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RESEARCH ARTICLE

PREVALENCE OF URINARY TRACT INFECTIONS, AETIOLOGY, ASSOCIATED RISK FACTORS, AND DIETARY ADHERENCE ON OCCURRENCE OF URINARY TRACT INFECTIONS IN DIABETIC PATIENTS

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Abstract

Background and Aims: Urinary tract infections (UTIs) impact an estimated 150 million people worldwide each year, with diabetes making up a sizable portion of those afflicted. The prevalence and contributing variables of urinary tract infections among patients with diabetes mellitus in the medical ward at Al-Kwait University Hospital in Sana'a, Yemen, were evaluated as part of the study.
Materials and Methods: In this cross-section study, 454 DM patients, referred to the medical ward at Al-Kwait university hospital clinics in Sana'a, Yemen. A urine culture was performed by collecting a clean, sterile urine sample (midstream urine) then culturing it, and isolating and identifying the causative bacteria. For collecting data, a standard questionnaire was used that included clinical, demographic, and risk factor information of UTI in DM.
Results: The mean patient age was 48.2 years, with 73.1% being ≥ 40 years old. The crude prevalence of urinary tract infections (UTIs) in diabetic patients was 21.8%, higher in males (27.03%) than females (17.6%). The highest prevalence was in age groups 30-39 years (48.2%) and 20-29 years (47.4%), while the lowest was in those ≥ 40 years (16.3%) and under 20 years (19.2%). Common pathogens included *Escherichia coli* (42.3%) and *Klebsiella pneumoniae* (34%).
Conclusion: The study concluded that 99/454 (21.8%) of diabetic patients had urinary tract infections (UTIs). Therefore, the study recommends providing health education to diabetic patients about the causes of UTIs and how to prevent them.
Keywords: Diabetes mellitus, risk factors, Sana'a, UTIs, Yemen.

INTRODUCTION

Due to elevated blood sugar levels that foster bacterial growth, a compromised immune system, and nerve loss (neuropathy), diabetics are more vulnerable to urinary tract infections (UTIs). Incomplete bladder emptying may arise from this, making infections more severe, complex, and recurrent. Both usual (frequent, urgent, burning) and atypical symptoms are possible, and infections are frequently more serious, necessitating quicker and longer antibiotic regimens. Additionally, they may result in severe side effects like sepsis or kidney infection (pyelonephritis). Increased blood glucose levels, decreased insulin production, and various degrees of insulin resistance are the hallmarks of diabetes mellitus (DM). Urinary tract infections are common in diabetics because of a compromised immune system brought on by decreased cellular responses[1,2]. An estimated 150 million people globally are thought to get UTIs each year, and a sizable percentage of these individuals have diabetes[3]. According to 2025 World Health Organisation research, the number of persons with diabetes has dramatically increased, and during the next 20 years, this trend is predicted to continue.

In Yemen, many people with diabetes are susceptible to urinary tract infections due to inadequate diabetes management protocols, as their weakened immune

systems are less effective at eliminating the pathogens that cause UTIs[4]. Poor metabolic management has also been associated with a higher risk of UTIs in diabetics[5,6]. A study on the National Survey of Infection Prevalence in Hospitals in Algeria by Huntington *et al.*[7], found that 26% of women over 60 had both diabetes and UTIs. A study on the diagnosis and treatment of UTIs by Jonathan *et al.*[8], found that the microorganisms causing UTIs in diabetic individuals were different from those causing UTIs in non-diabetic patients. In particular, compared to the microorganisms causing urinary tract infections in patients without diabetes, the pathogens causing urinary tract infections in 79% of all diabetic patients were more resistant to the medicines given[9,10].

E. coli was the most common organism causing urinary tract infections in both diabetes and non-diabetic patients[11-13], according to a study by Tumuhimbise *et al.*[14], on microbial aetiology and susceptibility to the asymptomatic bacteriuria among diabetic moms. In this study, UTIs were identified in 6% of all hospitalised diabetes patients. A high prevalence of diabetes probably corresponds with a high frequency of UTIs because UTIs are the most common cause of disease among diabetic people[15-18]. According to a CDC study on diabetes diagnosis, 54% of patients had increased urine glucose production, which encouraged the growth of harmful bacteria and caused UTIs. Pathogens that cause UTIs can flourish and colonise the urinary tract since these patients already have weakened immune systems. In order to create treatment approaches, this study will emphasise the factors linked to urinary tract infections in diabetic individuals. Additionally, despite the fact that many research on diabetes in Yemen have been carried out in the past, none of them have clearly identified the factors linked to urinary tract infections in diabetic patients; this study will help close this communication gap.

SUBJECTS AND METHODS

An active prospective follow-up research was the methodology used. The study was intended for all patients who agreed to participate and were seen in the medical ward at Al-Kwait University Hospital in Sana'a, Yemen between January 1, 2024, and December 31, 2024. 454 participants with a diagnosis of diabetes mellitus were enrolled in the study during its duration. Between the ages of 10 and 75, there are 199 males and 255 females, with a mean age of 48.2± 16.2 years. For every DM, clinical and demographic information as well as variables influencing UTIs were gathered. A urine sample was then collected (midstream). The samples were subsequently cultivated aerobically in blood agar and MacConkey agar, and the cultures were checked for important potential UTI bacterial pathogens.Possible bacterial pathogens were isolated and identified by standard laboratory techniques, and microbial sensitivity testing was carried out by disc diffusion method as described by Clinical and Laboratory Standards Institute (CLSI)[19].

Ethic consideration: Patients provided informed consent, and the study was authorised by the Ethics Committee of Sana'a University's Faculty of Medicine and Health Sciences (document number: 2023-35, dated January 25, 2023).

Data analysis

A statistical significance software version (Epi Info version 6, CDC, Atlanta, USA) was used to analyse the data. After calculating the first rates, the independence odds ratios from two-by-two tables were computed, and the uncorrected chi square test was used to establish the *p* value. For the small predicted cell sizes with a two-tailed probability value, Fisher's exact test was employed.

RESULTS

Table 1 show the gender and age distribution of 454 diabetic patients who underwent urinary tract infection testing in Sana'a. The mean age±standard deviation was 48.2±16.2 years, and the patients' ages ranged from 10 to 75 years. The majority of patients were in the ≥ 40 years age group (73.1%), followed by the 30-39 years age group at 12.3%.

Table 1: Sex and age distribution of 454 diabetic patients tested for UTI in Sana'a city.

Characters	Number (%)
Sex	
Male	199 (43.8)
Female	255 (56.2)
Total	454
Age in Years	
Less than 20 years	47 (10.4)
20 -29 years	19 (4.2)
30 – 39 years	56 (12.3)
≥ 40 years	332 (73.1)
Mean	48.2 years
SD	16.2 years
Median	53 years
Mode	50 years
Min to Max	10- 75 years

Table 2 shows the prevalence of urinary tract infections (UTIs) among different age groups and genders for 454 diabetic patients in Sana'a. The crude prevalence of UTIs among diabetic patients was 21.8%. The prevalence of UTIs among male patients was 27.03%, higher than the prevalence among female patients, which was 17.6%. Looking at age groups, the highest incidence of UTIs was recorded among those aged 30–39 years (48.2%), followed by those aged 20–29 years (47.4%).

Table 2: Prevalence of UTI among different Sex and age groups of 454 diabetic patients in Sana'a city.

Characters	Number (%)
Sex	
Male, n=199	54 (27.03)
Female, n=255	45 (17.6)
Total positive, n=454	99 (21.8)
Age in Years	
Less than 20 years, n=47	9 (19.2)
20 -29 years, n=19	9 (47.4)
30 – 39 years, n=56	27 (48.2)
≥ 40 years, n=332	54 (16.3)

Table 3: Bacterial pathogens isolated from urine samples of DM patients with urinary tract infections.

Name of pathogens	Frequency (%)
E. coli	41 (42.3)
K. pneumoniae	33 (34)
P. aeruginosa	9 (9.3)
Candida sp	8 (8.2)
E. faecalis	6 (6.2)
Mono-growth of pathogens	97 (96.04)
Mixed-growth of pathogens	4 (3.96)

However, the lowest incidence of UTIs was recorded among those aged 40 years and older (16.3%), followed by those under 20 years of age (19.2%).Table 3 shows the bacterial pathogens isolated from urine samples of diabetic patients with urinary tract infections. *E. coli* was the most common isolate, accounting for 42.3% of all isolates, followed by *K. pneumoniae* at 34%. *P. aeruginosa* and *E. faecalis* were less common, representing 9.3% and 6.2%, respectively. Monocotyledonous growth of pathogens was observed in 96.04% of cases, while mixed growth of pathogens was present in 3.96% of patients with urinary tract infections. The incidence of urinary tract infections in patients with type 1 diabetes was 22.6%, with a probability ratio of 1.3, a confidence interval of 0.7-2.6, an X^2 coefficient of 0.82, and a *p* value of 0.36. In patients with type 2 diabetes, the incidence of urinary tract infections was 17.9%, with a probability ratio of 0.75, a confidence interval of 0.4-1.4, an X^2 coefficient of 0.82, and a *p* value of 0.36.

Table 4: The association of UTI and different Type of DM among our 454 DM patients.

Type	N (%)	+ UTI (N=99)	*OR*	*CI*	X^2	*p*
DM1	376 (82.8)	85 (22.6)	1.3	0.7-2.6	0.82	0.36
DM2	78(17.42)	14 (17.9)	0.75	0.4-1.4	0.82	0.36
Total	454 (100)	99 (21.8)				

Table 5: The relationship between urinary tract infections and the behavior of diabetic patients using diabetes treatment and diet.

Behaviors	N (%) (454)	+ UTI (N=99)	*OR*	*CI*	X^2	*p*
Committed	356 (78.3)	45 (12.6)	0.12	0.07-0.2	81.2	<0.0001
Somewhat committed	48 (10.6)	18 (37.5)	2.4	1.2-4.7	7.7	0.005
Rarely committed	39 (8.6)	27 (69.2)	10.7	4.9-23.6	56.2	<0.0001
Only committed when blood sugar is high	11 (2.4)	9 (81.8)	17.6	3.5-120	23.8	<0.0001

Table 5 illustrates the relationship between urinary tract infections (UTIs) and the behavior of diabetic patients using diabetes medication and diet. 78.3% of patients adhered to their diabetes medication and diet, and the incidence of UTIs was very low (12.6%), with a significant protective ratio of 0.17, a confidence interval (CI) of 0.2–0.4, an X^2 coefficient of 81.2, and a *p* value <0.0001. Among patients who were somewhat compliant with their diabetes medication and diet, the incidence of UTIs was 37.5%, with a significant associated risk factor of 2.4, a CI of 1.2–4.7, an X^2 coefficient of 7.7, and a *p* value of 0.005. Among patients who rarely adhered to their diabetes treatment and diet, the incidence of urinary tract infections was 69.2%, with a significant correlation ratio of 10.7, a confidence interval of 4.9–23.6, an X^2 coefficient of 56.2, and a *p* value <0.0001. In addition, among patients who only adhered to their diabetes treatment and diet when their blood glucose levels were elevated, the incidence of urinary tract infections was 81.8%, with a significant correlation ratio of 17.6, a confidence interval of 3.5–120, an X^2 coefficient of 23.8, and a *p* value <0.0001.Table 6 shows the association of urinary tract infections (UTIs) with sex and age groups among 454 diabetic patients who visited Kuwait Hospital in Sana'a. The incidence of UTIs was 27.1% higher in males, with a significant correlation ratio of 1.74, a confidence interval (CI) of 1.1–2.8, an X^2 coefficient of 5.9, and a *p* value of 0.01. In contrast, the incidence of UTIs was 17.6% lower in females, with a protective correlation ratio of 0.6, a CI of 0.4–0.9, an X^2 coefficient of 5.9, and a *p* value of 0.01.

Table 6: Association of UTI infection with different sex and age groups of 454 DM patients attending Al-Kuwait hospital, Sana'a city.

Characters	UTI positive, N=99 N (%)	*OR*	*95% CI*	X^2	*p*
Sex					
Male, n=199	54 (27.1)	1.74	1.1-2.8	5.9	0.01
Female, n=255	45 (17.6)	0.6	0.4-0.9	5.9	0.01
Total positive, n=454	99 (21.7)				
Age in Years					
Less than 20 years, n=47	9 (19.1)	0.83	0.4-1.9	0.22	0.64
20 -29 years. n=19	9 (47.4)	3.5	1.2-9.5	7.6	0.005
30 – 39 years, n=56	27 (48.2)	4.2	2.3-7.8	26.1	<0.0001
≥ 40 years, n=332	54 (16.3)	0.33	0.2-0.55	22.2	<0.0001

Considering that the 20-29 age group had a higher rate of urinary tract infections (UTIs) (47.4%, with a significant associated odds ratio of 3.5, a confidence interval of 1.2–9.5, an X^2=7.6, and a *p* value of 0.005), the 30-39 age group also had a higher rate of UTIs (48.2%, with a significant associated odds ratio of 4.2, a confidence interval of 2.3–7.8, an X^2=26.1, and a *p* value <0.0001).

DISCUSSION

Urinary tract infections (UTIs) affected 99 patients (21.8%), according to the study. This could be because people are more vulnerable to UTIs due to decreased immunity. An analogous study carried out in Sudan revealed the frequency of asymptomatic UTIs in people with diabetes. Similar to the current study, 20.9% of the 200 diabetes individuals who took part in the study had bacteriuria[20]. In contrast to women without diabetes, whose relapse and reinfection rates were 2.0% and 4.1%, respectively, a study of Ugandan diabetes records revealed that 7.1% of women with diabetes had recurring UTIs and 15.9% had reinfection[21]. Healthcare may face a substantial cost burden due to the increasing risk of UTIs among diabetes patients and the recent global increase in DM prevalence[22]. According to available data, UTIs are the most prevalent bacterial infection among diabetes individuals[23]. Total 39.3% of people have a UTI. Over half (60.6%) of the patients in the current study experience one or two UTIs annually. According to a study done in the Kingdom of Saudi Arabia, 25.3% of individuals with diabetes had UTIs overall[8]. According to reports, the prevalence of diabetic UTIs is 13.8% in Ethiopia[24], 1.75% in India[25], and 9.71% in the USA[26].

In the current study, the incidence of UTIs was 27.1% higher in males, with a significant correlation ratio of 1.74, a confidence interval (CI) of 1.1–2.8, an X^2 coefficient of 5.9, and a *p* value of 0.01. In contrast, the incidence of UTIs was 17.6% lower in females. This result different from that reported by According to Fünfstück *et al.*[27], 65% of DM patients with UTIs were female. According to the study, among diabetes individuals, the incidence of UTI was significantly correlated with male gender. Additionally, compared to other research, Leonard *et al.*[28], shown that the urethra is located closer to the anus in females, which facilitates the passage of germs from the rectum to the urethra[28]. Our findings may be complicated by the fact that male patients are more prone to UTIs than female patients due to their noncompliance with diabetes treatment and nutrition.

The results of the study demonstrated a substantial correlation between the incidence of UTI in diabetic patients and the presence of disease consumables. The synergistic activity of polymicrobes may be the cause of this. When this study is contrasted with other research, Turpin *et al.*[29], also demonstrated that the severity of UTIs varies based on the pathogen's aetiology and risk factors. Another study revealed that whether or not a UTI was successful is also determined by the host's participation. Only when there is an imbalance between the pathogenicity of the organism infecting the urinary system and the host defences will an infection develop[30]. Diabetes mellitus isone of the diseases that interferes with the immuneresponse of the body, consequently allowing UTIs to develop[31-33].

In the current study, the incidence of urinary tract infections in patients with type 1 diabetes was slightly higher (22.6%), than that with DM2 (17.9%) with a probability ratio of 1.3 but the difference was not significant. Urinary tract infections (UTIs) are more common in patients with type 1 and type 2 diabetes than in the general population, albeit the risk factors and important characteristics may vary between the two kinds. In individuals with type 2 diabetes, UTIs are more frequent, more severe, and linked to worse outcomes. Both type 1 and type 2 diabetes impair immunity and raise blood sugar, or the amount of glucose in the urine, which promotes the growth of bacteria. Urinary tract infections (UTIs) are more common in individuals with type 2 diabetes than in those with type 1 diabetes, according to studies, while other risk factors and study groups may have an impact. UTIs in diabetic patients, particularly those with type 2 diabetes, are more likely to lead to serious complications such as pyelonephritis, kidney abscesses, and uremia. They are also frequently caused by antibiotic-resistant pathogens[34].

In diabetic patients, advancing age is a major risk factor for the development and severity of urinary tract infections (UTIs). The prevalence and incidence of UTIs increase with age, and elderly diabetic patients face a higher risk of complications and death. Our research findings were different in which;the 20-29 age group had a higher rate of urinary tract infections (UTIs) (47.4%, with a significant associated odds ratio of 3.5, a confidence interval of 1.2–9.5, an X^2=7.6, and a *p* value of 0.005, followed by the 30-39 age group (48.2%, with a significant associated odds ratio of 4.2, a confidence interval of 2.3–7.8, an X^2=26.1, and a *p* value <0.0001). While older DM patients age had low rate of UTI. In addition, while advancing age is generally a risk factor for urinary tract infections, in some studies conducted on diabetic patients, the lower incidence of urinary tract infections in older groups may stem from factors such as better overall metabolic control in healthier older adults, different types of bacteria, or differences in immune response/ complications; however, most evidence suggests that diabetes increases the risk of urinary tract infections, particularly with poor control and neuropathy, making study specific factors crucial for this particular outcome[35].

In the current study, 78.3% of patients adhered to their diabetes medication and diet, and the incidence of UTIs was very low (12.6%), with a significant protective ratio of 0.17, a confidence interval (CI) of 0.2–0.4, an X^2 coefficient of 81.2, and a *p* value <0.0001. Committed diabetics can prevent urinary tract infections (UTIs) primarily by achieving consistent blood sugar control through medication and diet, which reduces bacteria-enhancing glucose in the urine and supports immune function.The role of diabetes management in controlling blood sugar levels, consistently high blood sugar (hyperglycemia) leads to

high levels of glucose in the urine (glycosuria), creating an ideal environment for bacterial growth. Maintaining blood glucose levels within the target range, as determined by the A1C test, is the most effective way to address this underlying cause. In addition, effective diabetes management, including insulin therapy when prescribed, helps regulate blood sugar levels. Research has shown that insulin helps restore the body's natural levels of antimicrobial peptides (such as psoriatic acid and RNase 7), which are important for protecting against bacterial adhesion and infection. Also, poorly controlled diabetes over the long term can cause nerve damage (neuropathy), which can affect the bladder's ability to empty completely. This can lead to urinary retention, a condition in which bacteria can easily multiply. Proper diabetes management helps prevent or slow the progression of this nerve damage[36].

In the current study, *E. coli* was the most common isolate, accounting for 42.3% of all isolates, followed by *K. pneumoniae* at 34%. *P. aeruginosa* and *E. faecalis* were less common, representing 9.3% and 6.2%, respectively. Monocotyledonous growth of pathogens was observed in 96.04% of cases, while mixed growth of pathogens was present in 3.96% of patients with urinary tract infections. Results of current study are similar to that reported worldwide where in diabetic patients with urinary tract infections, the most common causative bacteria remains *E. coli*, along with other types of enteric bacteria (such as *Klebsiella*, *Proteus*, and *Enterobacter* species), and *Enterococcus* species, but these infections are often more complicated, characterized by resistant strains (ESBLs, fluoroquinolone resistant strains) and sometimes fungi (*Candida* species)[17,18,37]. *E. coli* is the most common bacterium in urinary tract infections (UTIs) among people with diabetes, primarily because it is the most common UTI in the general population, due to its origin in the gut and its specific virulence factors. Diabetes does not alter this basic prevalence, but it does create an environment that makes all types of bacterial infections, including those caused by *K. pneumoniae*, more likely and more severe[38].

E. coli is the leading cause of urinary tract infections because it is a commensal bacterium in the human gut, providing ample opportunity for fecal contamination and subsequent invasion of the urinary tract. This is particularly common in women (who also have a higher prevalence of UTIs than men). A key factor contributing to *E. coli's* role as a major causative agent is its specific virulence characteristics, particularly type I filamentous appendages, which allow it to adhere strongly to the cells lining the urinary tract (urinary epithelial cells), thus resisting the body's natural cleansing process. Furthermore, diabetic patients often exhibit increased bacterial adhesion to urinary epithelial cells, a phenomenon positively correlated with poor blood sugar control (elevated HbA1c levels). This enhanced adhesion facilitates *E. coli* colonization[39].

Limitation of the study

The cross-sectional study design's limitations made it impossible to determine the causes of some of the characteristics associated with UTIs in the sample population. Furthermore, this study did not examine variables that might have affected the findings, such as a person's residence or whether or not they smoked. The fact that this study was limited to one location in Yemen is one of its shortcomings. It may only include a small percentage of Yemenis, which makes it difficult to generalise the study's conclusions.

CONCLUSIONS

The analysis reveals that urinary tract infection (UTI) rates are high among diabetic patients, with no significant difference in UTI rates between the two types of diabetes. The current study concludes that males are more susceptible to UTIs among diabetic patients, contrary to the common belief that females are more prone. Based on this study, stakeholders in diabetes health can utilize its findings to guide awareness programs. The study recommends providing diabetic patients with health education on the causes of UTIs and how to manage and prevent them. It also recommends that the government increase the provision of services, such as treatments, to reduce the spread of opportunistic infections associated with UTIs. Patients should be encouraged to undergo regular medical checkups to monitor disease progression.

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AUTHOR'S CONTRIBUTIONS

Abdulmogni SS: writing original draft, methodology. **Hassan SMA:** methodology. **Hassan SMA:** investigation, formal analysis, data curation, conceptualization. **Aljabri AAS:** writing, review and editing. **Al-Moyed KA:** methodology, investigation. **Al-gunaid EA:** data curation, conceptualization. **Mughni GTAA:** writing, review and editing. Final manuscript was checked and approved by both authors.

DATA AVAILABILITY

Upon reasonable request, the corresponding author will provide the datasets created or examined during this investigation.

CONFLICT OF INTEREST

None to declare.

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