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Prevalence of Kidney Dysfunction among Orthopaedic Patients in Northwestern Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SMA, AMW, AJA, MNS and YAK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SA, AMM, SAA and BRU managed the analyses of the study. Author IUM and AI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Kidney dysfunction in orthopaedic cases may be as a result of kidney injury due to fracture, burns, osteomyelitis, spinal injury, spinal tuberculosis, sickle cell disease and various forms of arthritis. This study aimed at evaluating the biomarkers of kidney dysfunction among patients attending National othropeadic hospital Dala Kano. It is a hospital based prospective study conducted on a total of one hundred (100) subjects; sixty (60) orthopaedic patients and forty (40) apparently

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healthy individuals between the ages of 20-80 years among both sexes. Serum urea, creatinine, uric acid and chloride were estimated by spectrometric methods; sodium and potassium by flame photometric method; bicarbonate by titrimetric method while eGFR and BMI were calculated. The number of males 43(71.7) was higher than that of females 17(28.3).The overall prevalence of kidney dysfunction is 1.7%. Kidney dysfunction was found among gouty arthritis patients within the age group of 61-80 years, however none was found among 20-40 and 41-60 years. There was significant difference ($p<0.05$) in mean serum potassium (4.0±04 and 3.8±0.4 mmol/L), eGFR (188±54 and 152±33 ml/min/1.73m^2) and BMI (21.28±4.4 and 25.48±5.6 kg/m^2) between males and females. The prevalence of Kidney dysfunction in orthopaedic patients was found to be higher in males than females and increasing with age {(20-60 (0%); 61-80 (10%)}, however, most of the biomarkers of kidney function are irrespective of gender.

Keywords: Arthritis; biomarkers; kidney dysfunction; orthopaedic.

1. INTRODUCTION

Kidney diseases have become a major health concern with a marked burden globally especially in developing countries within Sub-Saharan Africa [1]. Kidney damage is a major determinant for the development and progression of accelerated atherosclerosis, ischemic vascular disease and cardiovascular events [2]. Biochemical markers plays an important role in accurate diagnosis of kidney disease and also for assessing risk and adopting therapy that improves clinical outcome. Serum creatinine, urea, uric acid and electrolytes are used as biochemical markers usually for routine analysis [3]. Renal damage or alterations in glomerular function affect the kidneys' ability to remove metabolic substances from the blood into the urine. Renal functions can be evaluated by measuring the glomerular filtration rate (GFR) [4].

Orthopaedics is a branch of medicine that deals with the treatment of deformities, diseases and injuries of bones, joints, muscles, tendons and nerves [5]. Kidney dysfunction in orthopaedic cases may be as a result of kidney injury due to fracture, burns, osteomyelitis, spinal injury, spinal tuberculosis, sickle cell disease and various forms of arthritis among others [5]. Major orthopaedic procedures can also cause high risk for kidney dysfunction due to severe electrolyte disturbances, perioperative sepsis and presence of other factors that may impair renal function such as diabetes, heart failure, arrhythmia and pulmonary embolism. Pre or post-operative complications are also risk factors for kidney disease especially acute renal failure leading to increased mortality and morbidity [6]. Individuals with even the earliest signs of chronic kidney disease (CKD) are at increased risk of cardiovascular disease and may die long before they reach end-stage renal disease (ESRD) [2].

Chronic kidney disease have been reported to affect about one in ten adults worldwide [7]. It was estimated that over 20 million Americans have chronic kidney disease [8]. The increased prevalence of ESRD among blacks in the United States (US) and South Africa compared with other races also suggests that ESRD may be more prevalent in Africa than in the US and other developed nations. The prevalence of chronic renal failure (CRF) has been shown in various parts of Nigeria to be between 1.6-10.0% [9]. These studies are hospital-based and fail to include orthopaedic patients. Furthermore, no studies have been carried out on orthopaedic patients in Kano which is the most populous state in Nigeria. Therefore, this study was aimed at determining the prevalence of kidney dysfunction in accordance to age and gender among patients attending National Othropeadic Hospital Dala, Kano by estimating serum urea, electrolytes, creatinine and eGFR as well as proteinuria of the studied subjects.

2. MATERIALS AND METHODS

This is a hospital based prospective study conducted in both out and in-patient departments of National Orthopaedic Hospital Dala-Kano, between January to march 2016. Ethical clearance was obtained from the Hospital research ethics committee. Subjects were fully consented prior to the enrolment and were selected at random. Consented subjects that falls between the ages of 20-80 years and their weight and height could be measured were included while those that could not meet up the criteria were excluded. The sample size for this study was determined from a standard formula for the calculation of minimum sample size as shown by Oyejide [10] at 95% confidence level using the prevalence of 3.6% as given by Alebiosu et al. [11] Total of one hundred (100)

subjects, sixty (60) patients and forty (40) apparently healthy individuals of both sexes were recruited. A semi structured questionnaire was administered to obtain the sociodemographic characteristics of the subjects. Weight and height were measured prior to the sample collection as adopted from the protocol of the State of Alaska Department of Health and Social Services [12].

Blood sample was collected from each subject by venepuncture from the antecubital vein of the forearm using disposable syringes. Five milliliters of blood sample in each case was delivered in a clean, labelled plastic centrifuge tubes. It was allowed to stand for 30 minutes for proper retraction and clotting and then centrifuged for five minutes at 3000 rpm; the serum was separated into dry and labeled cap sample tube. Early morning urine was collected for the determination of proteinuria by dip stick technique using Uro-dip 10e reagent strip and protein of ≥ 0.3g/l was defined as positive.

Serum urea was determined by urease-Berthelot method of Weatherburn [13]. Serum creatinine was determined by method of Rosano et al. [14] Serum uric acid was determined by enzymatic colorimetric method (uricase method) of Fossali et al. [15] Serum sodium and potassium was determined by flame emission spectrometry using Sherwood-410 flame photometer [16]. Serum chloride was determined by thiocyanide method of Skeggs and Hochstrasser [17]. Serum bicarbonate was determined by titrimetric method [18]. Body mass index (BMI) was calculated in Kg/ m^2 where as GFR was calculated using creatinine-based equation of modification of diet in renal disease (MDRD). GFR=186× $(S_{cr})^{-1.154}$× $(age)^{-0.203}$×0.742 (if the subject is female) ×1.212 (if the subject is black) and expressed in ml/min/1.73m^2 [19]. Estimated glomerular filtration rate <90 ml/min/1.73m^3 and/or proteinuria was considered as definition of kidney dysfunction [20]. The Anion gap was calculated as the difference between total concentrations of measured serum cations and the total concentrations of measured serum anions [21]. Graph pad instat (version 3.05 Inc. 2000) was used, results were expressed as mean ± SD. Dunnett one way ANOVA and unpaired t-test Welch corrected was used as tools of analysis.

3. RESULTS

The results in this study were presented in Tables 1-4.

Table 1 shows prevalence of kidney dysfunction and some socio-demographic factors among patients attending national orthopedic hospital Dala Kano. The number of males was higher than females with value of 71.7 and 28.3% respectively. The male patients have more patients with kidney dysfunction then female with prevalence of 2.3% and 0% respectively whereas the overall prevalence of kidney dysfunction in this study was 1.7%. No patients with kidney dysfunction were recorded among age groups of 20-40 and 41-60 years while 10 % of the patients within the age group of 61-80 years were recorded.

Table 2, shows mean serum concentrations of urea, uric acid and creatinine, eGFR and BMI of patients with orthopaedic cases and controls. There was significant difference ($p<0.01$) in mean serum urea concentration among patient with fracture, burns, and muscular injury as compared with controls. Significant difference ($p<0.05$) was also observed in mean serum urea among gouty arthritis patients. There was significant difference ($p<0.01$) in mean serum creatinine concentration among patients with gouty arthritis only. There was significant difference ($p<0.01$) in mean serum uric acid concentration among patient with diabetes, SCD, gouty arthritis and muscular injury as compared with controls. There was significant difference ($p<0.01$) in eGFR among patients with SCD, gouty arthritis, rheumatoid arthritis and muscular injury. Significant difference ($p<0.05$) exists between patients with burns, SCD, gouty arthritis and controls. There was also significant difference ($p<0.01$) in body mass index among septic arthritis patient.

Table 3 shows mean serum sodium, potassium, chloride and bicarbonate concentrations and anion gap of the studied subjects. There was significant difference ($p<0.01$) in mean serum sodium among SCD, TB arthritis and spinal injury patients as compared with the controls. There was also significant difference ($p<0.05$) in mean serum sodium among patients with burns as compared with the controls. There was significant difference ($p<0.01$) in mean serum potassium among TB arthritis and spinal injury patients as compared with controls. Significant difference also exists ($p<0.05$) in mean serum potassium among patients with SCD, osteoarthritis and spondyloisis as compared with controls. There was significant difference ($p<0.01$) in mean serum chloride in patients with SCD and rheumatoid arthritis and also significant

difference ($p<0.05$) was observed in patients with dislocation. There was significant difference ($p<0.01$) in mean serum bicarbonate among patients with burns.

Table 4 compared the Kidney function parameters between males and females. There was significant difference ($p<0.05$) in mean serum potassium, eGFR and BMI between males and females. There was no significant difference ($p>0.05$) in mean serum urea, uric acid, sodium, chloride and bicarbonate between both gender.

4. DISCUSSIONS

This study reveals the overall prevalence of kidney dysfunction among orthopaedic patients attending National Orthopaedic Hospital Dala – Kano as 1.7%. This finding is slightly above 1.6% as established by Oyediran and Akingbe in other part of Nigeria [11]. The established figure by this research falls within the prevalence range of 1.6-10% in various parts of Nigeria according to Odubanjo et al. [9]. However, the value is lower than 3.6% of Olabisi Onabanjo University Teaching Hospital, Sagamu and 10% of Lagos University Teaching Hospital by Alebiosu et al. and Mobayage et al. respectively [22,23]. The discrepancy may be due to the facts that this study considers the orthopedic cases while the former studies may include individuals with common urogenital problems. The current prevalence is higher in males than females with 2.3% and 0.0% respectively, this could probably explained by several studies that suggested females are more protected to renal diseases than males [24].

Table 1. Prevalence of kidney dysfunction among orthopedic subjects

Characteristics	Number of samples n=60, (%)	Patient with kidney disease n = 1, (%)
Age group (years)		
20 – 40	33(55.0)	0(0.0)
41 – 60	17(28.3)	0(0.0)
61 – 80	10(16.7)	1(10.0)
Sex		
Female	17(28.3)	0(0.0)
Male	43(71.7)	1(2.3)
Proteinuria	60	1(1.7)
Overall prevalence	**60**	**1(1.7)**

Table 2. Serum urea, uric acid, creatinine concentrations, eGFR and BMI of the patients with orthopaedic cases and controls

Disease conditions	Urea (mmol/L)	Creatinine (µmol/L)	Uric acid (µmol/L)	eGFR (ml/min/1.73m^2)	BMI (kg/m^2)
Fracture (n=15)	4.7±1.5**	54±9.3	410±161	173±37	23.63±4.3
Dislocation(n=3)	4.2±0.2	51±2.3	264±39.5	161±12.2	22 .21±1.6
Burns (n=3)	6.3±2.1**	59±8.5	260±1.9	185±31	18.09±0.6*
Hypertension (n=3)	2.4±0.2*	51±3.8	279±1.8	144±12	23.25±5.1
Diabetes(n=3)	4.3±1.9	65±12.7	538±74**	157±41	26.35±2.2
Tumor(n=3)	2.9±1.2	57±0.7	213±10.8	185±5.3	19.72±0. 3
SCD(n=3)	2.4±0.1*	44±1.8	708±79**	263±6.2*	17.87±0.2*
Gouty arthritis(n=3)	10.2±0.3**	131±1.3**	613±41**	110±2.1*	18.60±2.3*
R /arthritis(n=3)	5.0±0.1	57±0.8	493±88	128±5.1*	27.95±1.6
Septic arthritis(n=3)	2.7±0.1	56±18.6	348±21	229±79	15.89±0.3**
Osteo arthritis (n=3)	3.4±0.1	57±3.4	446±206	170±4.0	21.28±2.2
TB arthritis(n=3)	4.4±0.1	44±0.8	211±50	182±11	20.3 5±0.3
Spinal injury(n=3)	3.9±0.2	59±0.5	498±144	173±3.1	1 9.92±0.2
Muscular injury(n=3)	5.6±0.1**	42±1.7	575±42**	270±1.6**	21.34±0.3
Spinal TB(n=3)	3.5±0.9	48±7.1	368±303	212±10	24.36± 0.2
Spondyloisis(n=3)	3.5±0.1	53±1.5	383±48	182±11	20.71 ±1.8
Controls (n=40)	3.8±1.1	53±8.6	308±120	181±46	24.00± 3.8

Results are expressed as means ± S.D, N = 100, Nil shows No patients recorded
*Values with * significant difference (P<0.05) when compared to controls*
*Values with ** significant difference (P<0.01) when compared to controls R=Rheumatoid, TB=Tuberculosis*

Table 3. Serum electrolytes concentration and anion gap of the patients with orthopaedic cases and controls

Disease conditions	Sodium (mmol/L)	Potassium (mmol/L)	Chloride (mmol/L)	Bicarbonate (mmol/L)	Anion gap (mmol/L)
Fracture (n=15)	137±7.9	3.9±0.3	97±6.6	26±1.7	17.3±1 .6
Dislocation(n=3)	127±6.5	3.9±0.3	90±5.6*	25±0.8	16.9±0.4
Burns (n=3)	144±10.7*	3.9±0.3	101±0.9	29±3.2**	17.7±1.4
Hypertension(n=3)	141±4.7	3.6±0.1	98±4.2	25±1.3	17.6±0.1
Diabetes(n=3)	140±5.7	3.6±0.2	99±6.3	27±1.2	15.4±2.0
Tumor(n=3)	132±1.0	3.8±0.1	94±1.9	24±0.7	16.9±0.1
SCD(n=3)	160±1.6**	4.4±0.1*	115±1.5**	28±0.7	22.2±2.8**
Gouty arthritis(n=3)	129±1.1	3.7±0.1	91±1.4	25±1.0	16.7±0.1
R/ arthritis(n=3)	125±1.7	4.3±0.1	86±0.9**	26±0.8	16.7±0.3
Septic arthritis(n=3)	126±2.3	3.5±0.1	92±5.9	24±0.9	15.8±1.2
Osteo arthritis (n=3)	135±12.6	3.4±0.1*	99±10.0	27±1.5	16.8±0.6
TB arthritis(n=3)	163±1.2**	3.1±0.1**	114±1.5	28±1.1	24.0±0.1
Spinal injury(n=3)	147±1.5**	4.8±0.1**	104±0.9	26±0.7	20.5±2.1*
Muscular injury(n=3)	134±0.9	3.7±0.1	95±1.5	26±0.5	15 .8±0.1
Spinal TB(n=3)	131±2.9	3.9±0.1	92±0.9	26±0.5	18.5±2 .1
Spondyloisis(n=3)	131±3.3	4.4±0.1*	91±0.8	24±0.5	19.7±3.5
Controls (n=40)	134±4.1	3.9±0.3	96±2.8	26±1.3	16.6± 3.4

Results are expressed as means ± S.D, N = 100, Nil shows No patients recorded.
*Values with * significant difference (P<0.05) when compared to controls, SCD= Sickle cell Disease*
*Values with ** significant difference (P<0.01) when compared to controls, R=Rheumatoid, TB=Tuberculosis*

Table 4. Sex related parameters in orthopedic cases

Parameter	Male(n= 43) Mean ± S.D.	Female (n=17) Mean ± S.D.
Urea (mmol/l)	4.6 ± 1.6	4.5 ± 3.0
Sodium (mmol/l)	135 ± 10.6	136 ± 10.5
Potassium (mmol/l)	4.0 ± 0.4*	3.8 ± 0.4
Chloride (mmol/l)	95 ± 8.5	99 ± 10.3
Bicarbonate (mmol/l)	26± 2.2	26 ± 1.7
Anion gap (mmol/l)	17.6 ± 3.3	17.4 ± 2.0
Creatinine (µmol/l)	63 ± 36.6	56 ± 20.4
Uric acid (µmol/l)	353 ±1.93	418 ± 189
eGFR(ml/min/1.73m^2)	188±54*	152±33
BMI(kg/m^2)	21.28±4.4	25.48±5.6*

** Significantly higher at p<0.05 using t- test (two- tailed) Welch corrected*

Observation from the result of this study as shown in Table 2 revealed significant difference (p<0.01) in eGFR among patients with fracture as compared with control group. However, the eGFR of both groups do not indicate sign of kidney dysfunction, this may support the earlier findings by Meghan et al. which shows no association between eGFR and fracture [25].

This study also revealed a significant increase (p<0.01) in mean serum uric acid and eGFR in sickle cell disease (SCD) as compared with controls group with no significant difference (p>0.05) in mean serum creatinine. The finding is inconsistent with the reports by Triphathi et al. and Pandey et al. that studied the levels of serum uric acids and creatinine in SCD patients but consistent with the work of Idemodia who reported significant increase in serum uric acid among SCD in Benin [26,27,28]. The increased level of serum uric acid in SCD patients could be due to an increase in bone marrow activity and the turnover of nucleic acids associated with the condition. However, the eGFR is significantly higher among SCD patients in this study that may indicate normal renal function and is consistent with the study of Pandey et al. which concludes that renal insufficiency is not common among SCD patients in India [27]. The high eGFR may be due to marked increased in proximal tubular secretion of creatinine and uric acid in SCD patient; resulting to overestimation of eGFR [29].

The results in Table 2 indicates hyperuricaemia in all the patients with gouty arthritis as supported by Cucuainu and Brudascà [30]. Significant difference ($p<0.01$) in mean serum urea, uric acid and creatinine with significantly low level of eGFR was observed among patients with gouty arthritis, may indicate a typical case of kidney dysfunction. This finding may substantiate the recent incidences by Abdellatif and Elkhalili that found a range of 47 to 54% of patients with gouty arthritis are affected with kidney disease [31]. This may be due to uric acid crystals deposits in the kidney which may develop to kidney stones; a painful condition that obliterates kidney tubules and prevent removal of metabolic products [32].

There is also observed lowered BMI among patients with gouty arthritis in this study; it is in contrast with the study of Iseki et al. that suggested increasing BMI with risk of the development of ESRD in men [33]. Most patients with kidney disease are elderly and frail hence body mass may be reduced, therefore BMI may not influence eGFR estimation among such patients, on the other hand, the findings of Juraschek et al. suggested an elevated burden of gout in overweight adults [34,35].

There is decrease in eGFR among rheumatoid arthritis (RA) patients as compared with the control which contradict the research conducted by Hickson et al. indicating likely reduced kidney function overtime [36]. On considering the BMI of rheumatoid arthritis patients, the patients in this group falls within the overweight while Sandbag et al. associated obesity and rheumatoid arthritis and attributed the overweight at diagnosis to significant decreases in changes of achieving good control during the early phase of the disease [37,38]. Higher uric acid was strongly associated with RA and also patients with RA and elevated uric acid may require screening for renal dysfunction [39].

This study reported the BMI and eGFR within normal limits with lower level of mean serum creatinine concentrations among patients with tuberculosis arthritis. Huh et al. also established that serum creatinine reflected muscle mass and is independently associated with bone mineral density in subjects with normal kidney function [40].

As shown in Table 2 also, there was no significant increase in mean serum creatinine in patients with spinal injury as compared with controls. This study is consistent with the work of Kuhlemeier et al. whereas Rouleau and Guertin reported significant increase in serum creatinine among patients with spinal cord injury [41,42].

There was observed significant increase ($p<0.01$) in mean serum uric acid and eGFR among patients with muscular injury as compared with controls. This suggest that muscle injury causes over production of uric acid and also these abnormalities improve GFR as supported by Knochel et al. [43].

It was also observed that, there is no significant difference ($p>0.05$) in serum electrolytes among all the patients with fracture, however there was significant decrease ($p<0.01$) in mean serum chloride among patients with dislocation as compared with controls. This may be due to the facts that fracture and dislocation are both skeletal diseases, whereas electrolytes are associated with systemic acid– base balance as described by Owiredu et al., hence are mostly found in systemic disease [44].

Table 3 shows significant increase in serum sodium and bicarbonate among burn patients as compared with controls. This could be due to the loss in circulating plasma volume, haemoconcentration which result in dramatic outpouring of electrolytes and state of dehydration [45,46]. Significant difference ($p<0.01$) in mean serum electrolytes among patients with rheumatoid, osteo and tuberculosis arthritis as compared with controls may be due to the association of decrease in tubular reabsorption and secretion mechanisms for electrolytes balance such as sodium and potassium [44]. This discrepancy in serum electrolytes may also affect the endocrine and acid base function of these patients [46]. There was no significant difference ($p>0.05$) in all the serum electrolytes, creatinine and eGFR among both diabetic and hypertensive patients but observed significant decreased ($p<0.01$) in mean serum urea among hypertensive patients, this did not agree with the work of Yasmin et al. which reported decrease in sodium with no significant changes in potassium. This observation could be due to the facts that most of the patients are controlling the conditions, [47] hence this study may not necessarily concur to the fact that diabetes and hypertension are the leading causes of kidney diseases; that may be true for the uncontrolled conditions [48].

It was observed that, patients with SCD have significant increase ($p<0.01$) in mean serum sodium, potassium, anion gap and chloride as compared with their controls. The findings by Pandey et al. and Idemudia was found to be consistent with that of this study and they concluded that there is electrolyte abnormalities in patients with SCD [27,28]. The electrolyte abnormalities in sickle cell patients could be due to increased sodium and water reabsorption of other solutes [29]. The affinity of hemoglobin for oxygen depend on the blood pH among other factors, therefore the SCD patients have abnormal affinity of hemoglobin for oxygen which may bring about the abnormal electrolytes [49]. No significant difference ($p>0.05$) was found in all the electrolytes measured in patients with muscular injury, this is contrary to the fact that electrolytes have been link to the muscular functions [16].

Patients with spinal injury have shown significant increase ($p<0.01$) in mean serum sodium, potassium and anion gap as compared with controls. Reuleau and Guertin reported significant increase in serum potassium and chloride in spinal cord injury patients which is consistent with this study [42]. The neurological functions of spinal cord is attributed to some electrolytes, therefore, spinal injury may cause expected electrolyte abnormalities [50].

In this study, there was no significant difference between gender in mean serum urea, sodium, chloride, bicarbonate, anion gap, creatinine, uric acid, phosphate and calcium. Paudel et al. reported similar finding that none of the renal parameters shown significant sex difference [48]. Significant difference was observed between males and females in mean eGFR, BMI and mean serum potassium. Higher eGFR was observed in males than females, whereas Nitsch et al. reported both sexes faces increased risk of lower eGFR [51]. Body mass Index was found to be higher in females than males which is consistent with the findings of Nalado et al. among civil servants in kano and that of Gallapher et al. who reported women have significantly greater amount of total body fat than do men throughout the adult life [52,53]. Wachukwu et al. reported contrary in the southern part of Nigeria as males are higher in BMI then females; this may be connected with the differences in the socio-demographic factors between the regions [1]. BMI can influence muscle mass and sex can considerably affect it [33]. There was also significant difference in mean serum potassium with higher in males than females, this also supported the studies by Wysowski et al. in the US that females are more prone to hypokalemia than males because women are more susceptible to the development of QT prolongation which is associated with hyperkalemia [54]. The Limitations of this study is that urine sediments and early predictive markers of renal disease were not considered in the objective.

5. CONCLUSION AND RECOMMENDATION

Kidney dysfunction in orthopaedic patients was found to be higher in males than females and is increasing with age. However, most of the biomarkers of kidney function are irrespective of gender. Regular testing of kidney profiles among orthopaedic patients should be carried out for proper management to improve quality of life.

CONSENT

All authors declare that 'written informed consent was obtained from the patients for publication of this paper.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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