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## Original article

# Investigating the etiological agents of urinary tracts infection in diabetic patients in inpatients and outpatients in Iran

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## ABSTRACT

**Background:** Patients who suffer from diabetes are more exposed to urinary tract infections than normal people. The high percentage of urinary tract infections can be attributed to these people. The purpose of this research is to compare the rate of urinary tract infection in inpatient and outpatient diabetic patients with non-diabetic inpatient and outpatient patients. **Methods:** The statistical population of the present study consisted of diabetic patients; for this purpose, sampling of 200 diabetic patients (100 inpatients and 100 outpatients) as the experimental group and 200 non-diabetic patients (100 inpatients and 100 outpatients) as the control group. The witness was done. Sampling was done from the entire statistical population in fasting and non-fasting conditions. Fasting sugar level, non-fasting sugar level, sugar level two hours after breakfast, HbA1C test, urine test, and urine culture were measured. In order to analyze the data, SPSS software was used. **Results:** The present study showed that the rate of urinary infection in people with diabetes (outpatient-hospitalized) is higher than in non-diabetic patients (outpatient-hospitalized). It was noticed that the rate of urinary infection in inpatient diabetic patients (male and female) was higher than that of outpatients, and urinary infection in women with diabetes (outpatient-inpatient) was more than that of male patients with diabetes. **Conclusion:** Based on the findings of the present study, the higher level of blood sugar and HbA1C in diabetic patients causes an increase in urinary tract infections rate, and urinary tract infections are more common in hospitalized diabetic patients than in outpatient diabetic patients, and this rate is higher in diabetic women than in diabetic men. The results showed that diabetic people are prone to urinary tract infection, which is more common in women than in men.

## Introduction

Urinary tracts infections (UTIs) can involve the urethra, kidneys, or bladder and cause urethritis, pyelonephritis, and cystitis respectively. Women are at greater risk of developing UTI than men. Infection limited to the bladder can be painful and annoying, and serious consequences can occur if UTI spreads to the kidneys. Various factors such as immune system disorders, weakening of white

blood cells, poor blood supply, bladder dysfunction due to nephropathy, and glucosuria can cause urinary tract infections in diabetic patients [1,2].

Globally, 150 million persons are diagnosed with UTIs yearly. Diabetic patients are prone to have more infections, such as urinary tract infection (UTI), respiratory tract, soft tissue, and skin infection. Bacterial infection is identified as a major problem in diabetics, and the hazard of

acquiring an infection among patients with DM is higher than the normal individuals. UTIs causes significant morbidity in diabetic patients, and if complicated, can cause severe renal injury and serious infections [3].

Asymptomatic bacteriuria (ASB) is a common finding in many populations, including patients with diabetes, pregnant women, the elderly, and patients with impaired voiding. The majority of studies suggest a three-fold higher prevalence of ASB in patients with diabetes and there is also evidence that ASB confers an increased risk of symptomatic urinary tract infections (UTIs) in this specific population [8].

Diabetes is an important medical and public health issue world widely. Diabetes is the most common endocrinological disease, occurring with increasing prevalence, which has risen worldwide from 108 million cases in 1980 to 537 million cases in 2021. According to the International Diabetes Federation, the total number of people living with diabetes is predicted to rise to 643 million by 2030 and 783 million by 2045[8].

Worldwide, diabetes is considered as one of the most challenging health problems of 21<sup>st</sup> century. It affects every aspect of patients' life, including quality of life, employment and even causing premature death. It is considered as the 5<sup>th</sup> leading cause of death in developed countries [9].

According to the latest criteria of the American Diabetes Association, the diagnosis of diabetes is confirmed by registering one of the following: registration of at least one random blood sugar level above 200 mg/dL along with classic symptoms of diabetes (drinking, hyperuria, overeating), or fasting sugar higher than or equal to 126 mg/dL (fasting means not consuming any kind of calories for eight hours before the test), or hemoglobin A1C above 6.5% and the result of the sugar test two hours after eating breakfast is above 140 mg/dL [7].

Patients with diabetes are more prone to develop infections compared with the general population, with urinary tract infections (UTIs) being among the most commonly encountered. It has been estimated that in 2016 UTIs account for 7 million hospital visits per year, along with 1 million visits to the emergency department, in the United States, involving an estimated annual cost of ~1.6 billion US \$to the health care system [4].

Urinary tract infections (UTIs) are one of the most common microbial diseases encountered in medical practice affecting people of all ages. Worldwide, UTIs' prevalence was estimated to be around 150 million persons per year. Diabetic patients have a higher incidence of UTI than their non-diabetic counterparts with a higher severity UTI [5]. In 2012, the direct medical costs associated with managing UTIs in the 22 million diabetic patients in USA were estimated to be more than 2.3 billion \$ [5]. Patients with diabetes sometimes exhibited impaired immune function and aggravated infectious diseases. Urinary tract infection (UTI) is one of the major complications of diabetes [6].

Several factors contribute to an increased infection risk in patients with diabetes: defects in the host immune defense mechanisms (such as impaired neutrophil function, decreased T-cell-mediated immune response, low levels of prostaglandin E, thromboxane B2, leukotriene B4), incomplete bladder emptying due to autonomic neuropathy, and poor metabolic control. A higher glucose concentration in the urine allows urinary colonization by pathogenic microorganisms. Similar to the general population *Escherichia coli* and other enterobacteriaceae are the most commonly isolated uropathogens both in females and in males with diabetes [4].

Diabetic patients are prone to have various kind of infections more than non-diabetics. This high incidence rate of infections is attributed to altered immune functions like polymorphonuclear leucocyte function, adhesion phagocytosis, chemotaxis and impaired antioxidant system [9].

All these changes make diabetic patients prone to have more infections such as UTIs, and skin and soft tissue infections. The prevalence of UTI is high among diabetic patients. Patients with diabetes have more chances to get UTIs than non-diabetic. UTIs are five times higher among diabetics than non-diabetics and the risk of UTI for diabetic patients is two folds higher than that of non-diabetics. UTIs are more severe and carry worse outcomes in diabetic patients [9]. A potential explanation of the increased UTI in diabetic patients might be the nerve damage caused by high blood glucose levels, affecting the ability of the bladder to sense the presence of urine and thus allowing urine to stay for a long time in the bladder and increasing infection probability . Additionally, high glucose

levels in urine improve the growth of bacteria in the urine [5].

## Material and methods

### Study setting and participants

The study population was selected from people who were referred to Gonbadkavos Hospital in Golestan province in Iran and medical diagnosis laboratory due to suspected symptoms of diabetes (according to the latest criteria of the American Diabetes Association). The total number of these people during the study period was 400 patients. The total number of patients with diabetes after performing the above steps was equal to 200 people, 100 people were selected as diabetic inpatients and 100 people were selected as diabetic outpatients. The total number of non-diabetic patients was 200 patients, 100 patients were selected as non-diabetic inpatients and 100 patients as non-diabetic outpatients. Diabetes was defined as fasting blood sugar  $\geq 126$  mg/dL and hemoglobin A1c  $\geq 6.5\%$ , or the use of hypoglycemic drugs by the patient [7]. Patients were asked to fast for 8 hours before sampling. The night before sampling, it was better to have a light meal, not to take any medicine, and it was better to drink only water. After complying with the above, the patients went to the hospital's laboratory in fasting state for blood sampling.

### Blood glucose test

Venous blood samples from each patient were collected for FBS and 2HPP testing [16,17].

### Hemoglobin A1C test

2 ml of venous blood samples from patients and controls were prepared and HbA1c test was performed by MINDRAY BS 380 autoanalyzer [16,17].

### Urine cultures

A urine specimen was collected in an appropriate sterile box container from each patient. Urine analysis was carried out according to standard procedures and urine cultures were performed from diabetic patients by standard techniques using blood agar and MacConkey agar plates. Bacterial species were identified by the use of standard biochemical methods [18].

### Data analysis method

The data obtained from the two groups of patients and controls and readings were analyzed using the SPSS statistical software (Version9). The results of the experiments were analyzed using a completely random design and the differences were

compared with the Duncan method and at 5% reliability. Excell (2013) software was also used to draw charts.

## Results

The largest sample size was taken from women with 270 (67.5%). In addition, the most frequent age range was between 41-60 years old with the number of 162 (40.5%) samples (Table 1,2).

The most samples taken from diabetic patients were women with 139 (69.5%). In addition, the highest frequency of age range was related to the ages of 61 years and above with the number of 88 (44%). Also, the most sample taken from non-diabetic patients was related to women with 131 (65.5%). In addition, the most frequent age group was between the ages of 41-60 years with the number of 84 (42%) (Tables 3,4).

### The results of the microbial culture (diabetic patients)

Out of 200 samples taken from outpatient and hospitalized diabetic patients, 39 (19.5%) of the samples had urinary tract infections and 161 (80.5%) did not have urinary tract infections.

Out of 100 samples taken from outpatient diabetic patients, 16 (16%) samples had urinary tract infections, and the most infectious agent in outpatient diabetic patients was coagulase-negative staphylococci with a number of 8 (50%). Also, from the total of 100 samples received from hospitalized diabetic patients, 23 (23%) samples had urinary infections, and *Escherichia coli* isolates were the most frequent with 12 (52%) samples (Table 5).

The highest rate of urinary tracts infection was observed in diabetic people aged 61 years and above with 17 isolates and the lowest rate of urinary infection was observed in these patients in the age range of 0-20 years with 2 isolates (Table 6).

### The results of the blood sugar tests of diabetic patients with UTI

According to the table, in total, the average results of FBS, BS, 2HPP and A1C tests in hospitalized patients were much higher than in outpatients (Table 7).

### The results of the microbial culture (non-diabetic patients)

Out of 200 samples taken from outpatient and hospitalized non-diabetic patients, 20 (10%) samples had urinary tract infection and 180 (90%) samples did not have urinary tract infection. Out of

100 samples taken from outpatient non-diabetic patients, 7 (7%) of the samples had infections, and the most infectious agent in non-diabetic outpatients was coagulase-negative staphylococci bacteria with a number of 4 (57%). Also, from the total of 100 samples received from hospitalized non-diabetic patients, 13 (13%) samples were infected, and the most microbial agent was coagulase-negative staphylococci with 6 (46%) (Table 8).

From a total of 20 isolates with urinary infection in non-diabetic people, the highest and lowest infection rate was reported in the age range of 61 and above and 0-20 years with 8 and 0 isolates, respectively (Table 9).

**The results of the blood sugar tests of non-diabetic patients with UTI**

In total, the average results of FBS, BS, 2HPP and A1C tests in hospitalized non-diabetic

patients were much higher than non-diabetic outpatients (Table 10).

**Comparison of blood sugar and microbial culture results of diabetic and non-diabetic patients**

According to the graph, the rate of urinary infection in hospitalized diabetics was 23(23%) more than other people, also the lowest rate of urinary infection was observed in non-diabetic outpatients with 7(7%) (figure1).

In hospitalized diabetic patients, the highest amount of FBS, BS, 2HPP and A1C was observed compared to other investigated groups, and the lowest amount of FBS, BS, 2HPP and A1C was observed in the outpatient non-diabetic group (figure2).

**Table 1.** Frequency of gender range of samples

	Sex	Number	Percent
	male	130	32.5
	female	270	67.5

**Table 2.** Frequency of age range of samples

Age	Number	Percent
0-20	28	7
21-40	65	16.25
41-60	162	40.5
61>	145	36.25

**Table 3.** Frequency of gender range of samples taken from diabetic and non-diabetic people

Sex	Diabetic patients		Non-diabetic patients	
	Number	Percent	Number	Percent
male	61	30.5	69	34.5
female	139	69.5	131	65.5

**Table 4:** Frequency of age range of samples taken from diabetic and non-diabetic people

Age	Diabetic patients		Non-diabetic patients	
	Number	Percent	Number	Percent
0-20	11	5.5	17	8.5
21-40	23	11.5	42	21
41-60	78	39	84	42
61>	88	44	57	28.5

**Table 5.** Percentage frequency of infectious isolates in diabetic patients

Type of diabetic patient	Bacterial isolate				
	<i>Escherichia coli</i>	<i>Streptococcus</i>	Coagulase positive <i>staphylococcus</i>	Coagulase negative <i>staphylococcus</i>	total
Outpatient	4(25%)	4(25%)	0(0%)	8(50%)	16
Inpatients	12(52%)	3(13%)	2(9%)	6(26%)	23

**Table 6.** Percentage frequency of infectious isolates in diabetic patients

Age	Number (%)
0-20	2
21-40	4
41-60	16
61>	17

**Table 7.** Blood sugar test results of outpatient and hospitalized diabetics

Test	outpatient	hospitalized
	Average	Average
FBS	172	179.5
BS	237.5	260
2HPP	309.5	338.5
A1C	8.4	9.5

**Table 8.** Percentage frequency of infectious isolates in non-diabetic patients

Type of diabetic patient	Bacterial isolate				
	<i>Escherichia coli</i>	<i>Streptococcus</i>	Coagulase positive <i>staphylococcus</i>	Coagulase negative <i>staphylococcus</i>	total
Outpatient	2(28.5%)	1(14.5%)	0(0%)	4(57%)	7
Inpatients	5(38.5%)	1(7.75%)	1(7.75%)	6(46%)	13

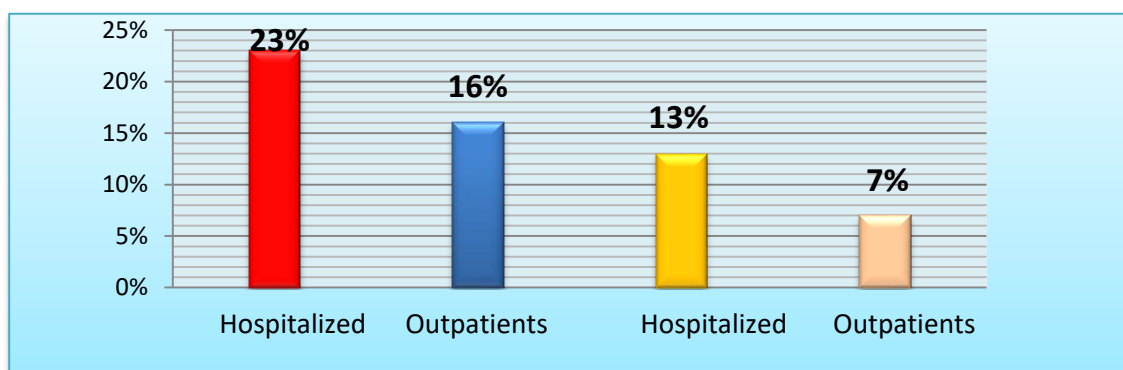
**Table 9.** Frequency of infectious isolates obtained from non-diabetic according to age range

Age	Number (%)
0-20	0
21-40	4
41-60	8
61>	8

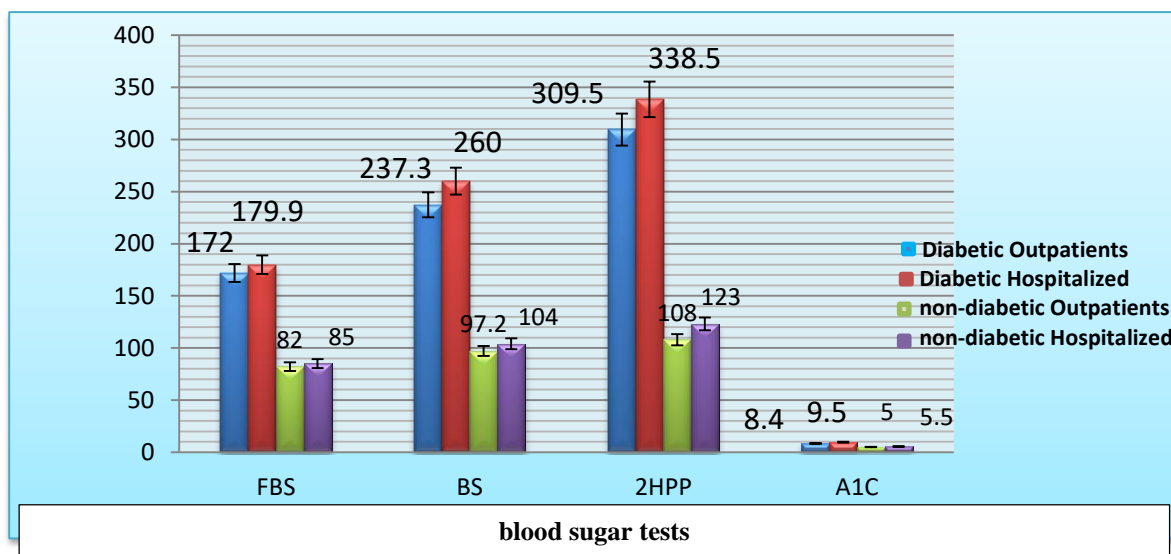
**Table 10.** Blood sugar test results of outpatient and hospitalized non-diabetics

Test	outpatient	hospitalized
	Average	Average
FBS	82	85
BS	97.2	104
2HPP	108	123
A1C	5	5.5

**Figure 1.** Comparison of urinary infection prevalence in diabetic and non-diabetic patients



**Figure 2.** Comparison of average FBS, BS, 2HPP and A1C in diabetic and non-diabetic patients



**Discussion**

The results of the present study indicated an increase in urinary tract infections in diabetic patients compared to the control group. According to the results obtained in the research, the rate of urinary infection in hospitalized diabetic patients was higher than that of outpatient diabetic patients, and in both groups of diabetic patients, the rate of urinary infection was higher than the control group

(hospitalized and outpatient). The results of the investigation of urinary tract infection in the current study showed that the rate of urinary tract infection in diabetic patients was higher than in the control group and that its level was higher in hospitalized diabetic patients than in outpatient diabetic patients.

**Makoyana et al.** in 2002 on an urban population with diabetes in Africa worked, and in this study, 32% of diabetics had urinary tract infections, which is higher than the present study

[10]. The variation in between the results of this research and other studies might be due to differences in the socio-demographic characteristics of the study setting.

In 2000, **Gerlings et al.** worked on 589 women with diabetes in an urban population for 18 months. In that study, 26% of women with diabetes had urinary tract infection, which is higher than the present study. It is, of course, only diabetic women were studied in the mentioned study, and the difference between inpatient and outpatient diabetic patients was not considered [11].

In 2003, **Alebiosu et al.** worked on an urban population in Nigeria of 124 people with diabetes in whom bacteriuria was asymptomatic, and in this study, the prevalence of asymptomatic bacteriuria in diabetic patients was 26.6 %, which is higher than the research. The present one is higher, of course. In the mentioned study, the prevalence of asymptomatic bacterial infection in diabetic patients was investigated and the difference between inpatient and outpatient diabetic patients was not considered [12].

In 2008, **Odetoin et al.** showed that the prevalence of asymptomatic bacteruria in diabetic patients with poor blood sugar control was observed in 54.4% of diabetic patients, while in patients with good blood sugar control, the bacterial rate was 2.9%, that is different from the present research, of course, in the mentioned study, the prevalence of asymptomatic bacterial infection in diabetic patients (controlled-uncontrolled) was investigated and the difference between inpatient and outpatient diabetic patients was not considered [13].

**Milland et al.** and **Gerlings et al.** showed in 2006 that in the prevalence of asymptomatic bacteriuria in type 2 diabetics, age was a strong contributing factor [14].

In 2005, **Boyko** showed in America that the prevalence of asymptomatic bacteremia was higher in women with diabetes with a duration of diabetes of more than 10 years [15]. the overall prevalence of urinary tract infection in patients with type 2 diabetes was 11.5% [1]. The magnitude of urinary tract infections was 22.3%. The odds of being infected by urinary tract infections were significantly higher in diabetic females [3].

**Chiță et al** in 2017 indicated the prevalence of UTIs in patients with diabetes was 12.0%, being higher in females than in males and higher in patients with diabetes compared with

patients with diabetes. Risk factors associated with UTIs were female gender, age, diabetes, longer duration of diabetes, and the presence of chronic kidney disease and coronary artery disease. The Gram-negative bacilli from the enterobacteriaceae family were predominant, with *Escherichia coli* being the most frequent of them (70.4%) [4].

**Georgia et al.** in 2023 from 437 adult patients of which 61% were female and 39% were male patients with a mean age of  $70.5 \pm 9.6$  years, were enrolled. The prevalence of ASB was 20.1%, in total. ASB was noted in 27% of female participants and 9.4% of male participants [8].

**Shah et al** in 2019, from 348 DM patients, indicated that the prevalence of UTI among diabetic patients was 40.2%. Furthermore, the prevalence among females was higher than among males and regarding the type of UTIs, cystitis was the most prevalent UTI [9]. The variation between the results of this research and other studies might be due to differences in the socio-demographic characteristics of the study setting.

Because diabetic patients are more prone to UTIs, it is critical to focus on early detection and treatment because this aids in providing better care for diabetes patients.

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#### Conflict of interest

Non declared.

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