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Article

Prevalence of urinary tract infections, associated risk factors, and antibiotic resistance pattern of uropathogens in young women at Noakhali, Bangladesh

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Abstract: Urinary tract infection (UTI) remains one of the most common infections among young females diagnosed in developing countries. The emergence of antibiotic resistance among uropathogens is a global problem. This study aimed to determine the prevalence and resistance of antibiotics to uropathogens, and to understand the relationship of uropathogens to multiple clinical, social and demographic factors of young female students in a university in Bangladesh. Four hundred freshly voided midstream urine samples collected from young female students and several clinical and socio-demographic variables along with UTI symptomatic queries were determined. Bacterial isolation was carried out by using standard and specific microbiological techniques and antimicrobial susceptibility pattern was determined by Kirby Bauer Disc diffusion method. Among the tested specimens, 106 (26.5%) has significant bacterial growth, 60 (57%) were symptomatic, and 46 (43%) were asymptomatic. The highest uropathogen was recorded within the age group of 24-25 years (51%). There was a significant association ($p < 0.05$) of uropathogen with anatomical abnormality of urinary tract, water sources for food preparation and bathing, and the number of person sharing the same toilet. Most predominantly isolated bacteria were *E. coli* (32.08%) followed by *Staphylococcus saprophyticus* (24.53%), *Streptococcus* spp. (16.04%), *Klebsiella* spp. (14.15%), *Aceinetobacter* spp. (4.72%), *Citrobacter* spp. (2.83%), *Enterobacter* spp. (2.83%), and *Pseudomonas* spp. (2.83%). In the effectiveness of each treated antibiotic, urinary pathogens were highly resistant towards nalidixic acid (80.19%), ampicillin (75.73%), cephalexin (70%) and azithromycin (68.48) while against imipenem (7.94%) and amikacin (18.87%) least resistancy were found. A good understanding of the etiology of uropathogens will assist the general practitioner to identify the correct therapeutic strategy for the proper management of UTIs.

Keywords: urinary tract infection; uropathogen; antimicrobial resistance; young females; risk factors; Bangladesh

1. Introduction

Urinary tract infection (UTI) is an infectious disease caused by actively multiplying microbial invasion of any of the urinary tract (UT) tissues. UTI is diagnosed using a combination of urinary symptoms and urine culture demonstrating numbers of a known uropathogen above a given threshold (usually defined as $>10^3$ CFU/ml of urine, but thresholds as high as 100,000 CFU/ml are also used) (Lee *et al*., 2020). UTI is the second most common infection worldwide and is considered the most common bacterial infection in humans. With nearly 150-250 million cases diagnosed each year in the community, it has reported that costing the global economy more than 6 billion US dollars only due to UTI (Dash *et al.*, 2013, Zowawi *et al*., 2015). Urinary tract infections have been reported at all ages, and in both sexes, with females being found to be four times more likely than males (Angami *et al*., 2015). The peak prevalence of UTI among teenagers is around 20% (Amali *et al.*, 2009), 25 to 30% incidence in females aged 20-40 years and ranges 4% to 43% in older females over 60 years of age (Mittal *et al.*, 2009). Previous studies in Bangladesh revealed that the prevalence of UTI in young females as 48.5% (21-30 years ages) in the outpatient department in a hospital (Moue *et al.*, 2015) , 32.25% (21-30 years ages) of patients attending Dhaka Dental College Hospital (Parveen and Rahim, 2017), 66.15% (15-32 years ages) in the northern part of the country (Hossain *et al*., 2017), and 77.78% (20-29 years ages) in garments worker (Begum *et al.*, 2006).

UTI is predominantly caused by Gram-negative bacteria like *Escherichia coli*, *Proteus* spp., *Klebsiella* spp., *Pseudomonas aeruginosa, Acinetobacter, Serratia* and *Morganella margani*. Gram-positive bacteria like *Enterococcus, Staphylococcus,* especially coagulase-negative Staphylococci, and *Streptococcus agalactiae* play a strong role causing UTI (Shaaban *et al.,* 2012). The prevalence of healthcare-associated urinary tract infections (HAUTIs) evaluated in regional studies ranges from 12.9% in the US, 19.6% in Europe, up to 24% in developing countries (Medina & Castillo-Pino, 2019). In the global prevalence study of infections in urology (GPIU) data, the distribution of the most frequently identified uropathogen included *Escherichia coli* (38.7%), followed by *Klebsiella* spp. (14.1%); *Enterococcus* spp. (12.7%); *Pseudomonas* spp. (10.4%); *Proteus* spp. (3.6%) and *Acinetobacter* spp. (3.6%), *Staphylococcus aureus* (2.9%), *Citrobacter* spp. (1.1%), coagulase-negative *Staphylococci* (1.1%), and others (9.1%) (Choe *et al*., 2018). UTI might be symptomatic or asymptomatic and recurrent as well as complicated or uncomplicated. Asymptomatic bacteriuria indicates significant bacteriuria (>10^5 CFU/ml) in a woman without symptoms such as dysuria, increased frequency of micturition, foul-smelling urine, suprapubic or lower abdominal pain, and backache. However, symptomatic bacteriuria is associated with the above clinical features and laboratory diagnosis (Davidson *et al*.,1991). The healthy individuals who do not have structural or functional abnormalities of the urinary tract, are not pregnant, or have not been instrumented (for example, with a catheter) are determined as uncomplicated UTI . All other UTIs are considered complicated (Foxman, 2010). Recurrent uncomplicated UTI is found due to bacterial re-infection or bacterial persistence, and recurrent UTI established if the patient suffers from 3 or more uncomplicated UTI occurrences within 12 months (Dason *et al*., 2011).

Additionally, increasing antimicrobial resistance is a major concern for UTIs. Semi-synthetic penicillin with or without inhibitors, ciprofloxacin, cephalosporins, nitrofurantoin, fosfomycin and trimethoprim/ sulfamethoxazole are common antibiotics which are used to treat UTI. Unfortunately, *E. coli* and other uropathogens became resistant to this antimicrobial (Hrbacek *et al*., 2020). A study of Haque *et al*., 2015 reported 75–100% resistance of *Pseudomonas spp.* to all other agents except nitrofurantoin. Whereas *Enterobacter spp.* revealed 50% resistance to nitrofurantoin, ceftriaxone, gentamycin, cefuroxime, and cefaclor but presented 100% resistance to all remaining antimicrobials. Haque *et al*., 2015 also reported multiple drug resistance (50% to 88%) of cefixime, ciprofloxacine, azithromycin, cefuroxime, cotrimoxazole and nalidixic acid against most prominent uropathogens in Bangladesh. Considering those facts, we have conducted a cross-sectional study to explore the prevalence of UTIs (symptomatic and asymptomatic), to evaluate antibiotic resistance pattern of the uropathogens, and the contribution of related risk factors in occurring UTI among university going young female in Noakhali, Bangladesh; which would eventually contribute taking empirical measures to reduce UTIs among young female in Bangladesh.

2. Materials and Methods

2.1. Sample selection

Female students attending different departments of the Noakhali Science and Technology University were selected for this study using a simple random sampling method. The university had a total of 7342 students, wherein 2656 were female (personal communication). It is one of the public universities located in the southeastern region of Bangladesh (www.nstu.edu.bd).

2.2. Ethical consideration

We have taken the university's institutional review board (IRB) approval before conducting the study. Written consents from participants have been taken before enrollment. The participants were informed about the merits and demerits of the study's participation and had the right to withdraw the consent at any time.

2.3. Data collection

All participants of the study interviewed with a preset questionnaire to gather clinical and socio-demographic data. The questionnaire covered several clinical features of UTI, including the presence of burning sensation or discomfort during urination, blood in urine, suprapubic tenderness, back pain, fever, chilling, the offensive smell in urination and vaginal irritation, and anatomic abnormalities of the urinary tract. Moreover, socio-demographic related risk factors including age, living conditions, number of persons using the same toilets, water sources for food preparation and bathing, marital status, and so on have been included in the questionnaire (Lane and Takhar, 2011).

2.4. Collection and processing of urine specimens

A 20-30 ml clean-catch voided midstream urine specimen was collected in sterile, labelled plastic containers with tight-fitting caps from the female students at their residence or laboratory. If specimens were collected from students' residence, it was transported to the laboratory maintaining cold chain (4ºC) (Lee *et al*., 2020). A semi-quantitative urine culture was done using a calibrated loop. A loopful (0.001 mL) of well-mixed un-centrifuged urine was inoculated onto the surface of MacConkey and blood agar media. All plates were then incubated at 37°C aerobically for 24 hours.

2.5. Determination of urinary tract infection (UTI) positive cases

A UTI positive case has been determined if the number of the colony was $\geq 10^4$ CFU/mL of a single uropathogen (*E. coli*, *Klebsiella* spp., *Proteus* spp., Enterobacteria, *Enterococcus fecalis*, *Staphylococcus saprophyticus*, *Streptococcus* spp., and so on) found on a urine culture plate. The UTI positive cases were also classified as "high burden growth" ($>10^5$CFU/ml) and "intermediate bacterial growth" (10^4 to $\leq 10^5$ CFU/mL) (Hawn *et al*., 2009; Obstetricians & Gynecologists, 2008; Rosen *et al*., 2007). Colonial appearance and morphological characters of isolated bacteria were noted, and isolated colonies were subjected to preliminary tests like Gram staining, motility by hanging drop, catalase test and oxidase test. These preliminary tests were followed by biochemical reactions to identify the isolated organisms (Murray *et al*., 2007). The identified organisms then subjected to antibiotic susceptibility testing.

2.6. Antimicrobial susceptibility testing

Antimicrobial susceptibility testing has been done according to the Kirby-Bauer disc diffusion method on Mueller–Hinton agar (Oxoid, UK) following the Clinical Laboratory Standards Institute guidelines 2018 (CLSI, 2018).The antibiotic discs of Cephalexin (30 µg), Nitroflurantoin (300 µg), Nalidixic Acid (30 µg), Cefixime (5 µg), Ceftriaxone (30 µg), Cotrimoxazole (25 µg), Azithromycin (15 µg), Ampicillin (25 µg), Amikacin (30 µg), Ciprofloxacin (5 µg), Gentamicin (10 µg) and Norofloxacin (10 µg) were used in this study.

2.7. Statistical analysis

For statistical analysis of the data, a bivariate table was constructed, and a Chi-square test has been performed to find out the significance of the association between UTI and different risk factors; and as a multivariate analysis, we performed binary logistic regression to find the impact of independent variables on UTI. All the analysis has been done at a 5% level of significance using Statistical Package for the Social Sciences (SPSS) software version 25 (SPSS Inc, Chicago, IL, USA). All statistical test values of $p < 0.05$ were considered statistically significant (Rahman *et al*., 2021).

3. Results

We have invited 617 female students in this study following a simple random sampling method; among them, 400 (65%) of them agreed to provide a urine specimen and take part in the survey. Bacteriological cultures of urine specimens revealed that 26.50% (106/400) of the participants were found with UTI. Among UTI positive cases, 46 (43%) were found as high burden growth ($>10^5$ CFU/mL), and 60 (57%) of them as intermediate burden growth (10,000-100,000 CFU/mL).

The most frequent causative organisms of UTI were *E. coli* (32.08%), followed by *S. saprophyticus* (24.53%), *Streptococcus* spp. (16.04%), and *Klebsiella spp.* (14.15%). Other less frequent bacterial isolates were *Acinetobacter* spp. (4.72%), *Citrobacter* spp.(2.83%), *Enterobacter* spp.(2.83%), and *Pseudomonas* spp.(2.83%)

(Figure 1). In this study, the occurrence of UTI was ranged from between 18 to 26 years old. The highest numbers of UTI were found within the age range of 24-25 years (51%) (Figure 2). In terms of presenting either any UTI symptoms based on the survey data, 60 (57%) of the UTI positives cases were found as symptomatic, and 46 (43%) were asymptomatic.

Besides, we found several socio-demographic risk factors such as "anatomical abnormalities in the urinary tract" ($p < 0.05$), "water used for food preparation and bathing" ($p < 0.05$), and "number of person sharing the same toilet" ($p < 0.05$) were found as significantly associated with the development of UTIs according to bivariate analysis. In particular, 66.67% (8/12) of participants with anatomical abnormalities of the urinary tract and 25.25% (98/388) of participants with non-anatomical urinary tract abnormalities were developed urinary tract infections. In addition, most of the study participants used supply water (centrally processed water supplied through the municipal pipeline) to prepare their food and for bathing purposes. In this case, UTIs were found in 29.94% (97/324) of "supply water" users and 11.84% (9/76) of groundwater users, respectively. Furthermore, the participants had to share the same toilets as 1-5, 6-10, 11-15, 16-20, >20 persons have found with UTI as 2.5% (1/40), 10.34% (3/29), 20.59% (7/34), 21.43% (6/28), and 33.09% (89/269), respectively (Table 1).

Determining the antibiotic resistance patterns of UTI isolates is essential to initiate prompt treatment of UTIs. Altogether, UTI pathogens in this study showed the highest resistance to the penicillin (ampicillin) group (75.73%, 78/103), wherein all isolates of *Enterobacter* spp. and *Pseudomonas* spp. were found resistant, and 93.3% of *Klebsiella* spp., 88.23% of *E. coli*, 84.6% of *S. saprophyticus* and 17.65% of *Streptococcus* spp. also found resistant to the antibiotic. All tested isolates showed resistance to amikacin and gentamicin in the aminoglycosides group as 18.87% (20/106) and 46.23% (49/106), respectively. *Staphylococcus saprophyticus* (38.5%), *Acinetobacter* spp. (20%), *E. coli* (14.71%), and *Klebsiella* spp. (13.3%) showed resistance to the amikacin. On the contrary, *Pseudomonas* spp. (66.6%), *Acinetobacter* spp. (60%), *S. saprophyticus* (57.7%), *E. coli* (55.88%), *Klebsiella* spp. (40%), *Citrobacter* spp. (33.33%), and *Streptococcus* spp. (17.64%) found resistance to gentamicin.

In the macrolide group, 68.48% (63/92) isolates showed resistance to azithromycin. Wherein 88.8%, 80%, 73.52% and 42.3% of *Streptococcus* spp., *Klebsiella* spp., *E. coli* and *Staphylococcus saprophyticus,* respectively found resistant to the antibiotic. Of all the antibiotics tested, nalidixic acid in the quinolone family found with the highest resistance (80.19%, 85/106) by the isolates. Whereby 100% of *Enterobacter* spp., 96.2% of *Staphylococcus saprophyticus,* 82.35% of *Streptococcus* spp. and *E. coli*, 73.3% of *Klebsiella* spp, 66.6% of *Pseudomonas* spp., and 40% of *Acinetobacter* spp. showed resistance to the antibiotic.

Within the fluoroquinolone family, all isolates of *Enterobacter* spp. and *Citrobacter* spp. showed resistance to ciprofloxacin, whereas, 73.53% of *E. coli*, 66.6% of *Klebsiella* spp., 60% of *Acinetobacter* spp., 57.7% of *Staphylococcus saprophyticus, 33.3%* of *Pseudomonas* spp., and 17.64% of *Streptococcus* spp. found resistant to the particular antibiotic. Furthermore, 100% *Pseudomonas* spp., 60% *Klebsiella* spp., 33.33% *Enterobacter* spp. and *Citrobacter* spp., 20% of *Acinetobacter* spp., 17.65% *Streptococcus* spp., 15.4% *S. saprophyticus* and 11.76% *E. coli* were resistant to nitrofurantoin. Against norfloxacin, *Enterobacter* spp. (100%), *Citrobacter* spp. (100%), *Klebsiella* spp. (60%), and *S. saprophyticus* (30.8%). found resistant to this particular antibiotic.

The uropathogens of this study showed high level of resistance to the first-generation cephalosporins (Cephalexin). Significantly, 100% of the *Acinetobacter* spp., *Pseudomonas* spp. and *Citrobacter* spp. were found resistant to the antibiotic followed by *Klebsiella* spp. (93.33%), *E. coli* (91.18%), *Enterobacter* spp. (66.67%), *S. saprophyticus* (38.5%), and *Streptococcus* spp. (35.29%). Moreover, *Pseudomonas* spp. (100%), *Acinetobacter* spp. (80%), *Streptococcus* spp., (64.71%), and *S. saprophyticus* (50%) also found resistant to the third generation of cephalosporin (cefixime). Furthermore, 67.65% of *E. coli,* 66.67% of *Citrobacter* spp., 60% of *Klebsiella* spp, 33.3% of *Pseudomonas* spp., 30.8% of *S. saprophyticus,* 29.41% of *Streptococcus* spp. and 20% of *Acinetobacter* spp. showed resistance to the another third-generation cephalosporin (Ceftriaxone).

In the case of the sulfonamide group (cotrimoxazole), *S. saprophyticus* (76.9%), *Pseudomonas* spp. (66.67%), *E. coli* (61.76%), *Acinetobacter* spp. (60%), *Klebsiella* spp. (53.3%), *Enterobacter* spp. (33.3%), and *Streptococcus* spp. (11.76%). On the other hand, 11.76% of *E. coli,* and 6.67% of *Klebsiella* spp. isolates were found resistant to imipenem, a carbapenem goup antibiotic (Table 2).

Table 1. Association of clinical and socio demographics variables with UTI positive isolates.

Variables	No of sample tested	Positive UTI cases	Percentages of positive UTI cases (%)	P- value
Age				
18-20	80	18	22.5%	**0.72469**
21-23	131	34	25.95%	
24-26	189	54	28.57%	
Marital status				
Unmarried	362	101	27.90%	**0.11638**
Married	38	5	13.16%	
Living condition/residency				
Hall	382	105	27.49%	**0.08679**
Home	18	1	5.56%	
Number of person sharing the same toilet				
1-5	40	1	2.5%	**0.0047551***
6-10	29	3	10.34%	
11-15	34	7	20.59%	
16-20	28	6	21.43%	
>20	269	89	33.09%	
Water sources for food preparation and bathing				
Supply water	324	97	29.94%	**0.01007***
Ground water	76	09	11.84%	
Anatomical abnormality of urinary tract				
Yes	12	8	66.67%	**0.03265***
No	388	98	25.25%	

* Significant at $p<0.05$.

Table 2. Antimicrobial resistance (R) pattern of isolated uropathogens (n = 106).

Microorganisms identified	AMP (%)	AK (%)	GEN (%)	AZM (%)	NA (%)	CIP (%)	NIT (%)	NOR (%)	CL (%)	CFM (%)	CTR (%)	COT (%)	IMP (%)	Mean (%)
	R	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**
S. saprophyticus (n=26)	84.6	38.5	57.7	42.3	96.2	57.7	15.4	30.8	38.5	50	30.8	76.9	NA	50
Streptococcus spp. (n=17)	17.65	11.76	17.64	88.8	82.35	17.64	17.65	NA	35.29	64.71	29.41	11.76	NA	35.29
E. coli (n=34)	88.23	14.71	55.88	73.52	82.35	73.53	11.76	NA	91.18	NA	67.65	61.76	11.76	55.89
Klebsiella spp.(n=15)	93.3	13.3	40	80	73.3	66.6	60	60	93.33	NA	60	53.3	6.67	60
Aceinetobacter spp. (n=5*)*	80	20	60	NA	40	60	20	NA	100	80	20	60	0	40
Enterobacter spp. (n=3)	100	0	0	NA	100	100	33.33	100	66.67	0	0	33.33	0	33.33
Pseudomonas spp. (n=3)	100	0	66.6	NA	66.6	33.3	0	NA	100	100	33.3	66.67	0	33.33
Citrobacter spp. (n=3)	NA	0	33.33	NA	0	100	33.3	100	100	NA	66.67	100	0	66.67
Total, n=106	75.73 (78/103)	18.87 (20/106)	46.23 (49/106	68.48 (63/92)	80.19 (85/106)	59.43 (63/106)	21.7 (23/106)	48.94 (23/47)	69.8 (74/106)	57.41 (31/54)	46.23 (49/106)	56.6 (60/106)	7.94 (5/63)	

[NB (Nota Bene) : Resistance (R), Not applied (NA), Ampicillin (AMP), Amikacin (AK), Gentamicin (GEN), Azithromycin (AZM), Nalidixic Acid (NA), Ciprofloxacin (CIP), Nitroflurantoin (NIT), Norfloxacin (NOR), Cephalexin (CL), Cefixime (CFM), Ceftriaxone (CTR), Cotrimoxazole (COT), Imipenem (IMP)]

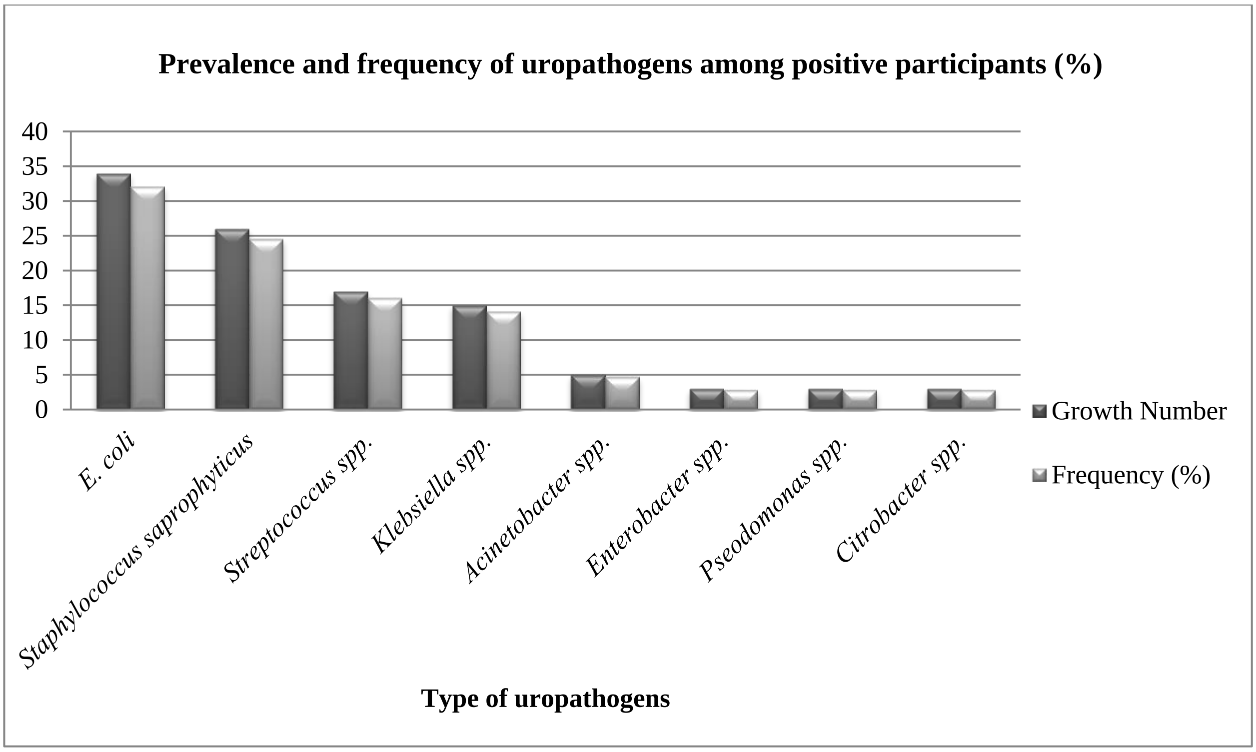

Figure 1. Prevalence and frequency of uropathogens.

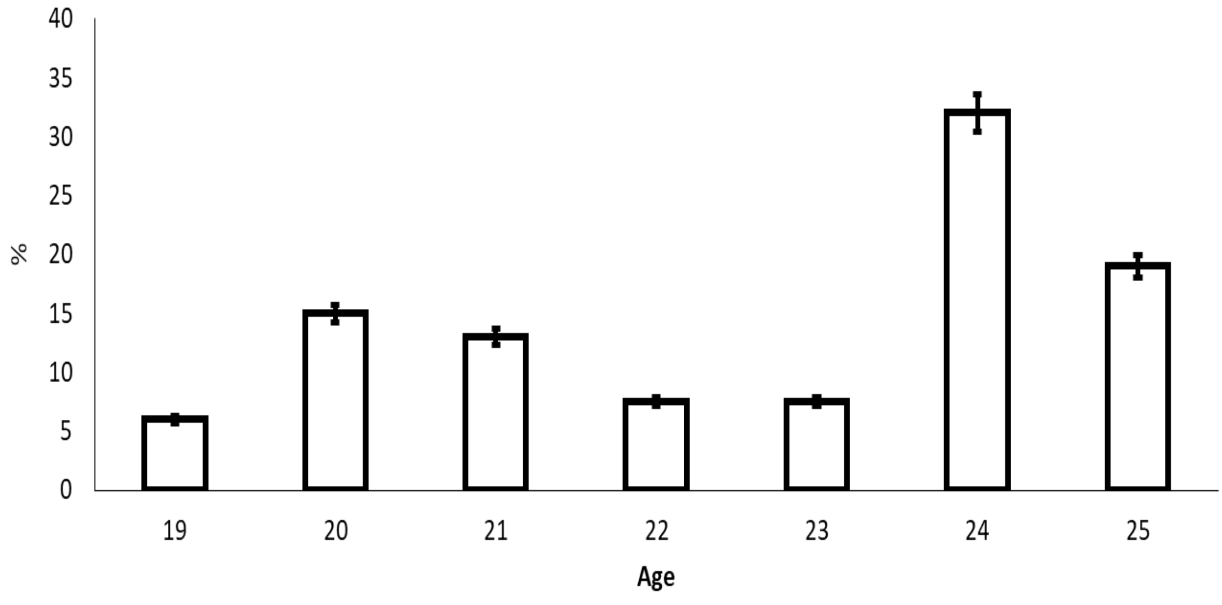

Figure 2. Age wise distribution of UTI positive samples and their percentages.

4. Discussion

It has been usually observed that UTI most commonly occurs in the female and up to 50% of all women experience a UTI at some point during their lifetime (Jung and Brubaker, 2019). In this study, since out of 400 samples processed, 106 (26.5%) yielded significant microbial growth, and 26.5% prevalence rate was obtained. This is consistent with prevalence rates of 24.14% and 27% obtained by others authors in Bangladesh (Bashar *et al*., 2009; Rahman *et al*., 2009). It is on record that lower rates of 9% and 16.4% in Bangladesh and 12.7% in India, have been reported by some authors (Ahmed *et al*., 2008; Begum *et al*., 2006, Rahman *et al*., 2014). Other previous authors recorded higher UTI prevalence rates of 32.25%, 48.5%, and 66.15% in Bangladesh (Hossain *et al*., 2017; Moue *et al*., 2015; Parveen and Rahim, 2017). The high or low UTI incidence rates may be attributed due to the subjects residing environmental condition. This may also be attributed to the lack of proper personal and environmental hygiene, low socio-economic status, sexual intercourse or sexual promiscuity, pregnancy etc. (Otajevwo and Eriagbor, 2014). A study by Sobel, 2014 reported that up to 60% of study participants experience at least one symptomatic UTI amid their lifetime and around 10% of women in the United States have one or more episodes of symptomatic UTIs each year. Our study also reported that a majority of the participants with UTI were symptomatic (60, 57%). It was also observed that the prevalence of infection increased with the age (51% at 24-25 years age), this could be possibly due to increased sexual activity in this specific age group (Seifu and Gebissa, 2018). However, this observation endorse the study conducted by Moue *et al*., 2015 which reported prevalence rates were 75.0% and 39.0% followed by the age group 15-23 years and 24-27 years respectively. Previously, Muhammad *et al*., 2020 also reported that the prevalence of UTI in the age group of 18-29 years were 24.8% from outpatients department at tertiary care hospital in Pakistan.

Our study revealed that *E. coli* (32.08%) was the most dominant UTI-causing bacteria and this finding is comparable with a previous study (31.5%) in India (Subramanian *et al*., 2011). However, The present report does not agree with the results of other studies in Bangladesh where relatively higher rates of *E. coli* (59.30%-92.30%) has been documented (Haque *et al*., 2015; Parveen and Rahim, 2017; Rahman *et al*., 2009; Rahman *et al*., 2014; Yasmeen *et al*., 2015). The second most frequent uropathogen in our study was *Staphylococcus saprophyticus* (24.53%). But the report in this study does not agree with a previous study in Bangladesh which recorded the isolate as 7.5% (Moue *et al*., 2015). Another third common uropathogen in our study was *Streptococcus* spp. (16.04%). The rate of the finding is in agreeable with data of previous study which reported the isolate as 15% (Rahman *et al.*, 2014). A previous study of Yasmeen *et al*., 2015 in Bangladesh however does not agree with the finding which reported the isolate as 2.20%. Other uropathogens isolated in the study were *Klebsiella* spp. (14.15%), *Aceinetobacter* spp. (4.72%) *Citrobacter* spp. (2.83%) and *Enterobacter* spp. (2.83%) which are consistent with findings of previous studies in Bangladesh (Rahman *et al*., 2009; Yasmeen *et al*., 2015). Besides, the low occurrence of *Pseudomonas* spp. (2.83%) in this study is found consistent with a low incidence (2.01%- 4.39%) of isolates reported in earlier studies in Bangladesh (Haque *et al*., 2015; Hossain *et al*., 2017; Parveen and Rahim, 2017). Moreover, a higher incidence (7-11.3%) of isolates were recorded in other similar UTI investigations in the previous studies in Bangladesh (Moue *et al*., 2015; Rahman *et al*., 2014).

Furthermore, we assessed the relationship between several risk factors and UTI. One of the observed factor in this study was anatomical abnormalities of the urinary tract of the participants and the result indicated that prevalence was higher in participants who have anatomical abnormalities than who does not. Previously, Golan *et al*., 1989 has shown that incidence of UTI was found to be higher in anatomical abnormalities of urinary tract in women. The present study also observed that women who were using supply water (purified groundwater supplied through the municipal pipeline) for bathing and cooking purposes for a long period of time had more probability of having UTI than those who were using groundwater (directly from tube-well). Comparatively, this study denies the quite similar study reported in previous investigation of Andersen *et al*., 2019 who showed that pump water is responsible for UTI more than in short well water using participants. Since supply water is treated centrally, so it is thought to be much cleaner, and residents are not encouraged to boil before using. There have some possible explanations for this finding; leakage of water pipes can also allow potentially harmful contaminants to enter supply water (Rahman *et al.,* 2021). Besides, due to staying in crowded hostels, poor sanitary conditions especially in their toilets is most probably the important risk factors for UTI in our study. Because, the prevalence of infection is higher among the participants, share the same toilet over crowdedly in their university residence (Table 2). Similar results were seen among the students from government universities in Nigeria reported by Onyebueke *et al.,* 2020. The study of Paudel *et al*., 2018 also reported that the unavailability of toilet facilities was a significant risk factor for UTI occurrence. Most probable reasons are the unclean state of residences, careless and dirty habits among the students, as well as damaged toilets and bathrooms that may increase the UTI incidence. Besides, Improper use of the toilet may lead to an infections as female urine is forcibly excreted and creates great splashes which can re-introduce pathogenic organisms from the environment into their urinary opening (Amali *et al*., 2009).

Antimicrobial resistance of urinary pathogens has become a public health concern in Bangladesh. Within the study, the most predominant *E. coli* isolate showed the resistance more than 50% of all applied antibiotics except imipenem (11.76%), nitrofurantoin (11.76%), and amikacin (14.71%). Similar to our findings, a study by Dasgupta *et al.,* 2020 reported a high level of resistance to cefixime, ceftriaxone, gentamicin, ciprofloxacin and azithromycin in *E. coli* isolated from tertiary care hospital patients located in Bangladesh. Similar results were also seen among patients from another teaching hospital in Bangladesh as amoxicillin, cephalexin, cefixim, ceftriaxone, nalidixic acid and cotrimoxazole resistant *E. coli* reported by Haque *et al*., 2015. *S. saprophyticus*, the second most predominant in the present study, showed the highest resistance to nalidixic acid (96.2%), ampicillin (84.6%), and cotrimoxazole (76.92%). This results were consistent for nalidixic acid, cotrimoxazole and ampicillin with other studies from hospital patients in previous studies in Bangladesh (Haque *et al*., 2015; Moue *et al*., 2015). The third most prevalent isolate *Streptococcus* spp. were showed the highest resistance to nalidixic acid (88.8%) and azithromycin (82.88%). A study by Lee *et al*., 2020 showed consistent results for Beta hemolytic Streptococcus but a different finding was documented in the review report in another recent study where the source of the pathogen was ambiguous due to lack of information (Ahmed *et al*., 2019). Another common isolate *Klebsiella* spp. from the present study revealed high resistance (53.3% to 93.3%) to all applied antibiotics except for imipenem (6.67%), amikacin (13.3%), and gentamicin (40%). This result has similarity with the result of recent and previous investigation in Bangladesh, as ampicillin, nalidixic acid, ciprofloxacin, nitrofurantoin, norfloxacin, cephalexin, ceftriaxone and cotrimoxazole resistance to *Klebsiella* spp. reported by several authors (Dasgupta *et al*., 2020; Haque *et al*., 2015; Moue *et al*., 2015; Parveen and Rahim, 2017; Rahman *et al*., 2009). However, the present study reported all *Acinetobacter* spp. were highly resistant to ampicillin (80%), gentamicin (60%), nalidixic acid (40%), ciprofloxacin (60%), cefixime (80%), and cotrimoxazole (60%). A study conducted by Rahman *et al*., 2009 showed consistent results for these particular antibiotics but ciprofloxacin. And our data showed all the *Enterobacter* spp. were resistant to ampicillin, nalidixic acid, ciprofloxacin, norfloxacin, apart from cephalexin (66.67%), but the result of resistances is comparatively higher than previous studies reported from Bangladesh (Dasgupta *et al*., 2020; Haque *et al*., 2015; Moue *et al*., 2015; Rahman *et al*., 2009). Besides, all *Pseudomonas* spp. showed resistance to ampicillin, cephalexin, and cefixime, 66.67% of those were resistant to gentamycin, nalidixic acid, and cotrimoxazole. This finding correlates with the previous studies on hospital patients in Bangladesh (Dasgupta *et al*., 2020; Haque *et al*., 2015; Rahman *et al*., 2009).This study also showed that isolates of *Citrobacter* spp. were 100% resistant to cotrimoxazole, and ciprofloxacin, which is relatively different from a previous study where showed resistance to cotrimoxazole and ciprofloxacin were 50% (Rahman *et al*., 2009).

Altogether, the results also revealed that among thirteen antibiotics used for resistance test, imipenem was the less resistance antibiotics 7.94% followed by amikacin (18.87%), and nitrofurantoin (21.7%) in the current setting which is consistent with our previous reports and other recent studies (Dasgupta *et al*., 2020; Demir and Kazanasmaz, 2020; Haque *et al*., 2015; Majumder *et al*., 2014, Pirkani *et al*., 2020). This might be due to the fact that imipenem is offered in injection form and its unavailability in tablet form in the community, minimized the chance to abuse (Seifu and Gebissa, 2018). Moreover, the isolates showed a high degree of resistance (around 50-80%) toward most of the remaining antibiotics of penicillin, macrolide, quinolone, cephalosporins, sulfonamide, and ciprofloxacin. Due to the lack of rational use these molecules have lost its effectiveness (Haque *et al*., 2015; Majumder *et al*., 2014). In addition, empirically use of antibiotic treatment in patients with a suspected condition usually begins before urine culture results are available, leading to the emergence and spread of antimicrobial resistance strains. Failure to treat infectious diseases with these antimicrobial agents is one of the main causes of antimicrobial resistance (Gupta *et al*., 2013).

According to Infectious Diseases Society of America (IDSA) guideline in 2011, if the prevalence of resistance against an antibiotic is more than 20% then the particular antibiotic is no longer used for empirical treatment of acute UTI (Colgan and Williams, 2011). Unfortunately, with the exception of imipenem and amikacin (<20%), most of the antibiotics used in our study, showed resistance (>20%) to treated antibiotics, thus they should not be used for empirical treatment of acute UTI according to standard treatment. However, several evidences of *in-vitro* antimicrobial susceptibility tests may help in selecting effective therapies to reduce the risk of this alarming resisatnce situation as there is shortage therapeutic options. Further, Centers for Disease Control and Prevention (CDC) recommended Antibiotic Stewardship Programs (ASPs) in hospitals which can help the clinicians optimizing the use of antibiotics to UTIs, and combat antibiotic resistance (https://www.cdc.gov/antibiotic-use/healthcare/pdfs/hospital-core-elements-H.pdf). Therefore, continuous monitoring of the prevalence and pattern of antimicrobial susceptibility of uropathogens is extremely important not only for appropriate drug selection but also for rational selection of empirical therapy (Bouza and Cercenado, 2002).

5. Conclusions

The pattern of UTI causing bacteria does not differ much in different settings, but increasing antimicrobial resistance to urinary tract pathogens is a major concern for developing and under developed countries. However, both imipenem and amikacin are optimistic in the treatment of severe cases UTI and their use should therefore be limited. In addition, The University authority should take appropriate steps to check the water pipeline on a regular basis and of course students should be encouraged to maintain personal hygiene and clean toilet facilities must be ensured. Moreover, antimicrobial susceptibility tests should be performed along with routine surveillance and studies should be monitored to administer an appropriate antibiotic in order to prevent the cases becoming symptomatic later with resultant renal damage.

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Conflict of interest
None to declare.

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