Journal of Research in Medical and Dental Science
2020, Volume 8, Issue 2, Page No: 33-38

Available Online at: www.jrmds.in
eISSN No.2347-2367: pISSN No.2347-2545

Prevalence of *Enterobacteriaceae* Among Children aged 5-15 from Some Selected Hospitals in Abuja, Nigeria

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ABSTRACT

Introduction: Enterobacteriaceae can be plants and animals' disease-causing pathogens, which promote in human, the most common bacterial infections such as gastroenteritis, urinary tract infection, meningitis, septicaemia, and pneumonia. This research work was done to evaluate the prevalence of Enterobacteriaceae amongst children of 5-15 years old in Abuja.
Methods: This was a retrospective study using the microbiological datasheet results of patients between January 2018 and April 2019 from selected hospitals and primary health care centres in Abuja, Nigeria. Eight hundred and twenty (820) datasheet results were collected and only two hundred and twenty-eight (228) were positive results.
Results: Out of the 228, 130 (57.02%) revealed the presence of enterobacterial species and the remains were results of other microorganisms such as protozoa and other bacteria types. E. coli (47.69%) was the most dominant species, followed by Salmonella (24.62%), Klebsiella (15.38%) while Citrobacter species was less prevalent (1.54%). Most of these pathogens were found in urine samples (70.18%). Moreover, children of 12 years old were the most infected (15.38%) but 5 years old, kids were less infected (5.38%). Then most of the pathogens were found in female children (66.67%). The frequency of female children infected with these bacteria was about twice the one of male children.
Discussion: It can be stated that E. coli was the most prominent species, the biggest positivity was found in urine samples. Also, 12 years old and female gender was more sensitive and affected with enterobacterial infections.
Conclusion: The Federal Ministry of Health should collaborate with the various health facilities. It should monitor and evaluate the health services delivered by these facilities in the Federal Republic of Nigeria, improve the teaching hospitals, other medical agencies, and collaborate with development partners and the private sector in improving its health facilities in general. Children should always wash their hands properly with potable water and soap before and after each meal and after using the toilets, as well as after playing.

Key words: Prevalence of *Enterobacteriaceae*, Children, *E. Coli*, *Salmonella*, *Klebsiella*

HOW TO CITE THIS ARTICLE: Namla Djadjiti, Onyemata E Kelechi, Onyinye F Nwagbara, Senol Dane, Prevalence of *Enterobacteriaceae* Among Children aged 5-15 from Some Selected Hospitals in Abuja, Nigeria, J Res Med Dent Sci, 2020, 8(2): 33-38

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Received: 13/03/2020
Accepted: 01/04/2020

INTRODUCTION

Child death remains a litmus indicator of a country's growth, speaks for itself of the focus, and values [1]. African children succumb to respiratory or intestinal infections such as diarrhoea that are no longer threats in industrialized countries or to early childhood diseases that are easily preventable [2]. Poor quality of drinking water, poor sanitation and inadequate hygiene also contribute immensely to child mortality and morbidity [3]. Childhood deaths has been reported to be concentrated in poor resource settings like Nigeria where poverty, ignorance and social instability have provided a platform on which malnutrition and infection-related diseases have resulted in childhood deaths [4]. There has been impressive progress in improving the survival rates and health of children, even in some of the poorest countries since 1990 [5]. It remains a trouble to note that, high rate of infant and child morbidity and mortality is still one of the greatest challenges facing most of the countries in Sub-Saharan Africa [2].

Enterobacteria are gram-negative bacteria from the family of *Enterobacteriaceae*, which include eight tribes such as *Escherichiaeae, Edwardsielleae, Salmonellae, Citrobactereae, Proteaceae, Klebsielleae, Yersineae* and *Erwineae*. Bacteria belonging to the family *Enterobacteriaceae* are facultatively anaerobic, gram-negative, non-spore forming rod-shaped bacilli [6]. This heterogeneous group of bacteria does not only form part of the normal flora of humans and animals but is also widely distributed in various environments such as water,

soil, and plants [6]. The presence of these bacterial species in the gastrointestinal tract of humans and companion animals play an imperative role in maintaining both the normal digestive and immune functions of the hosts [7]. Even though most members of the *Enterobacteriaceae* were previously considered to be harmless, it is evident that some strains potentially cause diseases and pathological conditions such as diarrhoea, gastroenteritis, urinary tract infections and inflammatory bowel diseases in humans, and companion animals [6]. Most of the recent studies carried out by researchers on *Enterobacteriaceae* were concerned with a rapid increase in the occurrence of *enterobacterial* strains isolated from humans' clinical specimens such as blood, sputum, pus, and urine. Therefore, a recent study reported that a total of 43 organisms were isolated and identified using standard physiological and biochemical methods and the organisms were *Citrobacter* (6), *Edwardsiella* (2), *Enterobacter* (12), *Escherichia coli* (4), *Klebsiella* (4), *Proteus* (4), *Salmonella* (2), *Serratia* (2) and *Shigella* (7) [8]. In another study, *Morganella* spp., *Salmonellae* spp. and *Klebsiella* spp. were the most prevalent *enterobacterial* strains that occur during both dry and raining seasons; also, the *E. coli* are known to be the most predominant isolated strains during bacteriological screening in the recent years [9].This study was conducted to evaluate the prevalence of *Enterobacteriaceae* amongst children aged between 5-15 years in some selected hospitals and health centers in Abuja, Nigeria.

Materials and Methods

Procedure

The experimental protocol was by following international ethical standards. The study was performed per under the Helsinki Declaration (1975, revised in 1996-2013). It was a descriptive cross-sectional study. The study was made between January 2018 and April 2019. Permission to conduct this research was sought and obtained from the Health Research Ethics Committee of the Federal Capital Territory of Nigeria (FCT-HREC) as well as the health department of the Abuja Municipal Area Council (AMAC).

Study area

Four hospitals; including Maitama, Garki, Nizamiye and Nyanya hospitals and two primary health centres such as Kuchigoro and Kabusa health centres in the Abuja were selected for this study.

Medical data sheets collection and techniques

The present study was a retrospective survey. Medical data of eight hundred and twenty paediatric patients suspected for any bacterial infection or malaria were collected from the selected hospitals and health centres. Out of 820 children, the laboratory results of two hundred and twenty-eight patients were positive for any infection. One hundred and thirty of the positive 228 cases revealed the presence of *enterobacterial* organisms, which include *E. coli spp*., *Citrobacter spp.*, *Klebsiella spp., Proteus spp., Salmonella spp*. and *Shigella spp*. The data were collected on a weekly basis, which lasted for three weeks. The data obtained from the hospitals or health centers were either sent to emails as soft copies or hand delivered by the laboratory technicians.

Data analysis method

Data obtained from this study were analysed using Microsoft Excel 2016 version 1902 updated on the 12th March 2019. Furthermore, after analysis, data were presented using the Pareto chart, geographical and chronological classifications.

Ethical considerations

Permission to conduct this research was sought and obtained from the Health Research Ethics Committee of the Federal Capital Territory of Nigeria (FCT-HREC) as well as the health department of the Abuja Municipal Area Council (AMAC).

RESULTS

Results of the geographical distribution of collected data

Out of the 228 datasheet results, one hundred and thirty (130) revealed the presence of enterobacterial species. Moreover, out of these 130 datasheet results that revealed the presence of enterobacterial species, 32 were from Nizamiye hospital, 26 from Maitama hospital, 44 from Kuchigoro primary health center, 8 from Nyanya hospital and 20 were from Garki hospital (Figure 1).

Results of enterobacterial species distribution

Escherichia coli species has the highest occurrence in various specimens or samples provided by patients with a frequency of 47.69% followed by *Salmonella* species with 24.62% dominance and *Klebsiella* species, which had 15.38% frequency. While *Citrobacter* species 1.54% frequency, had the least occurrence. However, the non-enterobacterial species such as the protozoan, the fungal and the other types of bacterial species were identified from eighty-four (84) datasheet results with a frequency of about 36.84% (Table 1).

Results of *enterobacterial* species distribution based on the age

The *enterobacterial* species were highly found with children of 12 years old, 15.38% followed by children of 9 years old 13.85% then children of 8 years old 13.08%. However, these microorganisms were less found in children of 5 years old (5.38%). However, the *E. coli* tribe was the most occurring across all ages except in children of 13 and 15 years old where the Salmonella tribe was dominant (Table 2).

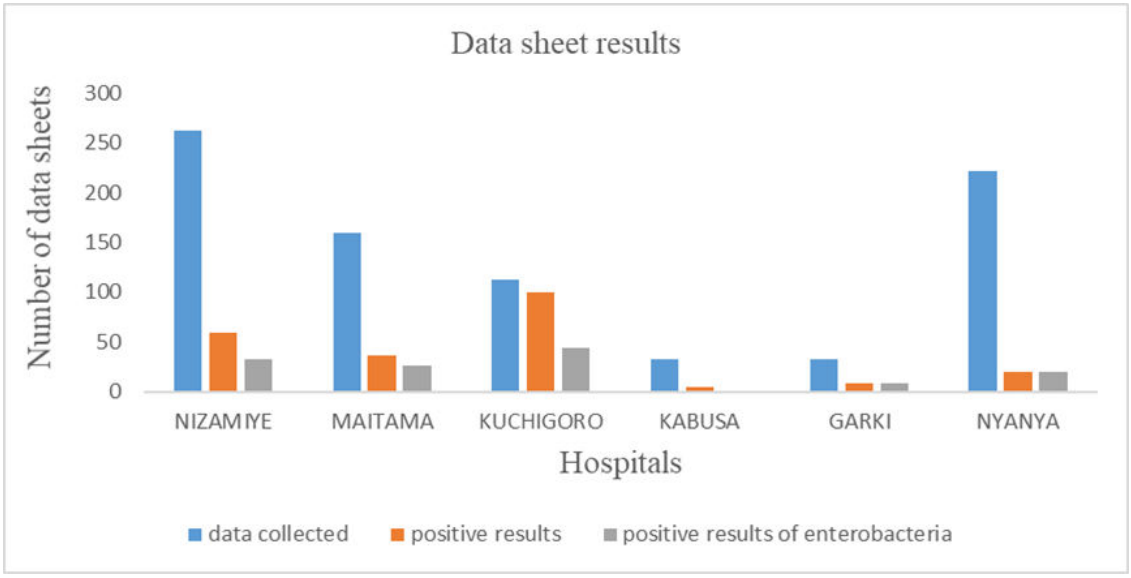

Figure 1: Column bar representation of the geographical distribution of data samples.

Table 1: Results of *enterobacterial* species distribution.

Enterobacterial **Species**	**Number of occurrences**	**Frequency of occurrence**
E. Coli	62	0.4769
Citrobacter	2	0.0154
Klebsiella	20	0.153
Proteus	11	0.0846
Salmonella	32	0.2462
Shigella	3	0.0231

Table 2: Results based on the age of children.

Age	*E. Coli*	*Citrobacter*	*Klebsiella*	*Proteus*	*Salmonella*	*Shigella*
5 Years	7	0	0	0	0	0
6 Years	4	2	2	0	2	1
7 Years	6	0	2	0	2	0
8 Years	8	0	3	0	6	0
9 Years	7	0	2	5	2	2
10 Years	6	0	2	0	1	0
11 Years	5	0	2	3	1	0
12 Years	9	0	4	3	4	0
13 Years	2	0	0	0	6	0
14 Years	5	0	1	0	3	0
15 Years	3	0	2	0	5	0

Results of *enterobacterial* species based on the type of specimen

The one hundred and thirty (130) enterobacterial species were isolated from a various clinical specimen collected from different parts of the human body. In the most samples, *E. coli* species had occurred more especially in the urine (70.18%) and wound swab (50.00%) but in the

stool samples, *Salmonella* species occurred the most with 57.14% as frequency (Table 3).

Table 3: Result based on the type of clinical specimen.

Specimen	*E. Coli*	*Citrobacter*	*Klebsiella*	*Proteus*	*Salmonella*	*Shigella*
C. Amber	0	0	0	0	1	0
J. Bile	0	0	0	0	0	0
Ear Swab	2	0	0	0	4	0
Stool	8	0	3	4	24	3
Sputum	2	0	1	0	0	0
HVS	3	0	2	2	0	0
T. Swab	0	0	0	0	0	0
W. Swab	7	0	1	3	3	0
Urine	40	2	13	2	0	0

Results of enterobacterial species by gender

In the present study, there was obvious gender difference in the incidence of different *enterobacterial* species. The frequency of female children infected with these bacteria was about twice the one of male children (Table 4).

Table 4: Prevalence of *Enterobacterial* species based on the gender of children.

Gender	*E. Coli*	*Citrobacter*	*Klebsiella*	*Proteus*	*Salmonella*	*Shigella*
Male	21	0	5	5	14	2
Female	41	2	15	6	18	1

DISCUSSION

Disease-causing organisms that cause bacterial infections particularly *enterobacterial* infections in humans especially in children are of health problem with a significant increase all over the world. In the present study, 15.85% (n=130) medical data sheet results collected revealed the presence of *Enterobacteria*. Thus, in humans, diseases such as typhoid, pneumonia, acute infantile diarrhea, hemolytic anemia, thrombocytopenia, and acute renal failure. In addition, *Salmonella* spp. and *E. coli* are the two enteric pathogens, which might play a huge role in scattering various infections though these microorganisms can cause cholera, diarrhea, septicemia and urinary tract infection [10].

Enterobacterial species were identified from medical data sheet results of children aged 5-15 years old from some selected hospitals and health facilities in Abuja. The unexpected high prevalence of *Enterobacterial* tribes in the children indicated that these microorganisms are the major disease-causing bacteria of bacterial infections or diseases amongst children because *Enterobacteria* are the most common Gram-negative facultative anaerobic isolates found in both children and adults even in the elderly people [11].

In the present study, *enterobacterial* species isolates were identified from one hundred and thirty (130) medical analysis data sheet results from January 2018 to April 2019. Six tribes out of the family of *Enterobacteriaceae* which include *Klebsiella* (15.38%), *Citrobacter* (1.54%), *Salmonella* (24.62%), *Escherichia coli* (47.69%), *Proteus* (8.46%) and *Shigella* (2.31%). It is worth to mention that *E. coli* was the most identified species. The highest proportion of these disease-causing organisms were found in urine samples (43.85%) and stool samples (32.31%). These findings support the previous studies in which *E. coli* are the most occurring species in children age 5-15 years old [12].

It has been known that the dangerous increase in the prevalence of extended-spectrum β-lactamase (ESBL)-producing *Enterobacteriaceae* results in important results for treatment outcomes [13]. *Escherichia coli* and *Klebsiella* spp. are important pathogens isolated from community-acquired and nosocomial-acquired infections and have been studied extensively [14-19]. These enzymes make the bacteria resistant to first-choice antibiotics. ESBL-positive strains cause a delay in the commencement of suitable antibiotic therapy, which consequently lengthens hospital stay and raises hospital costs [20]. The failure of antibiotic therapy can result in high mortality rates in patients infected with these bacteria [21].

Epidemiological studies around the world have investigated the prevalence of ESBL-producing Enterobacteriaceae and they have seen multiple mechanisms of drug-resistance [22-25]. Several studies on ESBL infection in the Asian-pacific region reported 60–80% of such cases were nosocomial-acquired while,

remaining were community-acquired infections [26, 27]. Over the last decade in Pakistan, an increase in resistance against quinolones has been observed in Enterobacteriaceae [28]. However, not much is known about fluoroquinolone-resistance in ESBLs and its relationship with plasmid-encoded genes.

Recent studies suggest that the predominance of the *Enterobacterial* species as the major disease-causing agents amongst children and adults in various zones in the Federal Republic of Nigeria is an alarming situation. Children and adults are exposed to the same *Enterobacterial* strains directly or indirectly through contaminated water, food [29]. However, these organisms are found living in the soil, water and decaying matter but also are commonly found in both human and animal large bowels.

Nevertheless, the apparently low prevalence of *Citrobacteria* as disease-causing microorganisms in this study may be due to the lack of suitable selective nutrient broth media for its culture. Though, the divergences between the findings of various works done and those of our own case study might be due to several factors such as the methods of isolation of bacterial strains, the sample size that is the number of analysed samples, the time period at which the investigation was carried out and the geographical location including the study area and study population. Therefore, these cues may lead to an increase or decrease in the prevalence of a specific Enterobacterial tribe.

According to the results of the present study, it can be stated that *E. coli* was the most prominent species, its biggest positivity was found in urine samples. Also, 12 years old and female gender was more sensitive and affected with *enterobacterial* infections.

CONCLUSION

This study revealed that the different species of *Enterobacteria* are more prevalent in the areas located at the peripheral part of Abuja and less prevalent in the central areas. The reason for such distribution can be related to the lack of adequate hygiene in those peripheral zones, which then had influenced the rate of *enterobacterial* infections.

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