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Aging and UTI: are Teenagers more prone?

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Abstract:

Background: None of the studies have classified UTI in males and females based on the age factor. Therefore the present study compared the prevalence of UTI in various age groups of males and females.

Methodology: Dipstick and microscopy urinalyses were carried out on 1569 consecutive urine samples of patients, and the results were statistically analyzed.

Results: UTI in females was more often than males, excluding children (p=0.27) and adults (p=0.30), groups. When compared within females, UTI was more prevalent in teenagers and old groups (p<0.01). Pyuria was significantly higher in all age groups of females except children (p=0.21) in comparison to age-matched males. Both young females and males had a significantly low prevalence of glycosuria and proteinuria when compared within the same-sex groups. We discovered that there are 56% chances of having pyuria, 26% chances of proteinuria, and 11% chances of glycosuria and hematuria in UTI patients with negative predictive value of more than 90%. This study also showed that 21% of glycosuric patients were positive for proteinuria (glomerular disease), which showed increased chances of progression to glomerular disease in these patients.

Conclusion: UTI within and in between males and females at different ages are significantly different. UTI negative patients have <10% chance of having glomerular disease, hematuria and pyuria.

Introduction:

Urine is a critical health indicator for many diseases such as UTI, diabetes, kidney, liver, and infectious diseases. Urine examination usually provides valuable clinical information about the functional status of the kidney and liver. The results can be used for the diagnosis, monitoring, and following the course of a disease. Therefore, urinalysis has evolved into a well-established and standardized laboratory practice from a bedside procedure (Hsiao, Yang, et al. 2015).

Urinary tract infection (UTI) is the infection of any part of the urinary tract. It can be diagnosed either based on pyuria or demonstration of at least 50,000 colony forming units per ml of urine. It is estimated that 150 million UTIs occur yearly on a global basis, which has resulted in more than 6 billion dollars of direct health care expenditures (Stamm and Norrby 2001). In general, age, sex, and location of the infection in the urinary tract play a significant role in UTI. UTI infects more in females than males. It is one of the common causes for which gynecologists are sought. However, male infants are more susceptible to developing UTI in comparison to female children (Arshad and Seed, 2015). It may be due to severe bacterial illness among infants and young children, which in turn may cause morbidity due to the development of infectious diseases. Patients with type 2 diabetes mellitus, hematuria, and proteinuria usually suffer from worse outcomes due to UTI (Carter, Tomson, et al. 2006; McDonald, Swagerty, et al. 2006; Nitzan, Elias, et al. 2015). Various impairments such as low immunity due to immune dysfunction and poor metabolic control may enhance the risk of urinary tract infections in these patients. However, none of the studies have discovered prevalence of the above-mentioned conditions of UTI, glycosuria, hematuria, and proteinuria in various male and female age groups.

The objective of this study was to compare the prevalence of UTI in various age groups of males and females. We have also studied co-relation of proteinuria, hematuria, and glycosuria with urinary tract infection besides studying the association of pyuria and positive urine culture in patients who suffered from suspected UTI.

Materials and Methods

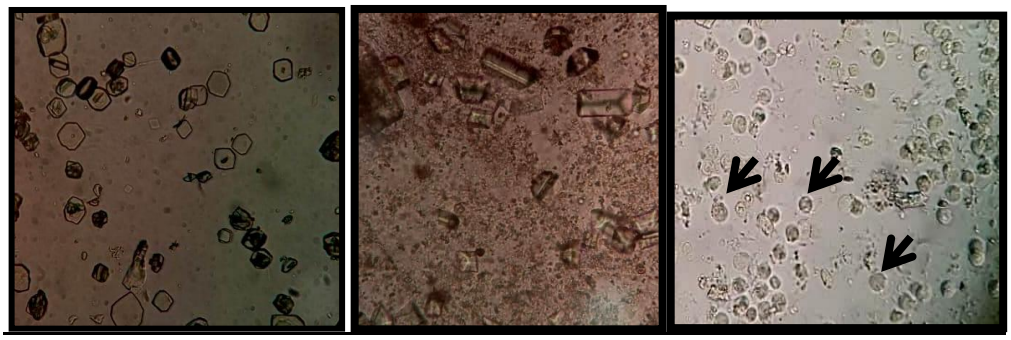
The 1569 consecutive urine samples of age in between 1 month-99 years were collected in a clean, wide-mouthed and dry disposable plastic cups. Patients were further categorized into five groups of children (0-12 years), teenagers (13-17 years), young (18-35 years), adults (36-65 years) and old age (>65 years). Key patient data consisting of name, age, gender, collection date and time were affixed to the container before the collection of samples. All the urine samples were completely processed within 2 hours of collection, to circumvent the growth of any contaminating bacteria. Urine samples thus obtained were divided into 2 parts for urinalysis. 1) **Dipstick urinalysis:** The urinalysis includes physical, chemical and microscopic examination. The first part was immediately tested using reagent strip for urinalysis. The strips had specific reagent pads for qualitative and semi-quantitative evaluation of protein, pH, blood, specific gravity, and glucose. **Microscopic analysis:** In microscopic urinalysis, urine samples were primed for microscopy by centrifuging 10 mL of urine for 5 minutes, at 1000 rpm. The supernatant was poured off and about

0.05 mL of the sediment was subsequently examined at low and high powers for the presence of white blood cells (WBCs), bacteria, red blood cells (RBCs), crystals, casts, epithelial cells, and fungi. Cut off values for positive results are: > 5 WBCs per high power field. Data either in between females and males or within same sex was compared by using chi square test.

Results

Population: 1569 consecutive urine samples of various age groups were studied. In the present study age of the patients ranged from 1 month to 92 years. We have categorized patients into 5 groups i) children (0-12 years) ii) Teenager (13-17 years) iii) Young (18-35 years) iv) adult (36-65 years) and v) old (>65 years). Male patients were in higher number in children (191 vs. 109) and old age groups (173 vs. 128) while, female patients were higher in young (162 vs. 256) and adult (197 vs. 226) groups. The number of male and female patients in teenager group was comparable (63 vs. 64) (Table 2). Among all urine samples, various parameters were analyzed by the urine test strips as well as microscopically in the DNA Xperts Diagnostics Private Limited, Noida (Table 1). UTI infection was found to be highest in teenagers when compared with other groups. Similarly glycosuria was completely absent in all the samples of teenager group, while adults showed significant difference with young groups (11% vs. 3%; $p<0.05$). This data also showed that proteinuria was found to be least in young age groups. No significant difference was observed in other parameters when compared among all age groups

Table 1: Comparison of various parameters of dipstick urinalysis and microscopy analysis in different age groups



(A) (B) (C)

Figure 1: (A) Uric acid crystals (B) Triple phosphate crystals (c) pus cells in urine

Parameters	Age Group				
	Children 0-12 (n=300)	Teenagers 13-17 (n=128)	Young 18-35 (n=417)	Adults 36-65 (n=424)	Old >65 (n=300)
pH	6.3	6.8	6.4	6.2	6.3
Specific gravity	1.02	1.02	1.02	1.04	1.04
UTI	14(5%)	15 (12%)	22 (5%)	28 (6%)	33 (11%)
Crystals	42(14%)	11 (9%)	52 (12%)	55 (13%)	30 (10%)
Blood	20(6.6%)	8 (6.2%)	43 (10%)	51 (12%)	30 (10%)
Pyuria	40 (13%)	27 (21%)	128 (31%)	126 (30%)	89 (30%)
Glycosuria	1 (0.33%)	0(0%)	13(3%)	45(11%)	24(8%)
Proteinuria	52(17%)	21(16%)	33(8%)	58(14%)	77(26%)

Females of all age except children group showed high prevalence of urinary tract infection in comparison to age matched males

Patients of all age groups were next categorized into male and female sub groups. Laboratory evidence of bacteriuria and pyuria are considered to be the main factors in determining UTI. Therefore, we have divided UTI into two groups of bacteriuria (symptomatic or asymptomatic) and pyuria. Pyuria

is most commonly caused by a UTI, which is an infection in any area of the urinary system, including the kidneys, ureters, urethra, or bladder. We observed bacteriuria in just one young male patient out of 162 which was significantly lower than males of other age groups (p<0.01) (Table 2). In comparison to male'sprevalence of pyuria was significantly higher in females (p<0.01) of all age groups except children group. On the contrary male children showed slightly high percentage of pyuria in comparison to females, although the difference was not significant (15% vs. 10%; p=0.21) (Table 2 and 3).Similarly, teenagers (teenagers; 17 vs 6%; p=0.05), young females (8% vs. 0.6%; p=0.0007 or <0.01) and older females (17% VS. 6.4%; P= 0.003 or <0.01) showed significantly higher prevalence of bacteriuria when compared with their age matched male subgroup. On the contrary, no significant difference was observed in between other groups (children; 6 vs 4%, adult; 7.5 vs 5 % (Table 2). Crystals were found to be significantly higher (p=0.03) in females of teenager group (Figure 1).

Parameters	**Children (0-12)**			**Teenagers (13-17)**			**Young (18-35)**		
	Males (n=191)	**Females (n=109)**	**p-value**	**Males (n=63)**	**Females (n=64)**	**p-value**	**Males (n=162)**	**Females (n=256)**	**p-value**
pH	6.3	6.4		6.2	6.4		6.6	6.3	
Specific gravity	1.02	1.02		1.02	1.02		1.02	1.02	
UTI	7(4%)	7 (6%)	0.27	4 (6%)	11 (17%)	0.05	1(0.6%)	21 (8%)	**0.0007**
Crystals	30(16%)	16 (15%)	0.81	2 (3%)	9 (14%)	**0.03**	24 (15%)	26 (10%)	0.15
Blood	12(6%)	8 (7%)	0.72	2(3%)	6 (9%)	0.14	17 (10%)	26 (10%)	0.91
Pyuria	29(15%)	11 (10%)	0.21	7(11%)	20 (31%)	**0.005**	25 (15%)	103 (40%)	**0.00001**
Glycosuria	1 (0.5%)	0 (0%)	0.69	0(0%)	0 (0%)	0.99	6(4%)	7 (3%)	0.58
Proteinuria	36(19%)	16 (15%)	0.35	14(23%)	7 (11%)	0.08	18(11%)	15 (6%)	**0.05**

Table 2: Comparison of various parameters of dipstick urinalysis and microscopy analysis in different male and female age groups

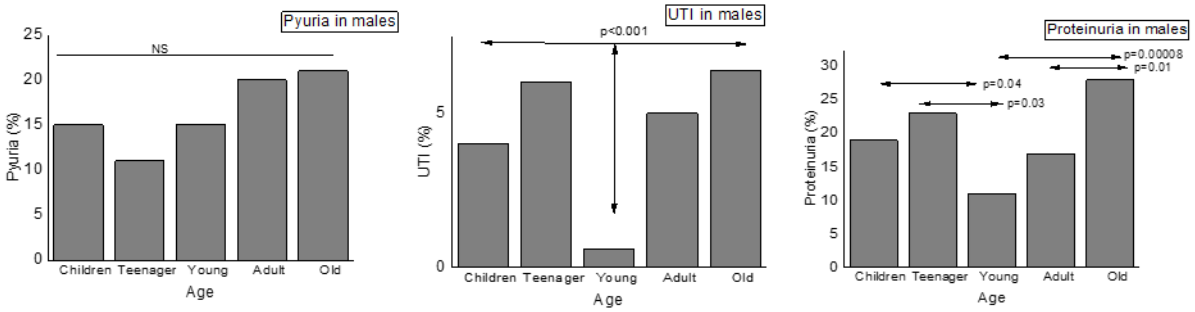
Parameters	**Adults (36-65)**			**Old (>65)**		
	Males (n=197)	**Females (n=226)**	**p-value**	**Males (n=173)**	**Female (n=128)**	**p-value**
pH	6.2	6.2		6.2	6.3	
Specific gravity	1.02	1.02		1.04	1.07	
UTI	10 (5%)	17 (7.5%)	0.30	11(6.4%)	22 (17%)	**0.003**
Crystals	26(13%)	30 (13%)	0.98	19(10%)	12 (9%)	0.65
Blood	28 (14%)	23 (10%)	0.20	18 (10%)	12 (9%)	0.77
Pyuria	40 (20%)	86 (38%)	**0.00006**	36(21%)	53 (41%)	**0.00011**
Glycosuria	27(14%)	18 (8%)	0.06	15(9%)	9 (7%)	0.60
Proteinuria	34(17%)	24 (11%)	0.12	49(28%)	28 (22%)	0.20

Least risk of glycosuria and proteinuria in young males

In case of pyuria no significant difference was observed among males of all age groups (p>0.05). Young males also showed significantly low glycosuria when compared with adult males (14% vs. 4%; p=0.002). In teenagers and children group, glycosuria was found to be almost absent (0% and 0.5% respectively) (Table 3 and Figure 2). Young males showed significantly less prevalence of UTI (0.6%) in comparison to all the groups. Proteinuria was higher in older males when compared with other groups. However, the data was found significant only when compared with younger and

adult groups (p=0.00008 and p=0.01 respectively) (Table 3 and Figure 3). Similarly, young males were at least risk of having proteinuria (11%) in comparison to children (19%; p=0.04) and teenager (23%; p=0.03) groups. This study also showed that hematuria was significantly higher in adult males when compared with teenagers and children (p=0.0001 and p=0.006 respectively). In brief this data suggest that younger males are at least risk of developing UTI, glycosuria and proteinuria in comparison to adult and old age group. Hematuria was not comparable among young, adults and older males (10%, 14% and 10% respectively) (Table 3).

Table 3: Comparison of various parameters of dipstick urinalysis and microscopy analysis within different age groups of males



Parameters	Age Group (males)				
	Children 0-12 (n=191)	**Teenagers 13-17 (n=63)**	**Young 18-35 (n=162)**	**Adults 36-65 (n=197)**	**Old >65 (n=173)**
pH	6.3	6.2	6.6	6.2	6.2
Specific gravity	1.02	1.02	1.02	1.02	1.04
UTI	7(4%)	4 (6%)	1(0.6%)	10 (5%)	11(6.4%)
Crystals	30(16%)	2 (3%)	24 (15%)	26(13%)	19(10%)
Blood	12(6%)	2(3%)	17 (10%)	28 (14%)	18 (10%)
Pyuria	29(15%)	7(11%)	25 (15%)	40 (20%)	36(21%)
Glycosuria	1 (0.5%)	0(0%)	6(4%)	27(14%)	15(9%)
Proteinuria	36(19%)	14(23%)	18(11%)	34(17%)	49(28%)

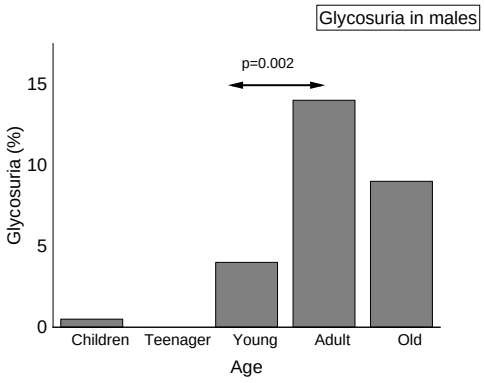


Figure 2: Percentage prevalence of pyuria, UTI, proteinuria and glycosuria in different male age groups

Least risk of pyuria in female children and low prevalence of glycosuria and proteinuria in young females

Unlike male children female children showed significantly low prevalence of pyuria in comparison to teenager, young , adult, old (10% vs 31%, 40%, 38% and 41%; p<0.001). Teenager and old groups showed high chances of bacteriuria in comparison to other groups. No case of glycosuria was reported in children and teenager group. Young females like males showed significantly low prevalence of glycosuria (3%) in comparison to adult (8%;p=0.009) and old age (7%; p=0.04) group and proteinuria in comparison to all groups. Additionally, significant difference was observed (p=0.004) in between old and adult age groups. Unlike male's hematuria was not significantly different in all the groups (Table 4 and Figure 4).

Table 4: Comparison of various parameters of dipstick urinalysis and microscopy analysis in different age groups of females

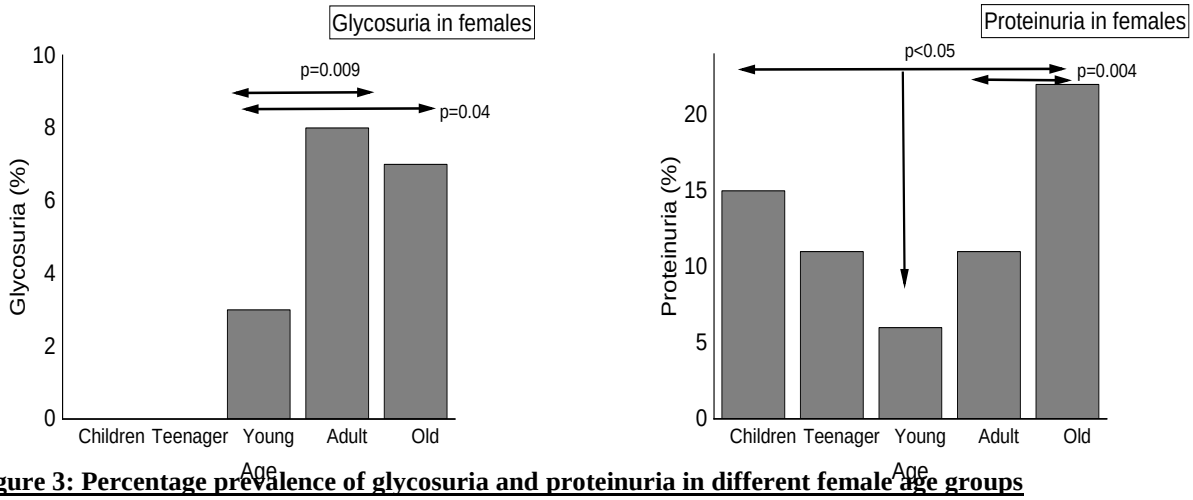


Figure 3: Percentage prevalence of glycosuria and proteinuria in different female age groups

Co-relation of proteinuria, hematuria and glycosuria with UTI

Our study showed that 26% (29/112) patients were positive for both UTI and proteinuria. This correlation was not significant among all groups with sensitivity, specificity, PPV and NPV of 26%, 85%, 12% and 93% respectively. Therefore there are 12% chances of correlation in between positive culture (UTI) and proteinuria and 93% chances of correlation between negative culture and proteinuria. Both hematuria and glycosuria was not significantly different in all the groups when compared with UTI positive groups. Similarly, 51 cases were found to be positive for both UTI and pyuria. However 61 of UTI positive cases were negative for pyuria (46%). This showed that UTI does not absolutely show presence of pyuria (Table 5).

Parameters	Age Group (Females)				
	Children 0-12 (n=109)	Teenagers 13-17 (n=64)	Young 18-35 (n=256)	Adults 36-65 (n=226)	Old >65 (n=128)
pH	6.4	6.4	6.3	6.2	6.3
Specific gravity	1.02	1.02	1.02	1.02	1.07
UTI	7 (6%)	11 (17%)	21 (8%)	17 (7.5%)	22 (17%)
Crystals	16 (15%)	9 (14%)	26 (10%)	30 (13%)	12 (9%)
Blood	8 (7%)	6 (9%)	26 (10%)	23 (10%)	12 (9%)
Pyuria	11 (10%)	20 (31%)	103 (40%)	86 (38%)	53 (41%)
Glycosuria	0 (0%)	0 (0%)	7 (3%)	18 (8%)	9 (7%)
Proteinuria	16 (15%)	7 (11%)	15 (6%)	24 (11%)	28 (22%)

Parameters	UTI positive (+ve)					Total
	0-12 (n=14)	13-17(n=16)	18-35(n=22)	36-65(n=28)	>65(n=31)	n=112
Proteinuria	5 (35%)	1(6%)	3(9%)	8(25%)	12(38%)	29(26%)
Glycosuria	0	0	2(9%)	8(29%)	2(6%)	12(11%)
Hematuria	0	3(6%)	3(14%)	2(7%)	4(13%)	12(11%)
Pyuria	5(43%)	7(50%)	9(28%)	15(57%)	15(48%)	51(46%)

	UTI			Sensitivity	26
Proteinuria		+	-	Specificity	85
	+	29	212	PPV	12
	-	83	1245	NPV	93

	UTI			Sensitivity	14
Glycosuria		+	-	Specificity	95
	+	12	67	PPV	15
	-	100	1390	NPV	93

	UTI			Sensitivity	12
Hematuria		+	-	Specificity	90
	+	12	139	PPV	8
	-	100	1318	NPV	93

	UTI			Sensitivity	45
Pyuria		+	-	Specificity	75
	+	51	359	PPV	12
	-	61	1098	NPV	95

Table 5: Co-relation of proteinuria, glycosuria, hematuria and pyuria with UTI

Comparison characteristics of dipstick urinalysis and microscopic analysis for blood

Microscopic analysis showed total of 176 cases positive for hematuria, however, dipstick urinalysis was not able to detect 24 cases out of 176(14%). The sensitivity, specificity, positive predictive value and negative predictive value of dipstick urinalysis for blood was calculated as 86%, 99%, 99.3& and 98.3% respectively (Figure 5 and Table 6).

Hematuria			
	Microscopy		
Dipstick		+	-
	+	152	1
	-	24	1392

Table 6: Comparison characteristics of dipstick urinalysis and microscopic analysis for blood

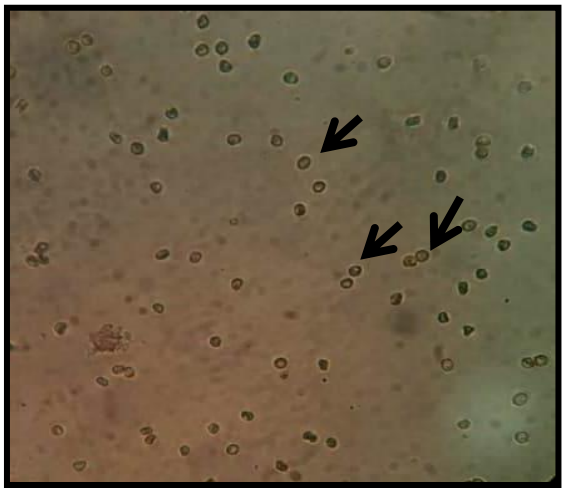


Figure 4: RBCs in Urine (arrow depicting RBCs)

We did not find any co-relation in between glycosuria and specific gravity (SG). 458 cases which were having SG>1.020 were not suffering from glycosuria.

Glycosuria			
Specific gravity (>1.020)		+	-
	+	19	458

Table 7: Co-relation of glycosuria and specific gravity

Discussion

Many studies have reported that urinary tract infection is more common in females than males. However, none of the studies have discovered the prevalence of UTI in various age groups of males and females irrespective of the fact that symptoms of UTI vary significantly with the patient's age and location of the infection within the urinary tract. In general, UTI affects females more often than males among adults. The estimated risk of symptomatic UTI in children aged 2 to 14 years is 1.6/1000/year in males and 3.8/1000/year in females. This study showed that young males have the least prevalence of UTI (1/162; 0.6%) when compared with males of other age groups. However, chances of infection were significantly higher in females of all age groups, excluding children and adults, where the difference was not found to be significant in comparison to age-matched males.

Pyuria (>5 white cells per high power field) or excretion of an increased number of white blood cells is considered to be presumptive evidence of UTI. Pyuria may consider as an indicator of UTI. It is suggested that 40% of patients with pyuria of more than ten white cells per high power field visualized also contained significant UTI (Najar, Saldanha, et al. 2009). Centrifuged urine sediment that shows the existence of pyuria does not indicate UTI, but it can be used for a suspected diagnosis of UTI. Conversely, UTI does not show pyuria. In this study, the prevalence of pyuria in male children (29/191; 15%) was comparatively higher than females (11/109; 10%) of the same age groups with an insignificant p-value (p=0.21). The precise reason for the increased predilection of male children to UTI in this age group is unclear; it may be related to geographical variation, genetic makeup, sanitary education, and increased susceptibility to sepsis and other bacterial infections that have been well described in males during early childhood. Pyuria was significantly higher in females of all the other groups when compared with males of the same age group ($p<0.01$ in all cases except children group).

High urine glucose content and defective host immune factors may affect the severity of the infection. Neutrophil dysfunction due to hyperglycemia, vaginal candidiasis, and vascular disease also play a role in recurrent infections(Chen, Jackson, et al. 2009). We did not find any significant correlation of UTI with glycosuria. Irrespective of age and sex, patients suffering from glycosuria did not show the presence of UTI. Next, we compared glycosuria in various age groups. There was no significant difference in females and males of all age groups. However, both young females and males were having a significantly low prevalence of glycosuria when compared with their respective adults groups.

Additionally, as expected, glycosuria was overall absent in both teenagers and children groups.

Due to the reported association between UTI and proteinuria, many clinicians recommend the exclusion of a UTI if a test result for total urinary protein is positive(Rothschild 1971; Beetham and Cattell 1993; Levey, Eckardt, et al. 2005). To further explore this, we have tried to find a correlation between UTI and proteinuria. Our study showed that only 25% (29/112) patients were positive for both UTI and proteinuria. This correlation was higher in the case of children (35%), adult (25%), and old groups (38%) in comparison to other groups. Therefore, UTI may not be the cause of proteinuria in this population. While young males showed a low prevalence of proteinuria in comparison to teenagers and children, young females showed a significantly small appearance of proteinuria when compared with all the other groups. In both males and females, proteinuria was found to be highest in the >65 age group. Similarly, male teenagers showed low prevalence (3%) of hematuria in comparison to female teenagers (9%). Hematuria was not significantly different in all the other groups when compared within the same sex and with UTI positive groups. In conclusion, UTI in females was more often than males, excluding children and adults, where the difference was not found to be significant in comparison to age-matched males. Prevalence of pyuria in male children (29/191; 15%) was comparatively higher than females (11/109; 10%) of the same age groups with an insignificant p-value (p=0.21). Both young females and males were having a significantly low prevalence of glycosuria and proteinuria when compared within same-sex humans. Diabetes Mellitus, hematuria, and proteinuria usually suffer from worse outcomes due to UTI (Carter, Tomson, et al. 2006; McDonald, Swagerty, et al. 2006; Nitzan, Elias, et al. 2015). We discovered that 56% cases ofpyuria, 26% cases of proteinuria, and 11% cases of glycosuria and hematuria were positive for UTI with negative predictive value of more than 90%. This study also showed that 21% of glycosuric patients were positive for proteinuria (glomerular disease), which showed increased chances of progression to glomerular disease in these patients. This study also showed that UTI does not absolutely show presence of pyuria (Table 5).

Conclusion: UTI within and in between males and females at different ages are significantly different. UTI negative patients have <10% chance of having glomerular disease, hematuria and pyuria.

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