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***PREVALENCE AND ANTIMICROBIAL RESISTANCE OF ENTEROHEMORRHAGIC E-COLI (E-COLI 0157) IN CHILDREN LESS THAN FIVE YEARS OLD WITH DIARRHEA IN ESUT***

ABSTRACT

Escherichia coli (e. coli) is a leading cause of diarrhoea in low- and middle-income nations, particularly among children under the age of five. This study aimed to determine the prevalence of Enterohemorrhagic E coli(e.coli 0157)and the antimicrobial susceptibility in children less than five years old in Enugu State University of Science and Technology Teaching Hospital. The study employed a cross-sectional design which was carried out from October-November 2024 Esuth Teaching Hospital. Samples were cultured on Coliform chromogenic (ecoli 0157) agar and antimicrobial susceptibility testing was performed using the Kirby- Bauer Disk Diffusion Method. The findings revealed a prevalence of 15 out of 83 participants (18%) for E. coli O157, with a slightly higher prevalence in females (21%) than males (15%). The most affected age group was children aged 1-2 years (46.7%). vomiting was reported (57%), fever,(23%), abdominal pain(64%) and dehydration(58%), with 85.5% presenting loose or watery stools and semi-formed stools (14.5%). Antimicrobial susceptibility testing indicated that while several strains were sensitive to antibiotics there was significant resistance to some. The study found an 18% prevalence of E. coli O157 in children under 5 in Enugu, Nigeria, with higher rates in females and the 1-2 age group. Also susceptibility studies showed significant rate of resistance in amoxicillin, nitrofurantoin and streptomycin drugs. Antimicrobial resistance was also shown to be prevalent. The outcome of the study indicate a key relationship between sex and prevalence of the disease as well as the relative epidemiological predispositions.

**INTRODUCTION**

**Background**

Diarrheal illnesses remain a major concern for infant health worldwide, particularly in underdeveloped nations such as Nigeria [1]. Among the many infections that produce these illnesses, Enterohemorrhagic Escherichia coli (EHEC) is notable for its severe health implications [2]. The O157:H7 serotype, in particular, is known to induce bloody diarrhoea and potentially fatal complications such hemolytic uremic syndrome (HUS) [3]. Accurate isolation and identification of E. coli O157 is crucial for disease control and prevention, highlighting the importance of extensive research and public health interventions.

Escherichia coli (E. coli) is a bacterium that is commonly found in both human and animal intestines [4]. While most E. coli strains are harmless, some, such as E. coli O157, produce potent Shiga toxins that disrupt the digestive tract [5].  These poisons cause severe gastrointestinal aches, bloody diarrhoea, and even hemolytic uremic syndrome (HUS), a potentially fatal kidney and blood clotting disorder [5,4].  The spread of E. coli O157 has been noted worldwide, with outbreaks connected to contaminated food and water sources, particularly undercooked ground beef and unpasteurized milk [4].  Developed countries have implemented stricter food safety regulations, resulting in fewer E. coli O157 illnesses. However, the burden remains significant in developing countries with limited access to clean water and sanitation infrastructure, as well as less stringent food safety regulations.

In Nigeria, the situation is particularly concerning. The combination of poor sanitation, limited access to clean water, and lax food safety standards provides an environment conducive to the spread of E. coli O157. According to a study by [6] this virus is present in both clinical and environmental samples, highlighting the need for enhanced diagnostic and prevention measures. Children under the age of five are especially prone to E. coli O157 infection because their immune systems are undeveloped, and they spend more time in contaminated areas. Young children have less established handwashing practices and explore their surroundings by putting objects in their mouths, which increases their risk of eating germs [6].   Furthermore, malnutrition, which is common in impoverished countries, can weaken a child's immune system, increasing the risk of severe effects from E. coli O157 infection.

The global data reveal significant variations in the burden of E. coli O157 infections. Developed countries report decreasing case counts, most likely as a result of improved food safety and sanitation.  [7] discovered that high-income countries have an incidence rate of fewer than one case per 100,000 individuals, while low- and middle-income countries have rates of 10 to 20 cases per 100,000. Poorer countries, particularly Nigeria, have a greater prevalence of E. coli O157, which is often associated with inadequate sanitary facilities and the challenges of maintaining a cold chain for food storage and transit. According to [8], low- and middle-income nations account for roughly 80% of all E. coli O157 cases. This disparity emphasises the vital need for focused public health strategies in developing countries to safeguard vulnerable groups, such as children. Children in Nigeria are particularly prone to E. coli O157 infections due to the high prevalence of malnutrition. Poor eating habits, combined with regular exposure to contaminated environments, increase the likelihood of serious illness outcomes. According to [6], malnutrition accounts for 45% of diarrheal mortality in children under the age of five. Addressing these issues would necessitate a multifaceted approach that includes increasing nutritional status, developing water and sanitation facilities, and enacting strict food safety standards.

The public health consequences of E. coli O157 infections extend beyond the direct health effects on those afflicted. It includes significant economic costs for healthcare, decreased productivity, and long-term health implications. In developing countries such as Nigeria, the healthcare system is usually overcrowded and resources are few, making the management of such illnesses extremely difficult [9].  Interventions to reduce the spread of E. coli O157 should be diverse. Improving diagnostic capabilities is crucial for early and accurate diagnosis of infections. Enhanced surveillance tools can help track the pathogen's movement and locate outbreak sources. Furthermore, public health campaigns that educate communities about proper food handling techniques, the importance of handwashing, and the dangers of drinking unpasteurized milk and eating undercooked meat can significantly reduce infection rates [5]. Furthermore, enforcing food safety rules can lower the risk of infection. Investments in water and sanitation systems are particularly crucial since they reduce environmental pollution and impede the bacteria spread [8]. In Nigeria, specialised public health measures that consider local socioeconomic and cultural factors are essential for effectively managing E. coli O157 infections [8].

**Aim and Objectives of the study**

* **Aim:** The aim of this study is to establish the prevalence of Enterohemorrhagic Escherichia coli (E. coli O157) and antimicrobial susceptibility in children under five years with diarrhoea at the Enugu State University Teaching Hospital.
* **The specific objectives include the following:**

1. Determine the prevalence of enterohemorrhagic Escherichia coli (E. coli O157) in children under the age of five who report diarrhoea at Enugu State University Teaching Hospital.
2. Evaluate the clinical symptoms and severity of illnesses associated with E. coli O157 infections in paediatric patients at the hospital.
3. Investigate the epidemiological patterns that influence the incidence of E. coli O157 infections in children under the age of five in Enugu, Nigeria.

**MATERIALS AND METHODS**

**3.1 Study Design**

The study adopted a mixed correlational design which combined quantitative and qualitative methodologies to thoroughly investigate both the epidemiological patterns and contextual factors that contribute to E. coli O157 outbreaks.

**3.2 Study Area**

The study area is at Enugu State Teaching Hospital Parklane in Enugu, Nigeria's capital. Enugu is a well-known city in southeastern Nigeria, particularly as an educational and medical hub. The hospital is a large healthcare centre that serves a diverse population from both cities and rural locations. It is situated near Shoprite (shopping plaza) in the centre of Enugu State (Coal City) GRA. Geographically, Enugu State is located in Nigeria's southeastern area, bordering Anambra, Ebonyi, Abia, Benue, and Kogi. The hospital's strategic location in Enugu's metropolitan centre allows it to serve a diverse spectrum of patients from across the state and beyond.

**3.3 Study Population**

This study's population covers all paediatric patients at Enugu State University Teaching Hospital, Parklane, with a focus on children under the age of five who present with diarrhoea. This includes both inpatients and outpatients seeking medical care at the hospital.

**3.4 Sample size**

To determine the appropriate sample size for this study, the study employed a simple random sampling to ensure full representation and account for both inpatients and outpatients. the sample size for each stratum would be calculated using the  Cochran’s Sample Size Formula.

Using the Cochrane Sample Size formula

**n=√(N×Z² ×p×q) ÷ (E² × (N-1)+ Z²×p×q)**

where N= estimated population size of ESUT =2000

Z= Confidence Interval= 1.96 or 95%

p = estimated proportion of the population (paediatric ward and Special care baby unit)= 10% or 0.1

q = estimated proportion of population not being studied= 90% or 0.9

E= margin of error = 0.0287

**SS = 83 participants**

**Data Collection**

The data collection procedure for the study consists of multiple stages. This procedure ensured the complete and reliable data collection by utilising questionnaires, laboratory testing, and data collectors.

***Questionnaires***

Questionnaires were used to collect demographics, medical history, and risk factors for E. coli O157 infections. The essential sections are demographic information on the children and their families including their age, gender, place of residence, and socioeconomic status.  Any previous diarrhoea episodes, hospitalisation history, or bacterial infection diagnosis. Details on food and water consumption, hygiene routines, and recent travel history. Trained data collectors provided questionnaires to children's parents or guardians. Face-to-face interviews were also used to verify that data is collected accurately and completely.

**3.5.2 Laboratory Tests:**

Stool samples were taken from children with diarrhoea at Enugu State University Teaching Hospital. To maintain the integrity of the samples, they were collected in sterile containers and transported to the laboratory under appropriate conditions.  Stool samples were then grown on Coliform Chromogenic Agar (CCA) agar, which is selective for E. coli O157.

**3.5.3 Data/Sample Collectors**:

Qualified health personnel, such as medical students, nurses, and laboratory technicians, are recruited and trained to collect data. They receive extensive training on the study's aims, ethical considerations, questionnaire delivery, sample collection, and correct handling of biological specimens.

**3.5.4 Inclusion and Exclusion Criteria**

**Inclusion criteria:**

* Children under the age of five present with diarrhoea.Enugu State University Teaching Hospital, Parklane, accepts both inpatient and outpatient cases.

**Exclusion criteria:**

* Children older than five years of age.
* Children experiencing non-diarrheal symptoms or disorders.

**Culture and Isolation**

* Stool samples are inoculated onto Coliform Chromogenic agar plates, which are selective for E. coli O157 due to their inability to ferment sorbitol.
* The plates are incubated at 37°C for 24-48 hours to allow for bacterial growth.
* After incubation, coliform chromogenic agar contains chromogenic substrates that allow for the identification of coliforms by producing coloured colonies when specific enzymes (such as β-galactosidase) are present. Colonies that appeared mauve or purplish-pink on Coliform Chromogenic agar were selected as presumptive E. coli O157.
* These colonies were then subcultured onto nutrient agar plates to obtain pure isolates for further analysis.

**Antimicrobial Susceptibility Testing (Kirby-Bauer Disk Diffusion Method)**

* Isolates were spread onto nutrient agar plates, and antibiotic-impregnated disks were placed on the surface. (Chloramphenicol, Ofloxacin, Meropenem, Pefloxacin, Ceftriaxone, Amoxicillin, Streptomycin, Nitofurantoin, Gentamycin, Ciprofloxacin) After incubation, zones of inhibition were measured to determine susceptibility or resistance.

**DATA ANALYSIS**

Data analysis for this study involved utilizing SPSS software to process and interpret the collected data thoroughly. Initially, the study population's demographic and clinical characteristics are summarised using descriptive statistics, which include frequencies, measures of central tendency (mean) and dispersion (standard deviation).

**3.9 ETHICAL CONSIDERATION**

Prior to the start of the study, informed consent were obtained from the parents or guardians, which included a detailed explanation of the study's objective, procedures, potential dangers, and benefits. The Enugu State University Teaching Hospital's ethical review board reviewed and approved the study protocol to ensure that it met ethical standards. The confidentiality of the participants was also ensured by employing unique IDs for samples and data rather than personal information.

**RESULTS**

**Table 4.1 Prevalence and Antimicrobial Resistance of Enterohemorrhagic E-coli (E-Coli 0157) in Children less than Five years old with Diarrhea in ESUT.**

The table below presents the demographic data of the study participants. Out of 83 samples collected from children under 5 years old at ESUT, 41 (49.4%) were male, and 42 (50.6%) were female. Among these children, 30 (36.1%) were between 1-2 years old, 25 (30.1%) were between 0-1 year old, 18 (21.7%) were between 2-3 years old, 6 (7.3%) were between 3-4 years old, and 4 (4.8%) were between 4-5 years old. Regarding the duration of diarrhea, 43 (51.8%) had suffered for 1 week, 24 (28.9%) for 2 weeks, 5 (6.0%) for 3 weeks, and 11 (13.3%) for more than 3 weeks. The majority of the children had loose/watery stool, while only 12 (14.5%) had semi-formed stool. Additionally, 37 (44.6%) of the children stooled more than 4 times daily, while 13 (15.7%) stooled once, 20 (24.0%) stooled twice, and 13 (15.7%) stooled thrice daily.

|  |  |
| --- | --- |
|  | **N (%)** |
| **Gender**  Male  Female  **Age**  0-12 months  13 moths-24 months  25 moths-36 months  37 moths-48 months  49 moths-60 months  **Duration of diarrhea**  1 week  2 weeks  3 weeks  >3 weeks  **Frequency of stooling**  Once  Twice  Thrice  4 times and above  **Consistency of stool**  Loose  Semi-formed | 41(49.4)  42(50.6)  25(30.1)  30(36.1)  18(21.7)  6(7.3)  4(4.8)  43(51.8)  24(28.9)  5(6.0)  11(13.3)  13(15.7)  20(24.0)  13(15.7)  37(44.6)  71(85.5)  12(14.5) |

**Objective 1. The Prevalence of Enterohemorrhagic Escherichia Coli (Coli O157) and Antimicrobial Susceptibility in Children Under the Age of Five who Report with Diarrhoea at Enugu State University Teaching Hospital.**

Out of the 83 children examined, 15 (18%) tested positive for diarrhea. Among them, 6 (15%) were male, and 9 (21%) were female. Of the children who tested positive, 46.7% were between 1-2 years old, 26.7% were between 0-1 year old, 20.0% were between 2-3 years old, and 6.7% were between 3-4 years old

**Fig 4.1. The Prevalence of Enterohemorrhagic Escherichia Coli (E. Coli O157) in Children Under the Age of Five who Report with Diarrhoea at Enugu State University Teaching Hospital.**

**Table 4.2 :** **Antibiotic Resistance Patterns of positive cases expressed in % of positive samples**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | NF | PE | C | CIP | CT | MP | OF | SN | AX | GN |
| **Resistance** | 45 | 50 | 40 | 55 | 43 | 39 | 40 | 41 | 57 | 47 |
| **Sensitive** | 55 | 50 | 60 | 45 | 57 | 61 | 60 | 59 | 43 | 53 |

Key:

|  |
| --- |
| SN= Streptomycin |
| GN= Gentamicin |
| CIP= Ciprofloxacin |
| C= Chloramphenicol |
| OF= Ofloxacin |
| MP= Meropenem |
| PF= Pefloxacin |
| CT= Ceftriaxone |
| AX= Amoxicillin  NF= Nitofurantoin |

**Objective 2. The Clinical Symptoms and Severity of Illnesses Associated with E. coli O157 Infections in Paediatric Patients at ESUT Hospital.**

The clinical symptoms presented by children less than 5 years old with diarrhea at ESUT include; vomiting, fever, abdominal pain and dehydration.

**Fig 2. The Clinical Symptoms Associated with E. coli O157 Infections in Paediatric Patients at ESUT Hospital.**

**Objective 3. The Epidemiological Patterns, Socioeconomic Characteristics, and Environmental Circumstances that Influence the Incidence of E. coli O157 Infections in Children under the Age of Five in Enugu, Nigeria.**

The epidemiological pattern of diarrhea among children under 5 years old at ESUT showed that the majority of the children had no recent travel history (75.9%), nor exposure to contaminated water (59.0%) or food (84.3%). Additionally, most of the children had no contact with animals (96.4%) or infected individuals (85.5%). However, 75.9% of the study participants had flies and rodents in their environment, 9.6% lived near livestock farms, and 25.3% had an open sewage system in their vicinity.

**Table 4.3 : Epidemiological patterns; Socioeconomic And Environmental Characteristics**

|  |  |
| --- | --- |
|  |  |
| **Epidemiological patterns**  **Recent travels**  Yes  No  **Exposure to Contaminated Water**  Yes  No  **Exposure to Contaminated Food**  Yes  No  **Contact with Farm Animals**  Yes  No  **Contact with Infected Individuals**  Yes  No  **Socioeconomic characteristics**  **Family size**  1-2 members  3-4 members  5-6 members  7-8 members  **Educational level of parents**  O’ level  B.Sc  M. Sc/M.A/Ph.D  **Occupation of parents**  Civil servants  Farmers  Artisans  Business men/traders  **Monthly income**  50-100k  101-200k  201-300k  >300k  **Housing type**  Rented apartment  Own apartment  **Access to clean water**  Yes  No  **Access to sanitation facility**  Yes  No  **Environmental circumstances**  **presence of open sewage system**  Yes  No  **Presence of livestock farms**  Yes  No  **Presence of flies and rodents**  Yes  No | 20(24.1)  63(75.9)  34(41.0)  49(59.0)  13(15.7)  70(84.3)  3(3.6)  80(96.4)  12(14.5)  71(85.5)  1(1.2)  29(34.9)  40(48.2)  13(15.7)  33(39.8)  50(60.2)  0  39(47.0)  1(1.2)  6(7.2)  37(44.6)  4(4.8)  40(48.2)  26(31.3)  13(15.7)  58(69.9)  25(30.1)  66(79.5)  17(20.5)  72(86.7)  11(13.3)  21(25.3)  62(74.7)  8(9.6)  75(90.4)  63(75.9)  20(24.1) |

**Discussion and Conclusion**

The study aimed to investigate the prevalence and antimicrobial resistance of Enterohemorrhagic Escherichia coli (E. coli O157) among children under five years old with diarrhea at the Enugu State University Teaching Hospital (ESUT). The findings reveal a significant public health concern, with 18% of the sampled children testing positive for E. coli O157. This prevalence is particularly alarming given the vulnerable nature of the pediatric population, which is at heightened risk for severe gastrointestinal infections [13].

#### **5.1 Clinical Presentation and Demographic Information**

Among the positive cases, a slightly higher prevalence was observed in females (21%) than males (15%). This gender disparity aligns with some existing literature that suggests biological and environmental factors may contribute to increased susceptibility in females [14, 15]. The age distribution of the positive cases indicates that the highest prevalence occurred in children aged 1-2 years (46.7%), emphasizing the need for targeted interventions for this age group, which is often more susceptible to infections due to factors such as developing immune systems and dietary changes [16].

On the other hand, clinical symptoms presented by the children included vomiting, fever, abdominal pain, and dehydration. These symptoms are consistent with E. coli infections and highlight the acute nature of the illness. The majority of the children presented with loose or watery stools (85.5%), further underscoring the severity of diarrhoea in this population. The high frequency of stooling, with 44.6% of the children stooling more than four times daily, necessitates prompt medical attention to prevent complications such as dehydration, which can be particularly dangerous in young children [17].

#### **Antimicrobial Susceptibility Patterns**

Antimicrobial susceptibility testing revealed critical insights into the resistance patterns of E. coli O157. While many strains exhibited sensitivity to multiple antibiotics, including gentamycin, ciprofloxacin, chloramphenicol, and meropenem, a concerning trend of resistance to commonly used antibiotics such as amoxicillin, streptomycin, and nitrofurantoin was also evident. This is consistent with some research evidence suggesting a need for a prompt public campaign against antimicrobial resistance among the paediatric population [18] For instance, one strain was sensitive to gentamycin (with a sensitivity rating of +++) and ciprofloxacin (rated +++), which are often considered first-line treatments for severe bacterial infections. However, the presence of resistance to other critical antibiotics, including ceftriaxone and meropenem- usually considered a last-line drug, raises alarms about the potential for treatment failures in clinical settings [18].

The data indicate that some strains were resistant to multiple antibiotics, complicating treatment options for pediatric patients. For example, one strain was sensitive to chloramphenicol and ofloxacin but resistant to a broad range of antibiotics, including meropenem and nitrofurantoin. This multidrug resistance not only poses a challenge for effective treatment but also highlights the need for ongoing surveillance of antimicrobial resistance patterns in the region [19].

#### **Environmental and Socioeconomic Factors**

The epidemiological patterns observed in the study reveal that a significant proportion of the children had no recent travel history or exposure to contaminated food and water, suggesting that local environmental factors may play a substantial role in the transmission of E. coli O157 as indicated by some research evidence [20]. Notably, 75.9% of the participants reported the presence of flies and rodents in their environment, which are known vectors for various pathogens, including E. coli. This finding underscores the importance of improving sanitation and hygiene practices in the community to mitigate the risk of infection [15].

Additionally, socioeconomic factors such as family size, parental education level, and access to clean water and sanitation facilities were explored. The data indicate that many families lacked adequate sanitation resources, which could contribute to the transmission of infections [20]. The presence of open sewage systems and proximity to livestock farms further exacerbate the risk, highlighting the need for public health initiatives aimed at improving living conditions in these communities [20].

The study's findings also point to the impact of socioeconomic status on health outcomes. Children from larger families or those with parents who have lower educational levels may be at increased risk for infections due to limited access to healthcare and education regarding hygiene practices [17]. The lack of access to clean water and adequate sanitation facilities further exacerbates the risk of infection, particularly in vulnerable populations such as young children [17, 20].

#### **Conclusion, Recommendation, and Public Health Implications**

In conclusion, this study reveals a concerning prevalence of E. coli O157 infections among children under five years old at ESUT, with significant implications for public health. The antimicrobial susceptibility patterns indicate a dual challenge: while some strains remain sensitive to critical antibiotics, the emergence of multidrug-resistant strains poses a serious threat to effective treatment. These findings underscore the urgent need for improved public health initiatives focused on enhancing sanitation and hygiene practices to reduce the incidence of E. coli infections.

The presence of resistant strains highlights the necessity for healthcare providers to be vigilant in their antibiotic prescribing practices. Empirical treatment protocols may need to be adjusted based on local resistance patterns to ensure effective management of infections. Furthermore, continuous monitoring of antimicrobial resistance is essential to inform treatment protocols and guide empirical therapy in pediatric patients.

Addressing the identified socioeconomic and environmental determinants is crucial for preventing future outbreaks and protecting children's health in Enugu, Nigeria. Public health campaigns should focus on educating families about the importance of hygiene practices, the safe handling of food, and the need for proper sanitation facilities. Additionally, interventions aimed at improving access to clean water and sanitation can significantly reduce the incidence of E. coli infections.

Future research should prioritize the exploration of the mechanisms behind antibiotic resistance in local strains of E. coli, aiming to develop targeted strategies for management and prevention. Understanding the genetic basis of resistance can inform the development of new therapeutic approaches and guide the use of existing antibiotics more effectively.

In summary, the findings from this study provide a crucial insight into the prevalence and antimicrobial resistance of E. coli O157 among young children in Enugu, emphasizing the need for comprehensive public health strategies to combat this pressing issue. By addressing the underlying environmental and socioeconomic factors, alongside vigilant monitoring of antibiotic resistance, we can work towards reducing the burden of E. coli infections and improving health outcomes for children in this vulnerable population

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