To determine the biochemical and hematological differences between diabetic patients and non-diabetic controls of asymptomatic bacteriuria in and around Indore region

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Abstract:

Background: A clear knowledge of the causative agents of UTIs and antibiotic susceptibility pattern of the isolates would be helpful in the treatment of UTIs. Data generated from this study could provide useful information for the effective management of diabetes mellitus and the prevention chronic complications. Hence, the aim of the present study is to establish biochemical and hematological differences between diabetic patients and non-diabetic controls of asymptomatic bacteriuria (ASB). **Materials & Methods:** This research was conducted at the Index Medical College and Hospital after receiving approval from the Institutional Ethics Committee. The majority of patients with diabetes are seen at the hospital's diabetic clinics, which are extremely well-established and run very smoothly. Patients come here for routine checks and treatment. Informed consent or assent, in addition to completion of a questionnaire, and ethical approval are all necessities. **Results:** Patients with diabetes had significantly higher levels of serum creatinine, C-reactive protein (CRP), and fasting plasma glucose (FPG) compared to non-diabetic controls ($P < 0.05$). **Conclusion:** There was no discernible difference between the patterns of resistance of isolates taken from diabetic patients and those obtained from controls who did not have diabetes in terms of the resistance patterns. This suggests that the rates of exposure to antimicrobial compounds experienced by bacteria from these two habitats are comparable to one another.

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Introduction:

India is one of many developing countries where the number of people with diabetes is going up [1-3]. This people moving to cities and living more like people in the urban areas. People with diabetes need to know more about how often they get infectious diseases. This is important for public health. It has been shown that Indians without diabetes have a high rate of Urinary Tract Infections (UTIs) [2-4]. People with diabetes are especially at risk for the bad things that can happen when these infections spread. So, more research needs to be done on urinary tract infections in diabetics to find out how they affect the severity of diabetes. Even though diabetes is very common in India, there is not yet a full report on how often people with diabetes get UTIs. So, the goal of this study is to study UTIs in people with diabetes to those in people without diabetes, as well as the clinical and microbiological profiles of these infections. The results of this study are expected to help people with diabetes deal with it better and avoid its long-term effects.

The bad effects of high blood sugar cause some parts of a body that have nothing to do with the immune system may also make them more likely to get sick. Poor local circulation, which can be caused by both macrovascular disease and microvascular dysfunction, can make it take longer to respond to infections and for wounds to heal [5]. When a person has sensory neuropathy in their legs, they may not feel when they are hurt. This can cause them to not take care of small wounds properly, which can make them more likely to get an infection [6,7]. Autonomic neuropathy can cause the bladder to not empty all the way, which can make it easier for bacteria to take hold in the urinary tract [8]. Also, there is evidence that a high amount of glucose in the urine can make some bacteria and yeasts grow faster [9]. People with diabetes have been known to get infections in their bladder, kidneys, vagina, gums, feet, and skin [10-12]

Patients with diabetes often get Urinary Tract Infections (UTIs), which is the sixth major effect of diabetes [10-12]. Several studies have shown that diabetes and UTIs, which usually happen in the urinary system, are linked [13-16]. Klebsiella pneumoniae, Escherichia coli, Streptococcus agalactiae, Enterococcus faecalis, coagulase-negative UTIs are often caused by Staphylococcus, Streptococcus pyogenes, and Candida albicans [17-19]. Both cystitis and bacteriuria are infections of the lower urinary tract, but they are usually mild and can be treated with antibiotics. Infections of the kidneys or ureters can sometimes start in the lower urinary system and move up [20]. Diabetes patients are more likely to get upper urinary tract infections, pyelonephritis, and renal or perinephric abscesses [21,22]. Emphysematous infections are infections that get worse when bacteria break down food and release gas. The link between UTIs and diabetes is still up for debate, but there is some evidence that lower urinary tract infections can move to the upper urinary tract and cause more serious problems, especially in people who already have diabetes [23,24].

A clear knowledge of the causative agents of UTIs and antibiotic susceptibility pattern of the isolates would be helpful in the treatment of UTIs. Data generated from this study could provide useful information for the effective management of diabetes mellitus and the prevention chronic complications. Hence, the aim of the present study is to establish biochemical and hematological differences between diabetic patients and non-diabetic controls of asymptomatic bacteriuria (ASB).

Materials & Methods:

This research was conducted at the Index Medical College and Hospital after receiving approval from the Institutional Ethics Committee. The majority of patients with diabetes are seen at the hospital's diabetic clinics, which are extremely well-established and run very smoothly. Patients come here for routine checks and treatment. Informed consent or assent, in addition to completion of a questionnaire, and ethical approval are all necessities. In order to obtain the participants' consent or agreement to take part in the research, we gave them consent papers to fill out, or we asked their parents or legal guardians to do so on their behalf if they were under the age of 21. The participants were given information regarding the nature of the study, as well as the potential dangers and rewards of taking part. Participation in the study was restricted to only those participants who provided their informed consent. Diabetic patients served as cases, while healthy participants served as controls, in this prospective, multi-center case-control study. There was a total of 250 participants in the trial.

The sampling of diabetes patients was not purposeful because a participant arrived at the health center where the medical team was executing the study by accident. However, this did not prevent the sample of diabetic individuals. Throughout the process of the free screening, volunteers who did not have diabetes were selected at random. All of the people who took part in the study were separated into two groups: those with diabetes and those without diabetes, as well as those who were younger and those who were older. In general, a purposive-cluster-randomized sampling technique was utilized for this study's data collection. The risk factors for ASB [25,26] were grouped into one of three categories: demographic, medical history, and measurable. Age, gender, married status, and greatest level of education were some of the demographic variables that were considered, albeit they were not the only ones. In this study, the presence of UTI symptoms and other health indicators were taken into consideration as part of the patient's medical history, while the findings of all tests were taken into consideration as quantifiable predictors. The findings of the laboratory tests indicated the presence of glucose, protein, pyuria, hematuria, and nitrite in the patient's urine. In addition to this, measurements of fasting plasma glucose, hemoglobin A1c, serum creatinine, and urea were taken in order to obtain information.

Questionnaires, which each participant in the study filled out, were used to collect information regarding demographics and health factors.

Using the GOD-PAP reagent, measurements of fasting plasma glucose were taken (Tulip Diagnostics). For the purpose of determining glycated hemoglobin levels (HbA1c), the Glycohemoglobin (Stanbio Lab, USA) Ion Exchange Resin method was applied. It was determined that the Jaffe kinetic method was the most appropriate way to evaluate serum creatinine, and EDTA-treated blood samples were utilized in the production of sera. In accordance with the guidelines provided by the manufacturer, Berthelot Enzymatic Colorimetric procedures were utilized in order to determine the total amount of urea (Tulip Diagnostics). C-reactive protein levels are being measured (CRP) For the purpose of measuring CRP, the semi-quantitative slide agglutination method was utilized. The processes were carried out in precisely the manner prescribed by the manufacturer (Tulips Diagnostic, India).

Statistical analysis:

For categorical variables frequencies with 95% confidence intervals (CI) were used. To know the associations between two or more investigative procedures we used Chi-square test. $P < 0.05$ was taken as the level of significance. Frequencies with 95% confidence intervals (CIs) was used for categorical variables. All the tests were performed on SPSS software. We also calculated percentages.

Results:

After receiving approval from the Institutional Ethics Committee, the researchers were able to begin recruiting a total of 250 people to take part in the study. There were 130 diabetic patients and 120 non-diabetic controls among the 250 participants, for a participation rate of 52% and 48%, respectively. The majority of the 131 people who took part in the study were in their 60s and 70s (52.4%), while 8.4% were younger than 30 (21 people). There was no statistically significant difference in the age distribution of study participants between diabetic patients and non-diabetic controls (Chi-square test: $\chi 2$ = % 4.77; P = 0.182). There were more females (147; 55%) than males (113; 45%) in the study, although this difference was not statistically significant. In addition, the gender distribution between diabetic patients and non-diabetic controls was not statistically significant (Chi-square: $\chi 2$ = 4.131; df = 1; P = 0.10). The majority of study participants (130; 52%) were married, although there was no statistically significant difference between the marital status of diabetic patients and non-diabetic controls (Chi-square: $\chi 2$ =2.896; df=3; P=0.726). Furthermore, there was no statistically significant difference between diabetic patients and non-diabetic controls for the classification of highest degree of education (Chi-square: $\chi 2$ = 7.344; df = 3; P = 0.096).

Risk analysis for critical predictors of ASB in diabetic patients was also performed using odds ratio computation and the results are presented on Table 2. Female diabetic patients were more at risk of ASB than male diabetic patients (OR = 8.318, 95% CI; 4.276 – 18.484). Forty nine out of 55 (90 %) female diabetic patients had ASB against 6 out of 55 (10 %) males. Also, diabetic patients with recurrent UTI were more at risk than those who had never had UTI or only had once (OR = 7.931, 95% CI; 2.492 – 38.713). Other predisposing factors for ASB in diabetic patients included no formal education (OR = 1.992 95% CI; 1.921 – 4.629) and attaining menopause (OR = 3.100, 95% CI; 2.914 – 5.371). BMI, glycosuria, pyuria proteinuria, HbA1c levels, FPG, CRP, age, duration of diabetes, and serum creatinine and urea levels did not influence the risk for ASB in diabetic patients (OR < 1 95 % CI).

Out of 130 diabetic patients tested for FPG, 78 (50.6 %) were hyperglycemia (FPG > 126 mg/dl), 75 (48.7 %) were normoglycemic while 1 (0.7 %) was hypoglycemic (Table 3). Meanwhile most non-diabetic controls (108; 97.7 %) had values within the normal range. Fasting plasma glucose levels of participants ranged between 59 and 368 mg/dl. Diabetic patients had significantly higher mean FPG (152.8 ± 68.2 mg/dl) than non-diabetic controls (98.7 ± 21.3 mg/dl). Glycated hemoglobin levels were measured only for diabetic patients and the results are also presented in the table. Out of 130 diabetic patients tested for HbA1c, 39 (38%) presented with poor glycemic control (HbA1c > 7.0 %) and 81 (62 %) with good control (HbA1c < 7.0 %). The mean HbA1c was 6.8 ± 0.9 % and the values ranged from 3.9 % to 14.1 %.

One hundred thirty (52 %) of the study participants were positive for CRP. More diabetic patients (96; 74 %) were positive for CRP than non-diabetic controls (33; 28%). The mean CRP was significantly higher in diabetic patients (23.5 ±17 .0 mg/dl) than in non-diabetic controls (5.8 ± 12.1 mg/dl) (P < 0.001) and the values ranged from 0 mg/dl to 48 mg/dl. Generally, the serum urea values for the study population ranged between 7 – 64 mg/dl with a mean value of 23.7 mg/dl.

Out of 154 diabetic patients whose serum urea were measured 8 (5.2 %) had a higher-than-normal value (**Table 4)**. There was no significant difference in the mean urea values between diabetic patients and non- diabetic controls (**P = 0.154**). Alternatively, more diabetic patients (57; 37.0 %) had high levels of serum creatinine than non-diabetic controls (7; 6.3 %). There was a highly significant difference in the distribution of mean serum creatinine levels between diabetic patients and non-diabetic controls (**P < 0.001**). The creatinine values for the study participants ranged from 0.40 mg/dl to 5.90 mg/dl.

The correlation between the different biochemical markers was analyzed. There was no correlation between CRP (R = 0.038; P = 0.786) and no correlation between CRP and HbA1c (R = - 0.219; P = 0.267).

Discussion:

A diabetic person's likelihood of having silent bacteriuria is affected by a number of characteristics, including age, gender, and body mass index (BMI) [21,27]. Patients with diabetes who are elderly reportedly have an increased risk of developing ASB [27,28]. On the other hand, the present study did not find any association between age and ASB, which is in line with the findings of other recent research [29,30]. In addition, a number of studies have found that the degree of glycemic control (HbA1c) in diabetic patients is a factor that increases the likelihood of developing ASB [29,30]. The findings of the current investigation, which showed that there was no connection between Hba1c levels and ASB, contradict this assumption. Studies [21,28] conducted on the topic did not reveal a correlation between ASD and glycemic control that was statistically significant. In this particular investigation, a significant association between ASB and the fasting plasma glucose level, body mass index, glycosuria, sexual activity, or duration of diabetes was not discovered. In the current analysis, risk variables for ASB in diabetic patients were women's gender, a history of recurrent urinary tract infections (UTIs), a lack of formal education, and menopause. Previous research [31] found that females are more prone to urinary tract infections (UTIs) than males. On the other hand, researchers [30] found no significant difference in the risk of ASB between diabetic males and females. The amount of education one has is one of the most important factors that determines social standing. A study found that diabetics who had a poor socioeconomic status had a greater incidence of urinary tract infections (UTIs) [32]. These findings suggested that the ASB risk factors vary from case to case. Laboratory testing was found to be the most reliable predictor of ASB when compared to both the patient's medical history and their demographics.

There have been no reports of diabetes patients in this particular region exhibiting any of the signs that are associated with the development of systemic problems. As a consequence of this, the current study was carried out to ascertain the level of prevalence of biochemical markers among diabetic patients in and around Indore. In diabetic patients, fasting plasma glucose (FPG) as well as hemoglobin A1 (HbA1) levels were evaluated to evaluate the degree of glycemic control. However, the mean FPG was significantly higher in diabetes patients (148.8 ± 70.1 mg/dl) than in non-diabetic patients (93.6 ± 18.5 mg/dl). Although the mean HbA1c value of diabetic patients was found to be within the normal range, the mean FPG was significantly higher in diabetic patients. In diabetic individuals, having a level of HbA1c that was below the optimum range was a sign of good long-term glycemic management.

There is evidence to imply that CRP is connected to inflammation throughout the body [33]. According to the findings of a study [34], there is a connection between CRP and insulin resistance, and diabetes individuals in Iraq have a blood CRP level that is two times higher than that of their non-diabetic counterparts. CRP, on the other hand, has not been linked to any pro-inflammatory markers in diabetic patients in any study. The current study found that diabetic patients had much higher mean serum levels of

CRP than non-diabetic controls did. This difference was statistically significant. Very high titers of CRP, which were measured at 20.5 ± 18.0 mg/l, were also found in diabetes individuals. This value was found to be three times greater than that seen in non-diabetic controls. Patients with diabetes who have high levels of CRP may have inflammation throughout their bodies, as this could be an indication of the condition.

Urea and creatinine levels in the serum are significant indicators of diabetic nephropathy and chronic kidney disease, respectively. In the current study, diabetes patients and non-diabetic individuals had their serum levels of urea and creatinine evaluated and compared. The individuals in the study had mean blood values that fell within the acceptable range for urea and creatinine; however, diabetes patients had considerably higher serum creatinine levels than non-diabetic controls did. The findings of this study are in line with the findings of other previously conducted investigations [35,36]. A recent study carried out in India found that diabetic patients had higher levels of serum urea and creatinine than the control group, and that these values were connected with the participants' blood sugar levels [37]. In the current investigation, there was no correlation between serum creatinine and glycemic control (HbA1c). One possible explanation for this disparity is that the two approaches were carried out differently. HbA1c, which represent long term (about 3 months) glycemic control, were measured in the present study. The previous authors used fasting blood sugar levels, which give a measure of glycemic control only at the time of recording. In contrast, fasting blood sugar levels were measured in the previous study. In the diabetic patients that participated in this investigation, a significant positive connection was shown to exist between serum creatinine. In diabetes individuals, this symptom could be an indicator of inflammatory processes that occur as a result of the breakdown of muscle tissue; nevertheless, this topic has to be researched more. This study provides further evidence that diabetes people may be at an increased risk of developing renal disease, despite the fact that glycemic management had no effect on blood creatinine levels.

A further comparison was made between diabetes patients who had oral infections and diabetic patients who did not have oral infections using the various biochemical indicators. The detection of CRP was significantly different between the two groups as a result of this discrepancy. Individuals with diabetes who also had oral infections had significantly higher CRP levels than diabetic patients who did not have oral infections ($P = 0.041$). This suggests that oral infections have a key influence in the inflammation that occurs throughout the body. In addition, high levels of HbA1c were found in 41.2% of diabetes patients who had oral infections, whereas only 7.7% of diabetic patients who did not have oral infections did so (P 0.001 for both comparisons). HbA1c values that were higher than 8% were substantially associated with oral yeast infection in a study that was related to this one [38]. The accumulation of these studies points to the possibility that diabetes patients who suffer from oral infections may have altered glycemic control.

Conclusion:

It is possible that alterations in blood cells and inflammatory indicators such as C-reactive protein play a significant role in the etiopathogenesis of diabetes (CRP). Patients who have diabetes may have an increased likelihood of having chronic systemic difficulties as a result of the elevated levels of CRP and serum creatinine that they experience. Urinary tract infections, also known as UTIs, have been associated to long-term issues with glycemic management as well as systemic inflammation in people who have diabetes. Isolates from the urinary tract revealed moderate to high resistance to antimicrobial medications that are widely prescribed, and the resistant patterns seen in urine isolates did not change over the course of observational time. In addition, there was no discernible difference between the patterns of resistance of isolates taken from diabetic patients and those obtained from controls who did not have diabetes in terms of the resistance patterns. This suggests that the rates of exposure to antimicrobial compounds experienced by bacteria from these two habitats are comparable to one another.

Conflict of interest:

None exist among the authors of the present study.

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Table 1: Demographic information of study participants

	Diabetics n (%)	Non-diabetic controls n (%)	Total n (%)
Age in years			
18-30	12 (4.8)	9 (3.6)	21 (8.4)
31-40	14 (5.6)	12 (4.8)	26 (10.4)
41-50	38 (15.2)	36 (14.4)	72 (30.4)
50 & above	80 (32)	51 (20.4)	131 (52.4)
Chi-square: χ2 = 4.77; df = 3; P = 0.182			
Gender			
Male	48 (37)	55 (47)	113 (45)
Female	82 (63)	65 (53)	147 (55)
Chi-square: χ2 = 4.131; df = 1; P = 0.092			
Marital Status			
Single	45 (18)	35 (14)	80 (32)
Married	58 (56)	62 (61)	130 (52)
Divorced	15 (6)	13 (5)	28(11.2)
Widowed/widowed	10 (4)	12 (4.8)	22 (8.8)
Chi-square: χ2=2.896; df=3; P=0.726			
Level of Education (N = 250)			
No formal education	20 (13.0)	6 (5.4)	26 (9.8)
Primary	61 (39.6)	46 (41.5)	107 (40.4)
Secondary	46 (29.9)	30 (27.0)	76 (28.7)
Higher education	27 (17.5)	29 (26.1)	56 (21.1)
Chi-square: χ2 = 7.344; df = 3; P = 0.096			

Table 2: Risk analysis for measurable predictors for ASB in diabetic patients

Indicators		**Bacteriuria**			**Odd Ratio (95% CI; LB-UB)**		
		Yes n (%)	**No n (%)**	**n**	**Value**	**LB**	**UB**
Glycosuria	Negative	46(41.1)	55(58.9)	101	1.982	0.498	3..021

	Positive	16(38)	27(62)	43			
Protenuria	Negative	38 (41)	55(59)	93	0.881	0.412	2.392
	Positive	25(43.0)	38(57)	63			
Urine Nitrite	Negative	59 (40)	81(60)	140	0.299	0.329	0.500
	Positive	3(100)	0(0.0)	3			
Pyuria	Negative	51 (38)	85(62)	136	0.172	0.028	0.799
	Positive	6(74)	3(26)	9			
Blood	Negative	51(39)	88 (61)	139	0.298	0.064	1.492
	Positive	7(68)	3(32)	10			
FPG (mg/dL)	High	25(34)	51(66)	76	0.701	0.421	1.002
	Normal	32 (45)	42(55)	74			
Serum creatinine	High	18(32)	38(68)	56	0.598	0.329	1.651
	Normal	39 (43)	54 (57)	93			
Serum urea (mg/dL)	High	5(50.0)	5(50.0)	10	1.923	0.388	6.992
	Normal	55 (39)	95(64)	150			
HbAlc (%)	Good	39 (46)	48(54)	87	2.001	0.994	4.381
	Poor	15 (32)	33 (71)	48			

Table 3: Comparison of HbA1c and FPG levels among diabetic patients and non- diabetic controls

Note: There is significant correlation when OR > 1; LB and UB > 1

Indicator	**Categories**	**Participant type**		**Total n (%)**
		Diabetic n (%)	**Non-diabetic n (%)**	
HbA1c (%)	Good Control (< 7 %)	81 (62)	-	-
	Poor Control (> 7%)	39 (38)	-	-
FPG (mg/dL)	Hypoglycemia (<60mg/dl)	2 (1)	0 (0)	2 (1)
	Normal (60-126 mg/dl)	71 (55)	105 (97)	169 (68)
	Hyperglycemia (>126 mg/dl)	88 (68)	5 (3)	93 (37)

Table 4: Comparison of serum levels of CRP and RF in study participants

Indicator	**Category**	**Participant type**		**Total n (%)**
		Diabetics n (%)	**Controls n (%)**	

CRP (mg/L)	Negative (< 6mg/l)	34 (26)	87 (72)	121 (48)
	Positive (>= 6 mg/l)	96 (74)	33 (28)	133 (52)

Table 5: Comparison of serum levels of creatinine and urea in study participants

Indicator	**Category**	**Participant type**		**Total n (%)**
		Diabetics n (%)	**Controls n (%)**	
Serum urea (mg/dl)	Normal	121 (93)	118 (98)	239 (96)
	High	9 (7)	2 (2)	11 (4)
Serum creatinine (mg/dl)	Low	6 (5)	15 (12)	21 (8)
	Normal	94 (72)	74 (62)	168 (67)
	High	54 (23)	7 (6)	61 (24)