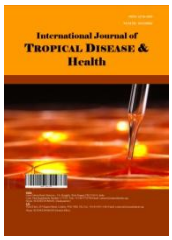

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Epidemiology of Pathogens Causing Urinary Tract Infections in Rural Communities of Enugu State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Urinary tract infection (UTI) is the infection of any part of the urinary tract, and about 150 million people worldwide develop UTI each year. Its is caused by bacteria, though fungi and viruses are etiologic agents, and can occur in community and hospital settings. This study was conducted to determine the epidemiology of pathogens causing urinary tract infections in Rural Communities of Enugu State, Nigeria. A total of 735 clean catch mid-stream urine samples were collected and

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tested for bacteriuria from February, 2021 to June, 2021. The participants were assessed clinically to ascertain eligibility for participation, and urine samples were assessed microbiologically to isolate pathogens causing UTI. Pathogens isolated were identified morphologically, and biochemically, and results were tabulated, with respect to participants demographics. Total number of participants that participated in urine culture was 735, of this number, 172(23.40%) were males, whereas 563(76.60) were females. 510(69.39%) were married whereas 225(30.61%) were single. Total number of bacterial isolates obtained was 649 (88.30%). Of this, Escherichia coli was the most prevalent, 316 (48.7%), followed by Staphylococci, 154 (27.7%). The least represented isolate was Pseudomonas, 2 (0.3%). Of the total number of isolates obtained, 151(23.27%) came from males, whereas 498 (76.73%) were from females. Total number of married participants with positive bacteriuria was 449 (69.18%), and those of them that were single constituted 198(30.51%). Age range of 31-40 gave the highest level of bacteriuria 151 (23.27%), followed by age range of 21-30, 146 (22.50%). The least representation of bacteriuria was seen among age group 10-20, 39(6.01%). The prevalent of UTI in this study was high, and females, youths, and married people showed a positive correlation with community acquired urinary tract infection. Intermittent screening of rural dwellers for positive bacteriuria, with emphasis paid on clinical symptoms and proper treatment will go a long way in tackling the menace of urinary tract infection in our rural communities.

Keywords: Epidemiology; pathogens; urinary tract infections.

1. INTRODUCTION

"Urinary tract infection (UTI) is the infection of any part of the urinary tract. The urinary tract consists of the kidneys, ureters, bladder and urethra. UTIs affect both the lower part of the urinary tract (the bladder and urethra), and the upper part (kidneys and ureters). It can occur in the community and hospital settings, causing serious morbidity and sequelae such as frequent recurrences, pyelonephritis with sepsis, renal damage, and pre-term birth, contributing to high social and health care costs" [1].

"About 150 million people worldwide develop UTI each year, with high social costs" [1], and "roughly eleven-million cases reported in the sole U.S. each year, the costs are estimated at $5 billion annually" (Foxman, 2014). "Although both men and women may become infected, the prevalence is more in women than in men. It is estimated that 40% of women develop at least one UTI during their lifetime" (Micali et al. 2014). In the Paediatrics, it is a common infection and can be particularly severe in infants aged less than 3 months (Shaikh, 2017). "A prompt diagnosis and appropriate treatment are essential to reduce the morbidity and sequelae following a UTI" [2].

"UTIs are mostly caused by bacteria, though other microorganisms such as fungi and viruses are rare etiologic agents" [3]. "Some studies carried out in the community have shown that Uropathogens such as *Escherichia coli* (46.4 - 74.2%), *Klebsiella spp.* (6.0 - 13.45%), *Proteus spp.* (4.7 - 11.9%) and *Enterococcus spp*. (5.3 - 9.54%) represent the main causes of UTI" [4]. *E. coli* has been indicated as the most frequent uropathogen involved in the community-acquired UTI [5] due to the fact of belonging to the normal flora of the human intestine and therefore easily colonizing the urinary tract.

This study was aimed at determining the prevalence of bacterial pathogens among individuals with community acquired UTIs in the rural communities of Enugu State, Nigeria, with respect to participants socio-demographic variables.

2. MATERIALS AND METHODS

2.1 Study Area

Study participants for this study were raised from three communities in the rural areas of Enugu State. Each of these communities were randomly selected from each of the three Senatorial Districts of Enugu State, using simple random sampling technique. They include: Enugu West, Enugu East, and Enugu North. The microbiological investigations were conducted in The Enugu State University of Science and Technology Teaching Hospital, and The University of Nigerian Teaching Hospital, Ituku/Ozalla, all in Enugu State.

2.2 Sample Size

This population-based, cross-sectional survey was conducted between February 2021 and

June, 2021 in Enugu state, Nigeria. A random sample of males and females aged 10-70 years residing in the selected communities within the three senatorial districts of Enugu state were selected.

2.3 Study Instruments

A well-structured questionnaire was used to collect data from the subjects on antibiotic usage, symptoms of UTI (pain or burning sensation at urinating; a feeling of urgency at urination; cramps or pain in the lower abdomen; the need to urinate more often than usual; urine that looks turbid and has foul smell; pain, pressure or tenderness in the area of the bladder and, back pain, chills, fever), physiological state, and some socio-demographic factors like, age and sex, in order to ascertain their suitability for either inclusion or exclusion.

Screw tight sterile universal containers (with Boric acid) were used to collect urine samples for bacterial isolation.

2.4 Inclusion and Exclusion Criteria

Subjects who represented at least three of the symptoms of UTIs, as outlined in the questionnaire, and who were neither on antibiotic therapy, nor have taken antibiotics within the last two weeks before the study, and women who met the above criteria, and who were not in their menstrual period, were included in the study.

Subjects excluded from the study were those who did not meet up with the criteria for inclusion and those who met the criteria for inclusion, but did not give their consent for participation.

2.5 Data/Sample Collection

Questionnaires were administered as self or by interviewer for the literate or illiterate respondents respectively. Subjects who met the inclusion criteria were educated on how to collect clean catch mid-stream urine aseptically, and thus were given urine bottles for sampling.Using a sterile, wide mouthed, and leak proof Boric acid universal containers, a total of 740 urine samples were collected from participants in the selected communities. The samples were pre-stored in a cooler, maintained at +2 to +6°C, using an ice pack, before transportation to testing site.

2.6 Urine Culture

A 10 µl (0.01 ml) well-mixed urine sample was inoculated on Sheep blood agar, Sheep chocolate agar, MacConkey agar (Oxoid, UK), and Chromagar ™ Orientation Media (M6: Plasmatec Laboratories, United Kingdom), and incubated at 37°C for 24 hours. The colony count with at least 10^5 CFU/ml for single midstream urine was taken as positive urine culture. All the isolates were preliminary screened by their colonial morphology, hemolytic reactions, pigment production, colour production on Chromagar ™ Orientation Media, and Gram reactions. These were followed by biochemical tests to identify the respective isolates. The following biochemical tests were used: Indole, Methyl red, Voges Proskauer, Citrate utilization, Urease, Oxidase, Catalase, Germ tube, and Bile esculin.

3. RESULTS

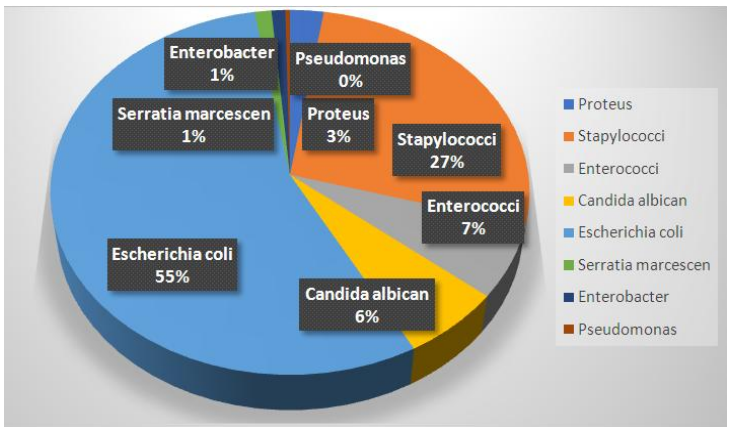

Fig. 1. Prevalence of pathogens causing UTI

Table 1. Summary of culture results

Number of samples	Frequency	Prevalence
Total number of participants recruited in the study, and who met the inclusion criteria	780	
Total number of participants that returned their urine bottles without urine	35	
Total number of urine bottles returned with urine	745	100%
Total number of urine specimen accepted for culture	735	98.66%
Total number of urine specimen rejected	10	1.34%
Total number of samples showing positive bacteriuria	649	88.3%
Total number of samples showing negative uropathogen (NBG and NSBG).	86	11.2%

Table 2. Biochemical reactions of the isolates

BCT	indole	Methyl red	Voges Proskauer	Citrate	Urease	Oxidase	Catalase	Germ tube
Isolates								
Klebsiella Spp.	-	-	+	+	+	-	+	NA
Proteus spp.	+	+	-	-	+	-	+	NA
Staphylococci	-	-	-	-	-	-	+	NA
Candida albican	NA	NA	NA	NA	NA	NA	NA	+
Escherichia coli	+	+	-	-	-	-	+	NA
Serratia marcescen	-	-	+	+	+	-	+	NA
Enterobacter	-	(-)	+	+	-	-	-	NA
Pseudomonas	-	-	-	+	-	+	+	NA
Enterococcus spp.	Catalase neg.		No hemolysis on sheep blood agar		Bile esculin test pos.			

Key: NA: Not applicable, BCT: Biochemical test.

Table 3. Socio-demographic characteristics of the participants from the questionnaire

Variable	Sub-category	Frequency	Percent
Age	10-20	42	5.4
	21-30	200	25.6
	31-40	199	25.5
	41-50	104	13.3
	51-60	114	14.6
	61-70	121	15.5
Sex	Male	172	22.1
	Female	608	77.9
Marital status	Married	648	83.1
	Single	132	16.9
Academic qualification	None	108	13.8
	FSLCE	153	19.6
	SSEC/GCE	247	31.7
	HND/BSc	246	31.5
	MSc	24	3.1
	PhD	2	0.3
Religion	Christian	778	99.7
	Islam	2	0.3
Occupation	None	51	6.5
	Student	111	14.2
	Farmer	88	11.3
	Trading	376	48.2
	Civil servant	152	19.5
	Clergy	2	0.3

A total of 780 participants responded to the questionnaire

Table 4. Socio-demographic characteristics of the participants who participated in urine culture

Variable	Sub-category	Freq	Prev. (%)	Kleb	Prot.	Staph.	Enterococci	Cand.	E. coli.	Serra	Enterobacter	Pseudo	Total
Age	10-20	52	7.07	12	NIL	9	NIL	3	14	NIL	1	NIL	39 (6.01%)
	21-30	165	22.45	28	NIL	20	5	6	83	NIL	3	1	146 (22.50%)
	31-40	175	23.81	19	1	27	10	12	78	3	1	NIL	151 (23.27%)
	41-50	143	19.46	9	4	33	9	9	64	4	1	NIL	133 (20.49%)
	51-60	115	15.65	5	5	46	6	4	37	NIL	NIL	NIL	103 (15.87%)
	61-70	85	11.56	4	4	19	7	2	40	NIL	NIL	1	77 (11.86%)
Sex	Male	172	23.40	19	2	35	14	1	78	1	1	NIL	151 (23.27%)
	Female	563	76.60	58	12	119	23	35	238	6	5	2	498 (76.73%)
Marital status	Married	510	69.39	65	10	98	22	20	227	4	2	1	449 (69.18%)
	Single	225	30.61	12	4	56	15	16	89	1	4	1	198 (30.51%)
Total: Gram positive: 227(34.98%) **Gram negative:422(65.02%)**				77 (11.9%)	14 (2.2%)	154 (23.7%)	37 (5.7%)	36 (5.5%)	316 (48.7%)	7 (1.1%)	6 (0.9%)	2 (0.3%)	649 (100%)

A total number of 780 participants were recruited for participation in the study. Of this number, 745 participants provided their urine samples for culture. Out of this number, 735 (98.66%) urine samples were accepted for culture, whereas 10 (1.34%) were rejected. Total number of samples showing positive bacteriuria was 649 (88.3%), whereas 86 (11.2%) showed negative result.

The table shows the distribution of various bacterial isolates and their prevalence. *E. coli* showed the highest prevalence (48.7%), followed by Staphylococci (23.7%). Klebsiella came third, with a prevalence of 11.9%. Pseudomonas showed the list prevalence of 0.3%.

3.1 Mean Age of Participants: 40 Years

Total number of participants that participated in urine culture was 735, of this number, 172(23.40%) were males, whereas 563(76.60) were females. 510(69.39%) were married whereas 225(30.61%) were single. Age range of 31-40 contributed the highest representation of participants, 175 (23.81%), followed by age range 21-30 (22.45%). The least represented was age range 10-20, 52 (6.01%). Total number of bacterial isolates obtained was 649 (88.30%). Of this, *Escherichia coli* was the most prevalent, 316 (48.7%), followed by Staphylococci, 154 (27.7%). The least represented isolate was Pseudomonas, 2 (0.3%). Of the total number of isolates obtained, 151(23.27%) came from males, whereas 498 (76.73%) were from females. Total number of married participants with positive bacteriuria was 449 (69.18%), and those of them that were single constituted 198(30.51%). Age range of 31-40 gave the highest level of bacteriuria 151 (23.27%), followed by age range of 21-30, 146 (22.50%). The least representation of bacteriuria was seen among age group 10-20, 39(6.01%).

4. DISCUSSION

This study determined the epidemiology of UTI, among participants from rural communities in Enugu State, Nigeria. A total number of 735 urine samples met our acceptance criteria for culture, hence they were cultured. These specimens were collected from participants aged 10-70, with a mean age of 40. Age range of 31-40 contributed the highest representation of participants, 175 (23.81%), and the least represented age range was, 10-20, 52(6.01%). There was more female's participation in this study 563 (76.6%), than males 172 (23.4%), and the prevalence of married participants 510 (69.39) was more than that of the singles 225(30.61).

Our analysis demonstrated that the prevalence of symptomatic community acquired UTI (CA-UTI) in this study was 735/649 (88.30%). This value is in conformity with a similar study performed elsewhere, in the south-east Nigeria, which yielded an overall prevalence of 89.17% [6]. However, the findings of this study are higher than those of similar studies: [7,8] which recorded prevalence of 43.6% and 59.2% respectively. A major factor which could have resulted to the wide variation observed in these results could be attributed to the selection of participants. While the present study focused on participants who represented at least, 3 of the major symptoms of UTI, these studies focused on both symptomatic and asymptomatic cases. The importance of symptomatic considerations in the diagnosis of UTI cannot be over emphasized. According to reports, the gold standard for the diagnosis of a urinary tract infection is the detection of the pathogen in the presence of clinical symptoms [9,10] (Salam et al. 2018). Differentiating UTI from asymptomatic bacteriuria, which usually requires no treatment in most age groups, can lower the frequency of unnecessary antibiotic prescriptions [11-15]. "Exposing patients to unnecessary antimicrobial therapy may select for and lead to subsequent infection with antimicrobial-resistant organisms, cause secondary infections (including *Clostridium difficile*) and is associated with increased risk of adverse effects and increased costs to the patient and health care system" (Salam et al. 2018).

Of the 735/649 (88.30%), that gave positive bacteriuria, 151 (23.2%) were from males, whereas 498 (76.73%) came from females, thus given a male/female ratio of 1:3.3. This finding supports the already known fact that UTIs generally affect females than males (Wei and Piotr, 2016). This is possible because females have wider and shorter urethra which is proximate to the anus, thus normal flora in feaces from the anus, can spread to the vagina from where it may ascend to the bladder, causing UTIs. This could be attributed to poor anal hygiene [16]. In addition, females lack prostatic fluid which acts as an antimicrobial agent in males. More so, females have moist and warm urethra which may support the growth of bacteria

than in males [17]. Furthermore, pathogens may easily be introduced into the urinary tract from the female reproductive system during sexual intercourse (Kurt, 2000).

Among the isolates, Gram-negative organisms constituted 422(65.02%), while Gram-positive organisms accounted for 227(34.98%). This is consistent with the report of a previous author who isolated 69% Gram-negative bacilli and 31% Gram-positive bacteria [18], from urine samples. *E. coli* was the most predominant isolate causing UTI in this study 316 (48.7%), followed by Staphylococci, 154 (27.7%), whereas *Klebsiella species* ranked third in prevalence 77 (11.9%). This is consistent with other studies [19,20] (Uwaezuoke and Ogbulie, 2006) and reiterates the fact that most organisms causing UTI are from the lower gastrointestinal tract. It is noteworthy that Enterococci was isolated more in the female (3.54%) population than male (2.16%), which can be likened to some predisposing factors, as reported earlier [16]. The least reported bacterium was Pseudomonas, 2 (0.3%).

Among the age groups, UTI occurred highest in the age group: 31–40 years, with a prevalence of 151 (23.27%), followed by age group: 21-30, 146 (22.5%), whereas the age range presenting the least bacteriuria was 10-20, 39 (6.01%). This is understandable because these age groups: (21-30, and 31-40), cover the very sexually active and prime reproductive years in both men and women, as sexual activity and pregnancy were reported to increase the risk of having UTI [21,22].

In terms of marital status, married participants yielded greater number of bacterial pathogens 449 (69.18%), than singles 198 (30.51%). “The findings of this study, represent a linear relationship with research finding, where age ≤19 years, female gender, married individuals, diabetes, genitourinary tract abnormalities, hospitalization, catheter, and increase in duration of catheter were found to bear statistically significant relationship with UTIs” (Martin et al. 2019).

5. CONCLUSION

In this study, the prevalence of CA-UTIs among rural dwellers in Enugu State, Nigeria, was high, and the consideration of symptomatic presentation was found to be of immense importance in the diagnosis of UTI. *Escherichia coli*, Staphylococci, and *Klebsiella species* were found to be the major causes of CA-UTIs. This study has demonstrated that female gender, youthful ages, and marriage, are the most important factors that have direct linear relationship with CA-UTIs.

6. RECOMMENDATION

We recommend routine UTIs screening of rural dwellers, with special emphasis paid to symptomatic presentations, before a diagnostic decision of UTI is made, more especially among the youths, females, and married people. This will help to detect early form of UTI, and initiate treatment, so as to prevent complications and reduce cost of treatment.

CONSENT AND ETHICAL APPROVAL

Ethical clearance for this study was obtained from The Enugu State University of Science and Technology Teaching Hospital, and The University of Nigerian Teaching Hospital, Ituku/Ozalla, where these studies were undertaken.

The study details were made known to the participants, and their consent, in the form of signature or thumbprint were obtained, before they were enrolled in the study.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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