four months and 320 (60.8%) of the children were males.

Escherichia coli are the target bacteria isolated from the diarrhoeal stool of children less than five years. The rate of isolation of *E. coli* strain from diarrhoeal stool sample of children less than five years depends on the number of samples and area of investigation. From this work carried out, three towns (Bida, Minna and Kontagora) in Niger state were investigated. The percentage of diarrhoeagenic *E. coli* isolates was 81(16.88%) out of 480 patients screened. This is contrary to the report

of a similar study carried out in India, Sudan, Kaduna and Kano with 52% (Virpari *et al.*, 2013; Ahmed *et al.*, 2009; Abdullahi *et al.*, 2010; Sule *et al.*, 2011). This result is also contrary to the report of 83.10% from similar study in Abakaliki (Ogbu *et al.*, 2008). The differences in the prevalence between these Nigeria cities might be attributed to different infrastructural and socio-economic indices.

In this study, the highest frequency of positive isolates 26 (5.46%) occurred among age group 13-24 months. This work is similar to the report by Abdullahi *et al.* (2010) on *E. coli* with 24%. Thirteen (13) representing 2.71% occurred among age group of 25-36 months, while the least occurred among 37-48 and 49-60 months respectively which agrees or similar with the findings or work of Sule *et al.* (2011) who reported that 14% positive isolates occurred among 0-12 month, and the least positive isolates occurred among age group of 25-36 months representing 4%. Reasons for high occurrence of *E. coli* among 13-24 months' children could be due to the fact that children at this age group could not differentiate between what to ingest and not to. Also they have not learnt the rudiment of adherence to specific or hygienic practice and can barely express themselves.

Frequency of diarrhoeagenic *E. coli* strain in this study shows that EPEC 27 (33.33%) is the most prevalent etiology of gastroenteritis in this area. This is followed by ETEC 17 (20.90%), EAEC 16 (19.75%), EHEC 13 (16.05%), and EIEC 8 (9.92%). The result agrees with the findings of Alikhani *et al.* (2006) who reported in their study on detection of typical and atypical enteropathogenic *E. coli* in Iranian children with diarrhoea. The result indicated that ETEC is the second prevalent of etiology of infectious diarrhea in children less than five years with 17 (20.99%). This is in conformity with findings of Iliyasu *et al.* (2016) who reported ETEC 59 (20.30%) in their studies of prevalence of infantile gastroenteritis associated with diarrhoeagenic *E. coli* in Tertiary health centers of Bauchi state, Nigeria.

In this study, EAEC 16 (19.755%) is the most third frequent strain isolated from diarrheal children. This is contrary to the findings of Okeke *et al.* (1999) in their study on

characterization of *E. coli* strains from cases of childhood diarrhea in Southwestern, Nigeria; where EAEC (10.30%) was found to be the most frequent diarrhoeagenic *E. coli* isolated in diarrhoeal case. Despite many strains isolated in childhood diarrhoeal in this study, EPEC is the most prevalent. This has confirmed that EPEC is a very important pathogen in children with diarrhea and the infection occur primarily in infants less than two years. According to Kaper, (1996) numerous studies on case-control studies in many countries have found EPEC to be more frequently isolated from children with diarrhoea than healthy controls.

The result of antibiotic susceptibility of the *E. coli* strains to some antibiotics in this study indicated that all test *E. coli* strains were susceptible to Ciprofloxacin, Tarivid, Streptomycin, and Nalidixic acid and resistance to Augmentin and Ampicillin. This result agrees with the findings of Baba *et al.* (2016) who reported in their studies on bacterial etiology of diarrhoeal diseases in children less than five years old in Umaru Sanda General Hospital, Bida, Nigeria. The result is also contrary to the findings of Sudershan *et al.* (2014) who reported in their studies of *E. coli* pathotypes and their antibiotic resistance in young children with diarrhoea in Hyderabad, India. The difference could be as of result of different antibiotics used and socio-economic indices.

For the statistical analysis, using the chi-square test of association to ascertain if association exist between certain variables and the occurrence of diarrhoeagenic *E. coli* and such variables includes age, appearance of stool, source of water, area of domicile, occupation of parents and education status of parents were statistically significant for the occurrence of diarrhoea as indicated by the chi-square values and the values $P < 0.05$, while sex (gender) variable is statistically insignificant to the occurrence of diarrhoeagenic *E. coli* in patients in the study area and the value $P > 0.05$. This study agrees with the findings of Baba *et al.* (2016) and Iliyasu and Oyawoye (2016) who reported in their studies that gender has no association with occurrence of *E. coli* with diarrhoeal patients based on statistical analysis.

Conclusion

The study revealed that the occurrence of all diarrhoeagenic *Escherichia coli* serotypes were the causative agents of diarrhoea and enteropathogenic *E. coli* being the most prevalent in the study area. All the test serotypes were susceptible to Ciprofloxacin, Tarivid, Streptomycin and Nalidixic acid, while all test isolates were resistant to Ampicillin and Augmentin. Statistical analysis showed that all variables considered were statistically significant ($P < 0.05$), while gender was statistically insignificant ($P > 0.05$).

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