Proteinuria Ratio and Related Factors in Type 2 DM Patients: A Hospital-Based Study in Somalia

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Abstract

Background: Diabetic nephropathy, a complication of diabetes mellitus, is marked by proteinuria, excess protein in the urine. Understanding these factors is crucial for early detection and intervention to prevent kidney damage in this population.

Objective: This study investigates the prevalence of proteinuria and associated factors among type 2 diabetes patients in Mogadishu, Somalia.

Methods: This retrospective cross-sectional design study was conducted at the Somali-Turkey Training and Research Hospital in Mogadishu, Somalia for the last six months. The study enrolled 529 diabetic patients who met the criteria. We measured the participants' anthropometric measurements of height, weight, body mass index (BMI), and waist circumference, and some biochemical analyses like fasting glucose, glycosylated hemoglobin A1C (HbA1C), urinalysis, lipid profile, and renal function tests were also measured. Proteinuria rate and related laboratory and demographic parameters were analyzed.

Results: There were 177 (33.5%) males and 352 (66.5%) females. Three-quarters of the participants, or 176, were in the 45-54 age range. Twenty percent of people had proteinuria overall. Multivariable analysis showed that waist (β =0.893, 95% CI: 0.818-0.974), p=0.010), serum creatinine (β =0.064, 95% CI: 0.017-0.232, p=0.001), urea (β =1.025, 95% CI: 1.002-1.048), p=0.030), and sodium (β =1.119, 95% CI: 0.921-1.361, p=0.013) levels to have association with proteinuria levels.

Conclusion: In our study, patients with type 2 diabetes had a high prevalence of proteinuria. In low-resource settings, screening with urinalysis is strongly recommended for all diabetic patients to guarantee appropriate care and stop the development of end-stage renal disease.

Keywords: *Proteinuria, hyperglycemia, Somalia, nephropathy, CKD.*

INTRODUCTION

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both [1]. Diabetes is one of the world's most common metabolic disorders, and its prevalence has been increasing in recent decades [2]. As per the World Health Organization (WHO) Diabetes Country Profile Somalia 2016, the prevalence of diabetes was 4.8% in the total population, with males 5.2% and females 4.5% [3]. On the other hand, The International Diabetic Federation's Diabetic Atlas 2019 estimated the prevalence to be 4.1% [4].

In Somalia, as in many other Sub-Saharan African (SSA) countries, there is increasing urbanization and dietary change towards Western diets. These demographic and epidemiologic trends toward diet-related noncommunicable diseases (NCDs), such as diabetes, cardiovascular disease (CVD), osteoporosis, and certain malignancies, are accompanied by a nutrition transition [5]. Reduced physical activity, a stressful lifestyle, increased alcohol use, and cigarette use, according to the WHO, intensify the impacts of the dietary shift [6].

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Microalbuminuria, which evolves into proteinuria, is one of the first clinically detectable abnormalities in diabetic nephropathy [7]. Proteinuria is a defining feature of diabetic nephropathy: microalbuminuria is the primary early predictor of diabetic glomerulopathy progression, and proteinuria can be seen as a measure of nephropathy severity and a promoter of nephropathy progression [8]. Diabetic nephropathy is the leading cause of End-Stage Renal Disease (ESRD) in many countries, accounting for around 20% of cases of chronic renal failure.

Diabetic kidney disease (DKD) is a serious and irreversible microvascular consequence characterized by persistent proteinuria, hypertension, and a steady loss of renal function. It contributes to a greater risk of illness and death caused by kidney failure and heart disease. Precise identification and measurement of proteinuria are crucial in the diagnosis and treatment of chronic renal illness [9].

The burden of kidney disease is increasing in Somalia. One study from Mogadishu by Sari *et al.* [10] reported that more than half of the patients admitted to the internal medicine clinic had acute or chronic kidney disease.

There is minimal data on the prevalence of diabetic nephropathy and diabetes in Somalia. Few studies have been done on Somali patients who migrated to foreign

countries, and few researches from a specific group of diabetic people in Somalia [11, 12].

This study aimed to assess the prevalence of proteinuria in patients with type 2 diabetes in a single center, Mogadishu, Somalia, and identify associated factors.

SUBJECTS AND METHODS

This investigation employed a retrospective cross-sectional design. The study site was Mogadishu Somali-Turkey Training and Research Hospital, Somalia's largest teaching hospital, located in the capital city Mogadishu. The timeframe for data collection spanned for six months and included all adult patients with type 2 diabetes who visited the clinic during that period.

Certain exclusion criteria were applied. These criteria encompassed patients with fever, elevated urine protein (proteinuria), urinary tract infections (UTIs), pregnancy, and confirmed or suspected kidney, liver, or other systemic diseases. Additionally, individuals not diagnosed with hypertension yet taking Renin-angiotensin system (RAS) blockers for prevention were excluded.

Following ethical approval from the hospital's Institutional Review Board (IRB), a retrospective analysis was conducted using anonymized patient data retrieved from electronic medical records. Due to the retrospective nature, informed consent was waived.

Data collection encompassed sociodemographic details (age, sex, smoking status) and clinical information (comorbidities, medication history) retrieved from medical records of 529 diabetic patients meeting the inclusion criteria (**Fig. 1**). A diabetic nurse performed standardized anthropometric measurements of height, weight, body mass index (BMI), and waist circumference on an empty stomach during morning hours. Central obesity was defined as exceeding specific waist circumference thresholds (90 cm for men, 80 cm for women). Body mass index classification followed World Health Organization (WHO) guidelines, categorizing patients as overweight (BMI 25-30 kg/m2) or obese (BMI > 30 kg/m2). Medical examinations such as blood pressure were measured on the left arm at heart level during enrollment using a mercury sphygmomanometer with appropriate cuff sizes. Hypertension was defined according to European Society of Cardiology (ESC) guidelines (office systolic BP ≥ 140 mmHg or diastolic BP ≥ 90 mmHg) or documented use of antihypertensive medication [13, 14].

Urinalysis was performed using an automated urine sediment analyzer (UriSed 3 PRO) interfaced with a urine strip reader (LABUMAT 2). Proteinuria was defined as daily urinary protein excretion exceeding 150 mg [15]. Statistical analysis utilized IBM SPSS Statistics software (version 20.0). The normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Data were presented accordingly: normally distributed data as mean ± standard deviation, non-normally distributed data as median (interquartile range). Categorical data were presented as frequencies and percentages. Group comparisons for continuous variables employed either the parametric t-test (normally distributed) or the non-parametric Mann-Whitney U-test. Univariate regression analysis identified potential proteinuria markers. Multivariable regression analysis was also performed. Binary logistic regression was run. P-value less than or equal to 0.05 was taken as statistically significant.

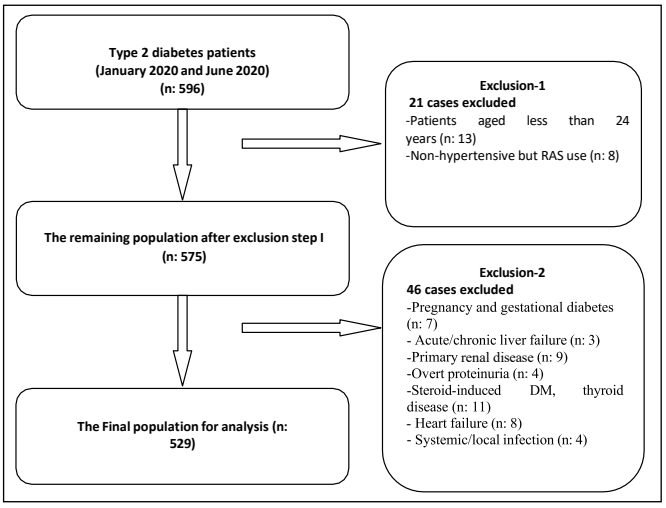

Fig. (1): Flowchart of inclusion and exclusion criteria in the study.

Afterward, important parameters were incorporated into a multivariable binary logistic regression model to investigate predictors of proteinuria. For each independent variable, odds ratios (OR) were computed along with their corresponding 95% confidence intervals (CI). The threshold for statistical significance was established at a two-tailed p-value below 0.05.

This work has been reported according to STROCSS criteria [16].

RESULTS

This study included 529 patients with type 2 diabetes mellitus who presented to the Department of Internal Medicine in Mogadishu Somali Turkey, Training and Research Hospital outpatient clinic.

Table 1: Sociodemographic characteristics of the patient.

Variable	Frequency n(%)
Age categories in years	
18-34	40 (7.6)
35-44	96 (18.1)
45-54	176 (33.3)
55-64	130 (24.6)
≥ 65	87 (16.4)
Sex	
Male	177 (33.5)
Female	352 (66.5)
Smoking	
Yes	10 (1.9)
No	519 (98.1)

Table 2: Basal characteristics of the patients with proteinuria and without proteinuria.

Variable	Proteinuria+ (n=106)	Proteinuria- (n=423)	p value*
AGE (years), mean ± SD	54.4±13.1	51.3 ±11.9	0.021
MALE, n (%)	33(31.1)	144(34)	0.570
SMOKING, n (%)	3(2.8)	7(1.7)	0.427
HYPERTENSION, n (%)	94(88.7)	364(86.1)	0.478
WAIST (cm), median (IQR)	105(11)	101 (8)	<0.001
BMI (km/m2), median (IQR)	32(4.25)	32 (2)	0.003
HEMOGLOBIN (g/dl), median (IQR)	13(3)	14(2)	<0.001
UREA (mg/dl), median (IQR)	40(36.2)	30(14)	<0.001
CREATININE (mg/dl), median (IQR)	1.2(1.07)	0.9(0.31)	<0.001
NA (mEq/L), median (IQR)	137(3.25)	138 (4)	<0.001
K(mEq/L), median (IQR)	4(0.7)	3.9(0.5)	0.003
HDL-c (mg/dl), mean ± SD	43±11.2	46±11.5	0.017
LDL-c (mg/dl), mean ± SD	134±46.1	128±34.4	0.236
TC (mg/dl), mean ± SD	219.3±61.1	215.6±46.2	0.562
TG (mg/dl), median (IQR)	167(113)	138.5 (96.5)	0.001
GLUCOSE (mg/dl), median (IQR)	264.5(156)	268(174)	0.678
HS-CRP (mg/l), median (IQR)	22(22)	12(13)	<0.001
HBA1C (%), mean ± SD	9.8±2.4	9.7 ±2.1	0.555
Medication (%)			
İNSULIN	51(48.1)	289 (68.5)	<0.001
OAD	25(23.6)	10(2.4)	
BOTH	30(28.3)	123 (29.1)	

HDL-c, high density lipoprotein; LDL-C, low density lipoprotein; TC, total cholesterol; TG, triglycerides; HS-CRP, high-sensitivity C-reactive protein; OAD, oral anti-diabetes drug; BMI, body mass index; HbA1c, haemoglobin A1c
*p value <0.05 was considered significant

Of the 529 diabetic patients in this study, 352 (66.5%) were females and 177 (33.5%) were males. 176 (33.3%) of the participants were aged between 45 and 54. The mean age of proteinuric and non-proteinuric patients was 54.4 years and 51.3 years, respectively (**Table 1**).

Of the 529 patients studied, 106 (20%) had proteinuria. We found no significant association between gender, smoking, hypertension, HbA1c, and proteinuria. We found there is a significant association between age, BMI, and proteinuria (p value<0.02 and 0.03, respectively). The renal function test assessed as serum urea and creatinine were higher in people with proteinuria than those without proteinuria (p<0.001). The mean serum triglycerides were significantly higher in the proteinuria group than in the non-proteinuric group (p=0.001) (**Table 2**).

106 (20%) of the 529 patients that were examined had proteinuria. We could not discover any correlation between proteinuria, smoking, hypertension, or HbA1c and gender. Age (p=0.021) and BMI (p=0.003) were shown to be significantly different among those with and without proteinuria. People with proteinuria had higher serum urea and creatinine levels in the renal function test than people without proteinuria (p<0.001). Table **2** shows that there was a significant difference (p=0.001) in the mean blood triglycerides between the proteinuric and non-proteinuric groups.

Proteinuria levels were used as dependent variables in univariate and multivariable analyses for potential proteinuria associations (**Table 3**). A multivariable revealed Waist (β =0.893, 95% CI (0.818-0.974), p =0.010), serum creatinine (β =0.064, 95% CI: 0.017-0.232), p =0.001), urea (β =1.025, 95% CI: 1.002- 1.048), p=0.030), and sodium (β =1.119, 95% CI: 0.921-1.361), p=0.013) levels to had association with proteinuria levels.

DISCUSSION

In many African nations, diabetes remains untreated for extended periods, and newly diagnosed diabetics commonly present established complications. In nations classed as high-income by the World Bank, the majority

Table 3: Univariate and multivariable analysis of predictors of proteinuria.

Variable	Crude OR (95% CI)	p-value*	Multivariate analysis+ OR (95% CI)	p-value*
AGE (year)	1.021 (1.003-1.038)	0.021		
WAIST (cm)	1.103 (1.059-1.149)	<0.001	0.893 (0.818-0.974)	0.010
BMİ (km/m2)	1.158 (1.069-1.253)	<0.001		
HS-CRP (mg/l)	1.033 (1.016-1.050)	<0.001		
UREA (mg/dl)	1.041 (1.026-1.056)	<0.001	1.025 (1.002-1.048)	0.030
CREATININE (mg/dL)	2.465 (1.624-6.038)	<0.001	0.064 (0.017-0.232)	<0.001
NA (mEq/L)	0.832 (0.785-0.881)	<0.001	1.119 (0.921-1.361)	0.013
K (mEq/L)	1.690 (1.154-2.476)	0.007		
HDL-C(mg/dl)	0.976 (0.957-0.996)	0.018		
TG (mg/dl)	1.002 (1.000-1.004)	0.034		
HEMOGLOBIN (g/dl)	0.655 (0.582-0.732	<0.001		
MEDICATION				
INSULIN	Reference category			
OAD	14.167 (6.420-31.261)	<0.001		
BOTH	1.382 (0.840-2.274)	0.203		

HS-CRP, high-sensitivity C-reactive protein; OAD, oral anti -diabetes drug; HDL-High density lipoprotein; TG, triglycerides; BMI, body mass index
* p value <0.05 was considered significant, CI: Confidence interval, OR: Odds ratio
+nagelkareke R square =0.408, Omnibus tests of model coefficients =p<0.001

of diabetics are over 60. Still, in low- and middle-income countries, most diabetics are between 40 and 60 and of working age [2]. The mean age of diabetic patients in our current study was 54 years, and this number is comparable to that of low-income countries as per the International Diabetic Federation (IDF). Diabetic nephropathy occurs in 20-40% of patients with diabetes and is the single leading cause of End-Stage Kidney Disease (ESKD) in Western countries [17]. Diabetic kidney disease is characterized by excessive urinary albumin excretion and loss of kidney function. The prevalence and severity of diabetic nephropathy have consistently been higher in Blacks than in other races [18]. In sub-Saharan Africa, the prevalence of MA ranges from 10.7% in Tanzania to 58% in Nigeria [19-21]. In this study, proteinuria was prevalent in 20% of the population.

Prior research has shown a wide range in the prevalence of microalbuminuria among diabetic patients, from 20% to 61% [22-24]. A study in Senegal by Djiby *et al.* [25] investigated the prevalence of microalbuminuria and related risk factors in a diabetic population. They found a prevalence rate of 27.14% among the 221 participants, similar to the results observed in the present study.

At univariate analysis, we observed a statistically significant correlation between proteinuria, urea, serum creatinine levels, sodium, and potassium levels.

In clinical practice, serum creatinine concentration is frequently used to indicate Glomerular Filtration Rate (GFR) and renal function [26]. Analysis of proteinuria shows early-stage renal illness, whereas GFR estimates its progression. Renal disease can be detected early if specific glomerular and tubular function markers are examined, according to Shemesh *et al.* [27], blood creatinine concentrations remained within the reference interval in a reasonable majority of patients with severely impaired GFR. Creatinine serves as an imperfect biomarker of glomerular filtration rate (GFR) due to its dependence on muscle mass. Consequently, fluctuations in muscle mass can lead to variations in the total creatinine pool independent of actual changes in GFR [26]. These findings highlight the limitations of serum creatinine as a marker of renal function, particularly in the early detection of diabetic nephropathy. Therefore, a cautious interpretation of creatinine levels is warranted. To enhance the assessment of renal function in diabetic patients, we recommend employing proteinuria or albuminuria alongside serum creatinine. This combined approach is particularly crucial for diabetic children and elderly individuals, as these populations often have lower muscle mass, potentially affecting serum creatinine concentrations and compromising its accuracy as a standalone marker.

Our findings indicate a strong connection between electrolyte levels and the presence of protein in urine (proteinuria). This aligns with previous research by Kumari *et al.* [28], who explored the relationship between blood electrolyte levels and kidney function in diabetic patients. Their study notably showed that diabetics with elevated creatinine levels, a marker of impaired kidney function, had statistically significant decreases in blood sodium and increases in blood potassium compared to those with normal creatinine. These electrolyte imbalances are more likely to occur in the presence of high blood sugar, glucosuria, and hyponatremia. Scientific evidence suggests that electrolyte imbalances are associated with declining kidney function in diabetic patients.

Effective proteinuria management in diabetic patients requires an individualized approach. The primary goals involve achieving good glycemic control, potentially limiting dietary protein intake and smoking cessation. In cases where persistent proteinuria coincides with hypertension, blockade of the renin-angiotensin-aldosterone system (RAAS) may be warranted.

LIMITATIONS

This is a study in a single center and, therefore, not representative of Somalia at large, whereas it could be used as a baseline for further studies with large geographical areas. Since our study is based on the retrospective analysis of patients' files from the health information system, we could not find the duration of diabetes in all our patients.

CONCLUSION

To summarize, the overall prevalence of proteinuria at our clinic in Mogadishu, Somalia was 20%. Those with proteinuria also showed some degree of renal impairment, illustrated by significantly higher serum creatinine levels than those without proteinuria. Considering the increasing incidence of type 2 diabetes in Somalia and the lack of proper primary health care in Somalia, we recommend raising awareness of chronic diseases, implementing proper and effective primary health care, and screening for Proteinuria or Microalbuminuria (MA) to reduce the future burden of diabetic renal disease.

ETHICS APPROVAL

Mogadishu Somali Turkiye Training and Research Hospital approved this study with an approval number of MSTH/6540. All procedures performed in studies involving human participants were following the ethical standards of the institutional and/ or national research committee and the Helsinki Declaration.

CONSENT FOR PUBLICATION

Informed consent was obtained from the participants of this study.

AVAILABILITY OF DATA

Data is available with the corresponding author upon request.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Declared none.

AUTHORS' CONTRIBUTION

All the authors contributed equally to the publication of this article.

REFERENCES

1. Soh SB, Topliss D. Classification and Laboratory Diagnosis of Diabetes Mellitus. In: Endocrinology and Diabetes. Bandeira F, Gharib H, Golbert A, Griz L, Faria M. Eds. 2014; New York, NY: Springer p. 347-59.
DOI: https://doi.org/10.1007/978-1-4614-8684-8_27
2. Whiting DR, Guariguata L, Weil C, Shaw J. IDF Diabetes atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract 2011; 94(3): 311-21.
DOI: https://doi.org/10.1016/j.diabres.2011.10.029
3. World Health Organization (WHO). Diabetes country profiles - Somalia 2016. [Internet]. 2016 [cited 2021 Apr 09]. Available from: https://www.who.int/diabetes/country-profiles/som_en.pdf
4. International Diabetes Federation (IDF). Diabetes Atlas. 9th ed. 2019.
5. Amuna P, Zotor FB. Epidemiological and nutrition transition in developing countries: Impact on human health and development. Proc Nutr Soc 2008; 67(1): 82-90.
DOI: https://doi.org/10.1017/S0029665108006058
6. Popkin BM. Global nutrition dynamics: The world is shifting rapidly toward a diet linked with noncommunicable diseases. Am J Clin Nutr 2006; 84(2): 289-98.
DOI: https://doi.org/10.1093/ajcn/84.2.289
7. Wolf G, Ziyadeh FN. Cellular and molecular mechanisms of proteinuria in diabetic nephropathy. Nephron Physiol 2007; 106(2): 26-31.
DOI: https://doi.org/10.1159/000101797
8. Williams ME. Diabetic nephropathy: The proteinuria hypothesis. Am J Nephrol 2005; 25(2): 77-94.
DOI: https://doi.org/10.1159/000084286
9. Gururaj N, Purnima P. To evaluate and standardize the method of spot urine protein creatinine ratio for estimation of proteinuria. Int J Adv Res Med 2020; 2(2): 173-9.
DOI: https://doi.org/10.22271/27069567.2020.v2.i2c.65
10. Sari Ö, Bashir AM. A retrospective evaluation of patients hospitalized in the Internal Medicine Department at the Turkey Recep Tayyip Erdogan Somalia Mogadishu Training and Research Hospital. Turkish J Intern Med 2021; 3(4): 177-87.
DOI: https://doi.org/10.46310/tjim.899718
11. Wallin AM, Löfvander M, Ahlström G. Diabetes: A cross-cultural interview study of immigrants from Somalia. J Clin Nurs 2007; 16(11C): 305-14.
DOI: https://doi.org/10.1111/j.1365-2702.2007.02099.x
12. Mohamed MH, Farah MA, Ali MA, Mohamed NA, Hassan AM. Knowledge, attitude, and practice on common diabetic complications among diabetic patients at Egyptian Hospital in Mogadishu, Somalia. J Biosci Med 2021; 9(9): 87-99.
DOI: https://doi.org/10.4236/jbm.2021.99008
13. Volpe M, Gallo G, Battistoni A, Tocci G. Implications of guidelines for hypertension management in Europe. Circ Res 2019; 124(7): 972-4.
DOI: https://doi.org/10.1161/CIRCRESAHA.119.314724
14. Carroll MF, Temte JL. Proteinuria in adults: A diagnostic approach. Am Fam Physician 2000; 62(6): 1333-40.
15. Mathew G, Agha R, Albrecht J, Goel P, Mukherjee I, Pai PS, *et al.* STROCSS 2021: Strengthening the reporting of cohort, cross-sectional, and case-control studies in surgery. Int J Surg Open 2021; 37: 100430.
DOI: https://doi.org/10.1016/j.ijso.2021.100430
16. American Diabetes Association. Diabetes care - Standards of medical care in diabetes. 2020; Diabetes Care 2020; 43(Suppl 1): S14-31.
DOI: https://doi.org/10.2337/dc20-S002
17. Young BA, Maynard C, Boyko EJ. Nephropathy, cardiovascular disease, and mortality in a national population. Diabetes Care 2003; 26(8): 2392-9.
DOI: https://doi.org/10.2337/diacare.26.8.2392
18. Ufuoma JC, Ngozi AD, Kester JC, Godwin Y. Prevalence and risk factors of microalbuminuria among type 2 diabetes mellitus: A hospital-based study from Warri, Nigeria. Sahel Med J 2016; 19(1): 16.
DOI: https://doi.org/10.4103/1118-8561.181889
19. Lutale JJ, Thordarson H, Abbas ZG, Vetvik K. Microalbuminuria among type 1 and type 2 diabetic patients of African origin in Dar Es Salaam, Tanzania. BMC Nephrol 2007; 8: 2.
DOI: https://doi.org/10.1186/1471-2369-8-2
20. Eghan BA, Frempong MT, Adjei-Poku M. Prevalence and predictors of microalbuminuria in patients with diabetes mellitus: A cross-sectional observational study in Kumasi, Ghana. Ethn Dis 2007; 17(4): 726-30.
21. Boelter MC, Gross JL, Canani LH, Costa LA, Lisboa HR, Trindade MC, *et al.* Prevalence and factors associated with microalbuminuria in type 2 diabetic patients at a diabetes clinic in northern Tanzania. J Diabetes Mellit 2015; 5(1): 49-57.
22. AlFehaid A. Prevalence of microalbuminuria and its correlates among diabetic patients attending diabetic clinic at National Guard Hospital in Alhasa. J Fam Community Med 2017; 24(1): 1.
DOI: https://doi.org/10.4103/2230-8229.197174
23. Hall V, Thomsen RW, Henriksen O, Lohse N. Diabetes in Sub-Saharan Africa 1999-2011: Epidemiology and public health implications. A systematic review. BMC Public Health 2011; 11: 564.
DOI: https://doi.org/10.1186/1471-2458-11-564
24. Djiby S, Fall T, Diop MB, Ndiaye A, Gaye M, Ba M, *et al.* Prevalence of microalbuminuria and associated risk factors in a population of diabetics followed at the Marc Sankale Center of Dakar. Open J Intern Med 2018; 8(1): 24-32.
DOI: https://doi.org/10.4236/ojim.2018.81004
25. Bargnoux AS, Cavalier E, Bargnoux AS, Bargnoux AS, Bargnoux AS. Serum creatinine: advantages and pitfalls. J Lab Precis Med 2018; 3: 71.
DOI: https://doi.org/10.21037/jlpm.2018.08.01
26. Regeniter A, Freidank H, Dickenmann M, Boesken WH, Siede WH. Evaluation of proteinuria and GFR to diagnose and classify kidney disease: Systematic review and proof of concept. Eur J Intern Med 2009; 20(6): 556-61.
DOI: https://doi.org/10.1016/j.ejim.2009.03.006
27. Shemesh O, Golbetz H, Kriss JP, Myers BD. Limitations of creatinine as a filtration marker in glomerulopathic patients. Kidney Int 1985; 28(5): 830-8.
DOI: https://doi.org/10.1038/ki.1985.205
28. Kumari S, Dash I, Mangaraj M. Association of serum electrolyte with renal function in diabetes mellitus-a pilot study. Int J Clin Biochem Res 2016; 3(3): 335-8.
DOI: https://doi.org/10.5958/2394-6377.2016.00066.6