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Research Article

Exploring the Prevalence of Urinary Tract Infection (UTI) In Type II Diabetic Patients: A Comparative Analysis of Dipstick and Microscopic Methods

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Abstract:

Background Knowledge: Diabetic patients at heightened risk for urinary and renal problems resulting from metabolic abnormalities. Urine dipstick examination is a quick and non-invasive diagnostic method often used to identify abnormalities in many clinical parameters, such as nitrites, protein concentrations, ketone bodies, and leukocyte esterase.

Aim: The study aims to examine the incidence of urinary tract infections (UTIs) in Type II diabetes patients by comparing the diagnostic effectiveness of dipstick testing and microscopic analysis.

Material and Method: A cross-sectional research including 264 diabetes individuals was performed. Urine samples were evaluated via dipstick techniques to assess factors such as nitrites, protein concentrations, ketone bodies, leukocyte esterase, and other indicators. Statistical methods, such as Chi-Square tests and Spearman's correlation, were used to assess connections between nitrites and other factors.

Result: Among the 264 patients, 48.5% were male and 51.5% were female, with ages ranging from 18 to over 61 years. Significant associations were observed between nitrites and clinical parameters such as protein levels ($p < 0.001$), ketone bodies ($p < 0.001$), and leukocyte esterase ($p < 0.001$). For instance, 78% of patients with negative nitrites showed normal protein levels, while 20.5% had trace levels. However, no significant associations were found between nitrites and demographic variables like gender ($p = 0.936$) or age ($p = 0.257$).

Conclusion: This research underscores the efficacy of urine dipstick examination in diabetic patients for identifying significant urinary abnormalities associated with nitrites. These results underscore the need of regular urine screening to successfully prevent or control problems in patients with diabetes.

Key words: Benedict test, Diabetes mellitus, Dipstick urine, Urinary tract infection.

Introduction

Urinary tract infection (UTI) is regarded as one of the most prevalent infectious disorders in females compared to males (Nagalo *et al.,* 2023). Diabetes mellitus is a metabolic condition marked by persistent hyperglycemia resulting from deficiencies in insulin production or insulin activity (Gabir *et al.,* 2000). The World Health Organization classifies diabetes mellitus (DM) into type 1 (T1D), type 2 (T2D), and gestational diabetes (GDM) based on etiology and clinical presentation (WHO, 1999; WHO, 2006). Type 1 diabetes arises when pancreatic beta cells are destroyed, resulting in either an absence of insulin production or insufficient insulin levels. This mostly affects youngsters and is also referred to as juvenile diabetes. Conversely, Type 2 Diabetes (T2D) arises from insulin resistance and mostly impacts adults. Gestational diabetes is defined by elevated blood glucose levels throughout pregnancy (WHO, 1999). Global screening for chronic kidney disease (CKD) is contentious. It is conducted in several nations worldwide. This topic pertains to the ambiguity over the potential benefit of early identification of renal diseases in reducing instances of end-stage renal disease (ESRD) in kids (Sumida *et al.,* 2020).

Sugars can be classified as reducing or nonproducing depending on their capacity to decrease copper in the Benedict's

test. The reducing property of sugar is attributed to the presence of free aldehyde or ketone groups. The majority of monosaccharide's and disaccharides are classified as reducing sugars, whereas sucrose is categorized as a non-reducing sugar. Reducing sugars can convert Cu2+ (cupric ions) to Cu+ (cuprous ions) in an alkaline media, resulting in a red precipitate of cuprous oxide or a yellow precipitate of cuprous hydroxide. Normal persons' urine contains minimal quantities of reducing chemicals, insufficient to yield a positive result in Benedict's or Fehling's tests. The urine contains several reducing sugars, including glucose, galactose, fructose, and lactose (Kumar *et al.,* 2018).

The sole critical laboratory finding necessary for diagnosing diabetes is hyperglycemia, either in a fasting state or following an appropriate tolerance test. This comment is not meant to diminish the significance of the readily performed urine glucose tests; and extremely. Most diabetics are likely identified through their physicians' practice of routinely conducting a thorough urinalysis for all patients (SB *et al.,* 2023). Nonetheless, the identification of a component in urine that diminishes in the Benedict test does not necessarily indicate that glucose is the culpable agent. From a practical perspective, it is essential to regard the patient as diabetic; yet, it is as vital to explore the issue in greater depth. Other sugars, including fructose, galactose, maltose, lactose, and pentoses (except sucrose), exhibit similar reactions in the Benedict test. Additionally, a false positive may arise following the use of some medications that are conjugated and eliminated as glucuronides (Smith 1959, Mitra *et al.,* 2023). Diabetes mellitus primarily impacts organs and tissues abundant in capillary networks, including the kidneys, retina, and nerves, due to the onset of microangiopathy. Comparable alterations in tiny arteries also transpire inside the oral tissues (Abu-Elteen *et al.,* 2006). The consequences of diabetes mellitus encompass enduring damage, dysfunction, and failure of multiple organs, potentially resulting in the progressive emergence of chronic complications such as retinopathy, which may cause blindness; nephropathy, which can lead to renal failure; and neuropathy, associated with the risk of foot ulcers, amputations, and sexual dysfunction (Agbor *et al.,* 2011).

When it comes to diabetic individuals, the urinary tract is the most common location of infection, and a number of studies have shown a correlation between urinary tract infections and cardiovascular disease (Laswad 2023). In children, it is a significant cause of hospitalization and antibiotic use, affecting up to 2.8% yearly in high-income nations, with recurrence rates between around 8% and 30% (Sarvari *et al.,* 2023). It is estimated that 11.3% of girls and 3.6% of boys get a urinary tract infection at least once during the first 16 years of life (Huang *et al.,* 2022). The most common pathogens in pediatrics that cause UTIs is *Enterobacteraie,* a Gram-negative microorganism (Chu *et al.,* 2018).

The screening programs being used in Japan, Taiwan, and Korea have resulted in successful intervention and early diagnosis. They assess the prevalence of chronic kidney disease in diabetes mellitus. This may result in the increased incidence of chronic kidney disease in diabetes mellitus (Mejia *et al.,* 2021). A further limitation of nitrite testing is that it necessitates over 4 hours for bacteria to effectuate the biochemical transformation of nitrate into nitrite; hence, urine samples taken within 4 hours post-urination are likely to provide incorrect findings (Wilson *et al.,* 2004). A simple, sensitive should be performed to reduce the symptoms and the risk of renal scarring and other UTI consequences (Arienzo *et al.,* 2020). Leucocyte esterase depends on the capacity of leucocytes to generate esterolytic proteins that hydrolyze esters. Leucocyte esterase testing may provide false-positive findings in people with acute leukemia or those undergoing antibiotic therapy(Beer *et al.,* 1996).

Dipstick testing serves as an effective preliminary screening method for urinary tract infections, with rapid findings that may inform further diagnostic and therapeutic choices. The research seeks to investigate these areas to address current knowledge gaps and enhance the overall healthcare strategy for treating UTIs in individuals with Type II diabetes.

Material and Method

Over six months, the study comprised a cross-sectional observational analysis carried out at the MLT Skill Lab, Abasyn University Peshawar, and MS Clinical Laboratory, Tarnab Farm Peshawar and as well as Alkhadimat hospital dabgari Garden Peshawar. Included were 264 patients altogether, male and female, Type II diabetes sufferers with urinary tract infections (UTIs). Raosoft was used with a 95% confidence level, a prevalence of 30%, and a 6% margin of error to ascertain the sample size. Included were anyone eighteen years of age and above with symptoms indicative of UTIs or having regular screening; excluded were those with Type I diabetes, recent UTI treatment, pregnant women, and those unable to provide informed permission. After informed permission, urine samples were gathered and examined by dipstick techniques, Benedict's test, and under microscopic inspection.

Using an alkaline copper sulfate solution, the Benedict test—which searches for reducing agents in urine—indicated glucose presence by color changes. Dipstick tests evaluated indicators suggestive of UTIs, leukocyte esterase and nitrites. To find WBCs, RBCs, bacteria, and other urine components pertinent to an illness, microscopic study included sediment analysis and centrifugation. SPSS version 25 was used for data analysis employing descriptive statistics to provide frequency distributions, percentages, and graphical representations of variables including gender distribution, prevalence of pyuria, hematuria, and proteinuria.

Result

The investigation included a total of 264 individuals, both male and female, from the MS clinical laboratory at Tarnab Farm, Peshawar and as well as Alkhadimat hospital dabgari Garden Peshawar. Of the 264 participants in the study, 128 (48.5%) were male and 136 (51.5%) were female. The Benedict test findings revealed that a significant number of subjects displayed differing levels of glucose in their urine, suggesting the presence of Diabetes Mellitus. Among the subjects, 33.7% (n=89) exhibited a negative result, signifying the absence of

detectable glucose in the urine. Nonetheless, 30.3% (n=80) exhibited trace levels of glucose, whilst 22.7% (n=60) presented a solitary positive (+) result, and 13.3% (n=35) revealed a double positive (++) result. The data indicate that roughly 66.3% of subjects exhibited positive or trace results, underscoring a notable prevalence of glucose, which linked to Diabetes Mellitus showing in the table (5.1).

Table 5.1 show study variable of gender and Benedict test

S.NO	Variable		Frequency	Percentage (%)
1	Gender	Male	128	48.5
		Female	136	51.5
2	Benedict test	Negative	89	33.7
		Trace	80	30.3
		(+)	60	22.7
		(++)	35	13.3

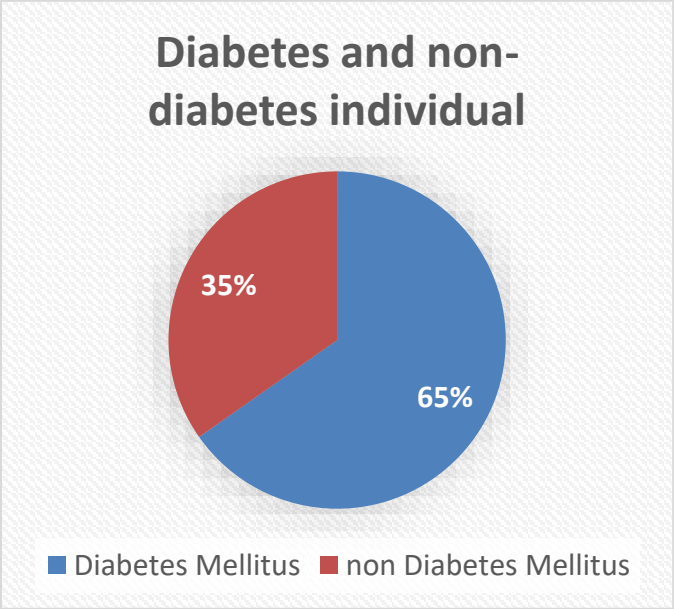

Figure1. Distribution of diabetes and non-diabetes individual

The evaluation of dipstick pee test outcomes indicated diverse irregularities among several parameters. Regarding protein levels, approximately 46.6% (n=123) of subjects exhibited zero findings, 36% (n=95) had trace amounts, and 17.4% (n=46) presented a solitary positive (+) result, signifying proteinuria show in the figure (5.5). Among the ketone bodies, 48.1% (n=127) tested negative, 34.8% (n=92) exhibited trace levels, and 17% (n=45) produced a single positive (+) result, indicating ketonuria in a portion of the population. Leukocyte esterase, a significant majority (69.3%, n=183) had negative results, while 26.5% (n=70) exhibited trace levels, and 4.2% (n=11) had a single positive (+) result, indicating the potential presence of pyuria and urinary tract infection.

For nitrites, 78% (n=206) of participants tested negative, while 20.5% (n=54) showed trace levels, and only 1.5% (n=4) had a positive (+) result, suggesting bacterial activity in a small proportion of samples.

In the analysis of blood detection in urine, 8.3% (n=22) of individuals presented zero results, whilst 44.3% (n=117) exhibited trace amounts, 39.8% (n=105) revealed a single positive (+) result, and 7.6% (n=20) displayed a double positive (++) result, reflecting diverse levels of hematuria.

Table 5.2 Summary of Dipstick Urine Analysis Showing Frequency and Percentage Distribution of Protein Levels, Ketone Bodies, Leukocyte Esterase, Nitrites, and Blood among Study Participants.

S.NO	Study Variable		Frequency	Percentage (%)
1	Protein level	Negative	123	46.6
		Trace	95	36
		(+)	46	17.4
2	Ketone Body	Negative	127	48.1
		Trace	92	34.8
		(+)	45	17
3	Leukocyte Esterase	Negative	183	69.3
		Trace	70	26.5
		(+)	11	4.2
4	Nitrites	Negative	206	78
		Trace	54	20.5
		(+)	4	1.5
5	Blood	Negative	22	8.3
		Trace	117	44.3
		(+)	105	39.8
		(++)	20	7.6

The urine pH exhibited a broad spectrum of values among the individuals, with the predominant pH levels of 5 and 6, each detected in 21.6% (n=57) of the samples. A pH of 7 was seen in 16.3% (n=43) of individuals, whereas somewhat alkaline pH levels of 8 and 9 were recorded in 8.0% (n=21) and 15.5% (n=41) of the samples, respectively. PH readings of 2, 3, and 4, indicative of high acidity, were infrequently observed, occurring in 0.4% (n=1), 6.1% (n=16), and 8.7% (n=23) of the samples, respectively. Merely 1.9% (n=5) of samples exhibited an extremely alkaline pH of 10 shown in the figure (2).

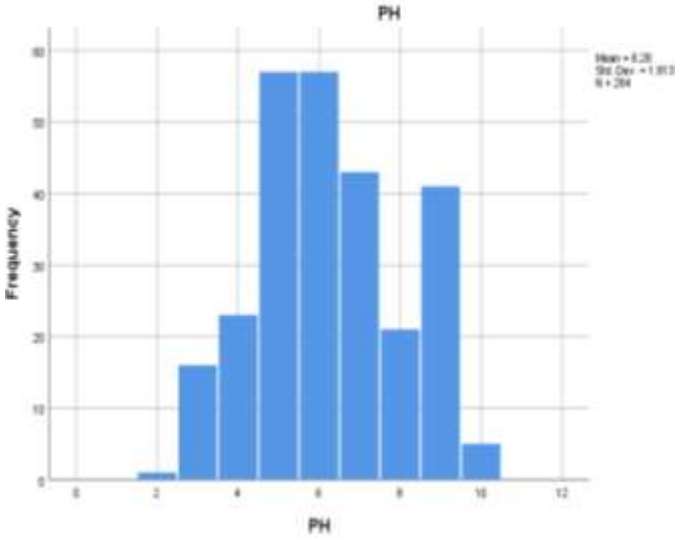

Figure 2

The urine RBC and WBC counts exhibited differing degrees of abnormalities among the diabetic patient. In the RBC count, 40.5% (n=107) of individual exhibited zero results, whereas 22% (n=58) shown 1 to 2 rare RBCs, and 24% (n=64) presented 5 to 10 RBCs intermittently. Significantly, 13.3% (n=35) demonstrated hematuria, indicating a notable presence of blood in the urine. In the WBC count, 43.2% (n=114) of participants were within the normal range, 25.4% (n=67) exhibited 1 to 5 WBCs, and 30.3% (n=80) presented 6 to 10 WBCs in their urine. A little percentage (1.1%, n=3) displayed a significant quantity of white blood cells, potentially signifying a robust inflammatory or infectious reaction shown in the table (5.3).

Table 5.3 Distribution of RBC and WBC Counts in Urine Analysis among Study Participants, Highlighting the Frequency and Percentage of Abnormal Findings

S.NO	Variable		Frequency	Percentage (%)
1	RBC count	Negative	107	40.5
		1 to 2 rare	58	22
		5 to 10 occasionally	64	24
		Hematuria	35	13.3
2	WBC Count	Normal	114	43.2
		1 to 5	67	25.4
		6 to 10	80	30.3
		Numerous	3	1.1

The correlation between nitrites and several study variables was evaluated using the Chi-Square Test of Independence. No substantial association was detected between nitrites and gender ($\chi2 = 0.132$, df = 2, p = 0.936) or age categories ($\chi2 = 10.11$, df = 8, p = 0.257); however, a weak positive correlation with age was identified (Spearman's r = 0.146, p = 0.017). A notable correlation was identified between nitrites and protein levels ($\chi2=61.55$, df=4, p<0.001 Spearman's r=0.366), as well as with ketone bodies ($\chi2=61.553$, df=4, p<0.001 Spearman's r=0.415). Nitrites had a substantial association with leukocyte esterase ($\chi2=157.087$, df=4, p<0.001; Spearman's r=0.535), demonstrating a robust positive correlation. The link with the Benedict test lacked statistical significance ($\chi2=11.659$, df=6, p=0.07), while a minor correlation was noted (Spearman's r=0.194, p=0.002).

Table 5.4 Summary of Chi-Square Test of Independence findings regarding the correlation between nitrites and specific clinical factors

S.NO	Variable	Chi-Square (x^2)	df	P-value	Conclusion
1	Nitrites vs. Gender	0.132	2	0.93	No association observed
2	Nitrites vs. Age	10.115	8	0.25	No association observed
3	Nitrites vs. Protein Levels	61.553	4	<0.001	Significant association
4	Nitrites vs. Ketone Body	61.553	4	<0.001	Significant association
5	Nitrites vs. Benedict Test	11.659	6	0.07	Weak association observed
6	Nitrites vs. Leukocyte Esterase	157.087	4	<0.001	Strong association observed

Discussion

Dipstick testing is recommended as a screening procedure. This recommendation comes from the International Consultation on Incontinence recommendations on LUTS (Staskin *et al.,* 2009). This research highlights the significance of urine dipstick examination in diabetic patients, demonstrating notable correlations between nitrites and essential clinical markers, including protein levels, ketone bodies, and leukocyte esterase. These relationships underscore the potential of nitrites as indicators of urine abnormalities, especially in persons with diabetes, where renal and urinary problems often occur. Although demographic parameters such as gender and age exhibited no significant correlations with nitrites, the biochemical markers provide crucial diagnostic information. These findings corroborate earlier research highlighting the need of regular urine monitoring in diabetes patients to identify early indications of renal or urinary problems.

One research indicated that the efficacy of a midstream urine sample for screening urinary tract infections in women warrants scrutiny. The CSU findings validate that examination of a fresh unspun urine specimen in a hemocytometer for white cells is the most effective surrogate marker for infection. The nitrite test exhibits poor performance, whereas leukocyte esterase had a sensitivity of just 59% (Khan *et al.,* 2024). The incorporation of younger controls allows for comparisons that suggest the prevalence of pyuria (34% with MSU and 33% with CSU) and bacteriuria (21% with MSU at 105 cfu/ml and 29% with CSU at 102 cfu/ml) is associated with the disease process. This warrants more examination. Symptom analysis indicates that 75% of patients exhibited OAB symptoms, while only 55% demonstrated normal urine output (Collins 2016).

The primary urine testing methods assessed for UTI diagnosis were dipstick and microscopy. Culture is typically regarded as the reference standard for diagnosing UTIs. However, the logistics of urine culture present a considerable limitation; it requires approximately 48 hours to yield results, is predominantly conducted in a laboratory, and incurs higher costs than alternative methods. Consequently, there is a necessity for alternative, expedited tests to facilitate the timely commencement of treatment (Kurotschka *et al.,* 2024).

Dipsticks provide the benefit of delivering instantaneous results, while also being cost-effective and straightforward to execute and understand. The analyses of dipstick tests shown significant variability, hence the findings must be approached

with care. The findings indicate that a dipstick test positive for both leukocyte esterase (LE) and nitrite effectively confirms illness, while a test negative for both LE and nitrite reliably excludes disease (Kollerup *et al.*, 2022).

Only four research on this exam were located, all done over 30 years ago. All trials indicated exceptional specificity for this test. Sensitivity was notably high in three investigations, whereas it was lower at 64% in the fourth study. The recent research used children under one year of age, indicating that the test may be less effective in extremely young individuals. The variation in test performance relative to patient age may be attributed to its apparent reliance on an overnight fasting sample, which is unattainable in youngsters who are not toilet trained (Craver *et al.*, 1997).

The findings of this research indicate that a dipstick test negative for leukocyte esterase and nitrite, or a microscopic examination negative for pyuria and bacteriuria in a CVU, bag, or nappy/pad specimen may fairly exclude a urinary tract infection. These patients may thereafter be eliminated from further inquiry, eliminating the need for confirmatory culture. Likewise, a combination of positive tests may confirm a UTI and need more research (Khan *et al.*, 2024). In this instance, however, culture confirmation may be favored before commencing other, potentially invasive, procedures. Antibiotic sensitivities, obtainable by culture, may potentially be a crucial factor. If quick test combinations were regularly used to confirm or exclude illness, a reduction in the number of cultures requested would be anticipated, resulting in cost savings. Furthermore, it is probable that the incidence of infants without sickness subjected to incorrect antibiotic medication while awaiting culture results would decrease. This may impact antibiotic resistance on a population scale (Kurotschka *et al.*, 2024).

Conclusion

This study emphasizes notable correlations between nitrites and essential clinical parameters in diabetic patients, such as protein levels, ketone bodies, and leukocyte esterase, highlighting their potential significance as critical markers in urinary analysis for this demographic. No correlation was found with demographic variables like gender or age; however, the results underscore the importance of particular biochemical and enzymatic markers in assessing urine problems in diabetic patients. These findings offer significant insights into the diagnostic efficacy of urine dipstick analysis in diabetes patients and its role in detecting underlying pathological alterations**.**

Recommendation

Additionally, it is advised that additional study be conducted to investigate these connections and the implications they have for the improvement of clinical outcomes in diabetes management.

Conflict of Interest:

The author declares no conflict of interest.

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