VOLUME 39, NUMBER 12
December 2022

ISSN 0189 - 160X

WAJM

WEST AFRICAN JOURNAL OF MEDICINE

ORIGINALITY AND EXCELLENCE IN MEDICINE AND SURGERY

OFFICIAL PUBLICATION OF
THE WEST AFRICAN COLLEGE OF PHYSICIANS *AND*
WEST AFRICAN COLLEGE OF SURGEONS

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ORIGINAL ARTICLE

Malnutrition Inflammation Complex Syndrome in Pre-dialysis Chronic Kidney Disease Patients in a Nigerian Tertiary Hospital

Syndrome Complexe de Malnutrition et d'Inflammation chez des Patients Atteints de Néphropathie Chronique Pré-Dialysés dans un Hôpital Tertiaire Nigérian

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ABSTRACT

BACKGROUND: Malnutrition Inflammatory Complex Syndrome (MICS) is a non-traditional cardiovascular risk factor that is associated with poor overall outcomes in chronic kidney disease (CKD). However, it has not been well studied among Nigerian CKD population despite its potential for response to therapeutic intervention.

OBJECTIVES: To determine the prevalence and severity of MICS and some of its associated factors among pre-dialysis CKD patients.

METHODS: This was a cross-sectional study that involved 51 pre-dialysis CKD patients and 51 healthy controls. MICS was assessed using malnutrition inflammation scores (MIS) among the participants. MIS of $\geq$ 6 was used as the criterion for diagnosis of MICS.

RESULTS: The mean ages of the CKD and control groups were 50.96 ± 11.42 years and 48.31±9.83 years, respectively. The prevalence of MICS was significantly higher in the CKD group compared to the control group (54.90% vs 7.8%; *P* =<0.001). MICS was mild and moderate to severe in 64.3% and 35.7% of the pre-dialysis CKD participants, respectively. Among all the study participants, lower educational level, low estimated glomerular filtration rate, (*P*<0.001), dyslipidemia (*P* =<0.001), anaemia (P=<0.001) and hypertension (*P*=0.033) were significantly associated with MICS. There was significant negative correlation between the MIS and estimated glomerular filtration (r = –0.73, *P* <0.001), and haematocrit (r = –0.335, p =0.016).

CONCLUSION: MICS was common in pre-dialysis CKD population. It was significantly associated with hypertension, dyslipidemia, educational level, anaemia and estimated glomerular filtration rate in pre-dialysis CKD patients. Early diagnosis and treatment may reduce poor cardiovascular outcomes in them. **WAJM 2022; 39(12): 1253–1259.**

Keywords: Malnutrition Inflammation Complex Syndrome, Pre-dialysis, Chronic kidney disease.

RÉSUMÉ

CONTEXTE: Le syndrome du complexe inflammatoire de la malnutrition (MICS) est un facteur de risque cardiovasculaire non traditionnel qui est associé à de mauvais résultats globaux dans la maladie rénale chronique (MRC). Cependant, il n'a pas été bien étudié parmi la population nigériane atteinte de MRC, malgré son potentiel d'intervention thérapeutique.

OBJECTIFS: Déterminer la prévalence et la gravité de la MICS et certains de ses facteurs associés chez les patients atteints d'IRC en pré-dialyse.

MÉTHODES: Il s'agissait d'une étude transversale portant sur 51 patients atteints d'IRC en prédialyse et 51 témoins sains. Le MICS a été évalué en utilisant les scores d'inflammation de malnutrition (MIS) parmi les participants. Un indice de malnutrition supérieur ou égal à 6 a été utilisé comme critère de diagnostic de la MICS.

RÉSULTATS: L'âge moyen des groupes de personnes atteintes de NC et de témoins était de 50,96 ± 11,42 ans et de 48,31±9,83 ans, respectivement. La prévalence des MICS était significativement plus élevée dans le groupe IRC que dans le groupe témoin (54,90 % contre 7,8 % ; P =<0,001). La MICS était légère et modérée à sévère chez 64,3 % et 35,7 % des participants à l'IRC avant dialyse, respectivement. Parmi l'ensemble des participants à l'étude, un niveau d'éducation plus faible, un faible débit de filtration glomérulaire estimé. (P<0,001), la dyslipidémie (P =<0,001), l'anémie (P=<0,001) et l'hypertension (P=0,033) étaient significativement associés au MICS. Il y avait une corrélation négative significative entre le MICS et la filtration glomérulaire estimée (r = -0,73, P <0,001), et l'hématocrite (r=-0,335, p =0,016).

CONCLUSION: Le MICS était fréquent dans la population IRC pré-dialyse. Il était significativement associé à l'hypertension, la dyslipidémie, le niveau d'éducation, l'anémie et le taux de filtration glomérulaire estimé chez les patients IRC pré-dialysés. Un diagnostic et un traitement précoces pourraient réduire les mauvais résultats cardiovasculaires chez ces patients. **WAJM 2022; 39(12): 1253–1259.**

Mots clés: Le syndrome du complexe inflammatoire de la malnutrition, Pré-dialyse, maladies rénal chronique, Titre courant proposé : Le MICS chez les patients IRC pré-dialysés.

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INTRODUCTION

Malnutrition is a non-traditional cardiovascular risk factor that is highly prevalent in both pre-dialysis chronic kidney disease (CKD) patients and those on renal replacement therapy (RRT).[1–5] Malnutrition is characterized by a reduction in body protein with or without fat depletion when nutrient intake is not commensurate with requirements and it is improved by nutritional repletion.[6] The nutritional state that characterizes CKD is beyond what inadequate nutritional intake could explain, thereby suggesting the contribution of other factors such as inflammation, metabolic acidosis, impaired insulin/insulin-like growth factor-1 signaling pathways which reduce protein synthesis independent of the presence of adequate nutrition.[7–9]

Inflammation has been identified as a major contributor to the poor nutritional state in CKD.[7–9] In fact, CKD has been described as a chronic inflammatory state.[9,10] Inflammation occurs simultaneously and acts in synergy with malnutrition,[8] hence the term Malnutrition-Inflammation Complex Syndrome (MICS).[7] The causes of inflammation in both pre-dialysis CKD patients and those on dialysis include accumulation of pro-inflammatory substances such as advanced glycosylated end products, increased oxidative state, non-biocompatibility with dialyzer membrane, dialysate back leak and dialysis catheter-related infection.[10]

Inflammation contributes to poor nutritional state in CKD by activation of ATP-ubiquitin-protease pathway, hypermetabolism, reduced appetite and insulin resistance. The consequences of inflammation include loss of muscle mass, reduction in serum albumin, prealbumin and transferrin, alteration of lipoprotein and endothelial structure and function which favour atherosclerosis that accounts for increased risk of cardiovascular disease.[8]

MICS is associated with increased rate of hospitalization and infection, limitation of functional status, erythropoeitin hyporesponsiveness, increased cardiovascular morbidity and mortality and reduced quality of life in CKD patients.[11–15]

Majority of the studies on mal-nutrition in Africa, especially Nigeria, have focused on the malnutrition part of CKD while the inflammatory component of nutritional status has not been well studied. The malnutrition inflammation score (MIS) is a semi-quantitative nutritional assessment tool that consists of parameters that is able to assess both malnutrition and inflammation in CKD patients.[16] This assessment tool offers the clinician the opportunity to diagnose and institute interventions that will reduce cardiovascular risk and attendant complications in those with MICS. This study therefore assessed the prevalence and severity of MICS among pre-dialysis CKD patients. It also investigated the potential risk factors associated with MICS in the study population. The identified significant cardiovascular risk factors associated with MICS in this study may serve as therapeutic targets to reduce MICS and its attendant consequences among Nigerian CKD patients. The finding of this study will also fill some of the existing gaps in literature, especially in the inflammatory component of mal-nutrition in CKD population in Nigeria.

MATERIALS AND METHODS

This was a cross-sectional study that was carried out over a six-month period from March - October 2018 at a tertiary health centre in Nigeria.

The sample size was calculated using the formula for cross-sectional studies:[17] $N = (Z1–a/2)^2P(1-P)/d^2$ where N=minimum sample size, Z1–a/2= level of significance at 95% confidence interval =1.96. P= available prevalence of malnutrition inflammation complex syndrome among pre-dialysis CKD patients. A value of 46.7% which was reported as the prevalence of malnutrition and inflammation among pre-dialysis CKD in a previous study was used; [18] and d = degree of precision limit required=5 % (0.05). Sample size calculated was: $(1.96)^2$ (0.467) (1–0.467)/ $(0.05)^2$ = 3.8416(0.467) 0.53/0.0025 = 0.938/ 0.0025= 376. For small finite population, the corrected sample size was; Nf = n/ 1+n–1/N. Where N= average number of pre-dialysis CKD patients seen at nephrology clinics (from clinic register) in the hospital in the previous 6 months. N = 60 pre-dialysis patients in the previous 6 months. Therefore, n= calculated sample size which was 376 Nf = corrected sample size. Which is 376/1 + 376–1/60 = 376 / 7.25=51. A total of 51 pre-dialysis CKD patients and 51 healthy controls were recruited for the study.

Inclusion criteria were consenting adult CKD patients of age 18–65 years, estimated glomerular filtration rate (eGFR) of < 60 mls /min/1.73m^2, and those yet to commence renal replacement therapy (RRT). CKD patients with inflammatory gastrointestinal disease, dementia, chronic liver disease, nephrotic syndrome, on-going infection, chronic infection such as tuberculosis and those on steroid therapy were excluded. Patients attending the nephrology out-patient clinic who fulfilled the inclusion criteria were consecutively recruited. They were age- and sex-matched with apparently healthy controls without CKD who were recruited from the same hospital.

An interviewer-administered questionnaire was used to obtain socio-demographic information, medical, drug and social history from all study participants. Study participants were physically examined and blood pressure values were taken using standard protocols.

The body weight was taken using standard weighing scale with the participants wearing light clothing and without shoes. Measurement was taken to the nearest 0.5kg. The height was taken in meters to the nearest 0.5m using a graduated height scale. Participants were in erect posture and their backs against a straight wall without headgear or shoes. Waist circumference (WC) in centimeters (cm) was taken using a tape measure at the level of the umbilicus. Body mass index (BMI) was calculated using the formula: BMI= Weight (kg)/Height^2 (m^2). Mid-upper arm circumference (MUAC) in centimeters (cm) was measured using a tape measure at the midpoint between the tips of the shoulder and the elbow around the arm. Triceps skin fold thickness (TSF) in millimeters (mm) was measured with Harpenden skin-fold caliper at the same point as the MUAC behind the right arm. Mid-arm muscle circumference (cm)

(MUAC – (0.31415×triceps fold thickness). Blood samples were taken for serum albumin, total iron binding capacity, creatinine and haematocrit. The estimated glomerular filtration rate (eGFR) was calculated using CKD-EPI formula. CKD was staged according to KDIGO guidelines.[19]

The MIS, which is made up of 10 components, was assessed in this study. These include five nutritional history-based components from SGA (weight change, dietary intake, gastrointestinal symptoms, functional capacity, and co-morbid conditions); two physical examination components that assess the subcutaneous body fat and signs of muscle wasting (triceps subcutaneous fold and mid upper arm circumference); the body mass index (BMI); serum albumin; and serum total iron binding capacity (TIBC). Co-morbidity was scored as contained in the MIS questionnaire: 0 if no medical illnesses were present except CKD; 1 is mild co-morbidity, excluding such major co-morbid conditions (MCCs) as severe congestive heart failure, severe coronary artery diseases, clinically evident acquired immunodeficiency syndrome (AIDS), moderate to severe chronic obstructive pulmonary disease and metastatic malignancies; score 2 is moderate co-morbidity (including one of the diseases listed under MCCs); and score of 3 if two or more MCCs co-existed. Each component was scored based on severity from 0 (normal) to 3 (severely abnormal). The sum of all the 10 MIS components ranges from 0 (normal) to 30 (severely malnourished).[11] A cut off value of ≥6 was used to diagnose MICS.[20] The severity of MICS was graded as mild if MICS was between 6–10 and moderate to severe if MICS was ≥11.[20] BMI of greater than 25kg/m^2 was used to define overweight and obesity.[21] Dyslipidemia was defined as any or a combination of the following: total cholesterol >200 mg/dl, high-density lipoprotein cholesterol (HDL-C) <50 mg/dl in females, and <40 mg/dl in males, low-density lipoprotein cholesterol (LDL-C) >130 mg/dl, triglyceride (TG) >150 mg/dl.[22] Anemia was defined as haematocrit <12g/L in females and <13g/L in males using the WHO criteria.[23]

Ethical Approval and Considerations

Ethical approval was obtained from the Human Research and Ethical Committee of the University of Abuja Teaching Hospital, (protocol number: UATH/HREC/PR/2017/08/095, and approval date: 8th of September 2017). The procedures were in accordance with the ethical standards of the National code for Health Research Ethics and with the Helsinki Declaration of 1975, as revised in 2013. Informed consent was obtained from all participants in the study. Confidentiality of the provided information was ensured throughout the study.

Data Analysis

Data from the study were entered and analyzed using IBM SPSS version 21 software. Discrete variables were presented as frequencies and percentages. Continuous variables were presented as means with standard deviation and categorical variables were expressed as proportions and percentages. The Chi-square test was used to test significant differences between categorical variables and Fisher's exact was used when one or more expected cell count was less than 5. Independent t-test was used to compare means of quantitative variables. Pearson's correlation was used to assess association between MIS, eGFR, age and haematocrit. *P*-value of <0.05 was regarded as significant.

RESULTS

The study participants were made up of 51 pre-dialysis CKD patients and 51 controls without CKD. There was no significant difference in the mean age of the CKD and control groups (50.96 ± 11.42 vs 48.31 ± 9.83; *P*=0.213, respectively). Most of the participants were married and had tertiary level of education. A significantly higher proportion of CKD patients had hypertension (*P*<0.001), diabetes mellitus (P=0.015), increased BMI (*P*<0.014), dyslipidaemia (<0.001) and anaemia (*P*<0.001)) Table 1.

The mean MUAC was significantly lower in the CKD group (27.69 ± 4.62cm

Table 1: Socio-demographic and Clinical Characteristics in Study Participants

Characteristics	CKD Group (n=51) Mean±SD/ n(%)	Control Group (n=51) Mean±SD/n(%)	P-value
Age(years)			
Mean Age	50.96 ± 11.42	48.31 ± 9.83	0.213
≤40	10(19.6)	14(27.5)	
41 – 60	30(58.8)	30(58.8)	0.287
≥60	11(21.6)	7(13.7)	
Sex			
Male	27(52.9)	26(51.0)	
Female	24(47.1)	25(49.0)	0.843
Marital Status			
Single	8(15.70)	13(25.50)	
Married	43(84.30)	36(70.60)	
Widowed	0(0.00)	2(3.90)	0.149
Educational level			
Below tertiary	29(56.9)	18(35.3)	0.023
Tertiary	22(43.1)	33(64.7)	
Clinical			
Hypertension	46(60.5)	30(39.5)	<0.001
Diabetes Mellitus	21(41.2)	10(19.6)	0.015
Dyslipidaemia	40(78.4)	11(33.3)	<0.001
Smoking	5(9.8)	4(7.8)	0.050
Anaemia	47(92.2)	21(41.2)	<0.001
Body Mass Index			
<25kg/m^2	19(37.3)	31(60.8)	0.014
≥25kg/m^2	32(62.7)	20(39.2)	

vs 30.16 ± 3.69cm; *P* <0.001). Similarly, the MAMC was significantly lower in the CKD group (24.61 ± 4.27cm vs 27.05 ± 3.04cm; *P* <0.001). The mean serum albumin was significantly lower in the CKD group (34.76 ± 7.86g/dl vs 39.45 ± 5.58g/dl ; *P*<0.001). The mean TIBC was significantly lower in the CKD group (266.86 ± 71.98mg/dl vs 312.65 ± 41.50mg/dl; *P*= 0.001).Table 2 . The MIS ranged from 0 to 16. The median MIS was significantly higher among CKD patients compared to controls (6.0 vs 1.0; *P* <0.001) Table 2.

Among the CKD patients, overall weight change > 0.5 kg over the preceding 3 months was present in 17(33.3%); poor dietary intake was present in 19 (37.3%); gastrointestinal symptoms were present in 25(49.0%); functional capacity was reduced in 25(49.0%); and more than one co-morbidity was present in 48(94.1%) Physical examination showed that 15(29.4%) patients had reduced body fat and 15(29.4%) patients also had muscle wasting.

The prevalence of MICS was significantly higher in the CKD group compared to the control group (54.90% vs 7.8%; *P* <0.001). MICS was mild and moderate-to-severe in 64.3% and 35.7% of the pre-dialysis CKD participants, respectively Table 3.

Among all the study participants, lower educational level, low eGFR (*P*<0.001), dyslipidemia (*P* <0.001), and hypertension (*P*=0.033) were significantly associated with MICS Table 4.

There was significant negative correlation between the MIS score and eGFR (r = –0.73, *P* <0.001) and haemoglobin concentration (r = –0.335,*P*=0.016) Table 5.

Table 2: Comparison of Nutritional Indices, Biochemical and Clinical Parameters in Study Participants

	CKD Group (n=51) Mean±SD/ n(%)	ControlGroup(n=51) Mean±SD/ n(%)	P-value
Clinical			
Systolic BP (mmHg)	138.29±15.47	125.78±15.85	<0.001
Diastolic BP (mmHg)	85.10±10.42	78.63±10.00	0.002
Fasting blood glucose(mmol/l)	5.53±1.17	5.39±0.88	0.497
Total cholesterol(mmol/l)	4.20±1.47	4.46±0.69	0.250
Nutritional Indices			
Body mass index(kg/m^2)	26.58±5.68	25.22±4.35	0.178
MUAC(cm)	27.69±4.62	30.16±3.69	0.004
MAMC (cm)	24.61±4.27	27.05±3.04	0.001
TSF thickness (mm)	9.80±3.84	9.92±4.87	0.885
Waist circumference(cm)	87.73±16.51	85.19±11.69	0.374
Laboratory Indices			
Haemoglobin (%)	9.52±1.89	12.94±1.74	<0.001
eGFR(ml/min/1.73m^2)	28.34±16.09	91.26±10.79	<0.001
Serum albumin(g/dl)	34.76±7.86	39.45±5.58	<0.001
TIBC (mg/dl)	266.86±71.98	312.65±41.50	0.002
Median MIS (IQR)	6.0(7.0)	1.0(2.0)	<0.001

eGFR, Estimated Glomerular Filtration Rate; TIBC, Total Iron Binding Capacity; TSF, Triceps Skin Fold Thickness; MAMC, Mid-arm Muscle Circumference; MUAC, Mid-upper Arm Circumference; GIT(gastrointestinal) IQR, Interquartile Range; MIS, Malnutrition Inflammatory Score.

Table 3: Prevalence and Severity of MICS among Study Participants

MICS	CKD Group n(%) (n=51)	Controls Group n(%) (n=51)	P value
Present	28(54.9)	4(7.8)	<0.001
Absent	23(45.1)	47(92.2)	
Severity of MICS			
Mild	18(64.3)	4(7.8)	
Moderate to severe	10(35.7)	0	

MICS, Malnutrition Inflammatory Complex Syndrome.

DISCUSSION

This study determined the prevalence and severity of MICS and its associated factors among pre-dialysis CKD patients. The prevalence of MICS was significantly higher in the CKD group compared to the control group. MICS was mild and moderate-to-severe in 64.3% and 35.7% of the pre-dialysis CKD participants, respectively. Lower educational level, low estimated glomerular filtration rate, dyslipidemia, anaemia and hypertension were significantly associated with MICS among the study participants.

In this study, the prevalence of the combination of malnutrition and inflammation among pre-dialysis CKD patients was 54.9% which was significantly higher than 7.8% observed among controls. This showed that CKD is associated with malnutrition and inflammation. Among the CKD patients with MICS, it was mild in 64.3% and moderate-to-severe in 35.7%. The prevalence found in our study is within the range of 31.4–70.5% that has been previously reported in some studies.[1–5,23,24] This wide difference in the prevalence rates from previous studies may be partly due to the difference in the methodology of the studies such as type of patients (pre-dialysis or end stage renal disease), study region (developing or developed) and criteria used to determine the presence of malnutrition or combination of both malnutrition and inflammation.

The prevalence of MICS in this study is higher than 33% reported among pre-dialysis CKD patients in India by Jagadeswaren *et al*[2] This may suggest that the burden of MICS and its consequences may be higher among CKD patients in Nigeria compared to India. However, this must be interpreted

Table 4: Bivariate Association between MICS, Socio-demographic Characteristics and Cardiovascular Risk Factors in the Study Participants

	MICS Present n(%) n=32	MICS Absent n (%) n=70	P-value
Age (years)			
≤40	5(15.6)	19(27.1)	0.105
41 – 60	19(59.4)	41(58.6)	
≥60	8(25.0)	10(14.3)	
Gender			
Male	18(56.3)	33(47.1)	0.261
Female	14(43.7)	37(52.9)	
Educational Level			
Below tertiary	22(68.8)	25(35.7)	0.002
Tertiary	10(31.2)	45(64.3)	
Estimated GFR			
<60mls/1.73m^2	28(87.5)	23(32.9)	
≥60mls/1.73m^2	4(12.5)	47(67.1)	<0.001
Dyslipidemia			
Present	29(90.6)	28(40.0)	<0.001
Absent	3(9.4)	42(60.0)	
Diabetes Mellitus			
Present	13(40.6)	18(25.7)	0.100
Absent	19(59.4)	52(74.3)	
Hypertension			
Yes	28(87.5)	48(68.6)	0.033
No	4(12.5)	22(31.4)	
Smoking			
Yes	5(15.6)	4(5.7)	0.106
No	27(84.4)	66(94.3)	
BMI			
<25kg/m^2	17(53.1)	35(50)	0.496
≥25kg/m^2	15(46.9)	35(50)	
Anaemia			
Present	31(96.9))	37(52.9)	<0.001
Absent	1(3.1)	33(47.1)	

MICS, Malnutrition Inflammatory Complex Syndrome.

Table 5: Correlation between MIS, Age, eGFR, and Haemoglobin Concentration

	R	P-value
Age	0.163	0.102
Estimated GFR	–0.729	<0.00
Haemoglobin Concentration	–0.335	0.016

MIS, Malnutrition Inflammatory Score; GFR, Glomerular Filtration Rate.

with caution because the observed difference may be partly due to the different cut off value used to define MICS in these studies. Jagadeswaren *et al*[2] used a cut-off value of ≥7 in their study unlike our study where a ≥6 was used.

The MICS prevalence rate of 54.9% is higher than 31.4%, 46.7% and 43.2% prevalence of malnutrition reported in previous studies that were conducted among pre-dialysis CKD patients in Nigeria.[4,19,25] The difference may be partly due to differences in the criteria used to assess malnutrition in their studies. While Adejumo *et al*[19] used body mass index, serum albumin and total cholesterol, Agaba *et al*[25] used BMI and serum albumin. Our study used MIS which combined SGA, BMI, serum albumin and TIBC into a single tool for assessment of MICS, thereby increasing its sensitivity in diagnosing malnutrition. This may therefore explain the higher prevalence in our study compared to these studies. Also, the study by Okunola *et al*[4] was conducted among stage 2–5 CKD patients unlike our study that involved stage 3–5 CKD patients. The inclusion of earlier stages of CKD in the study by Okunola *et al*[4] may partly account for the lower prevalence of malnutrition in their study.

The prevalence in our study is lower than 60% and 61.2% reported by Aggarwal *et al*[5] and Giabe,[26] respectively. The higher prevalence rate reported by Aggarwal *et al*[5] may be due to the fact that the study was conducted among both end stage renal disease patients on haemodialysis and pre-dialysis CKD patients, and the use of a lower MIS cut off of ≥3 to diagnose MICS. Similarly, the higher prevalence by Giabe[26] may be partly due to the fact that his was conducted among HD patients even though a similar cut off value of ≥6 was used to diagnose MICS similar to our study. In addition, the HD patients in the study by Giabe[26] were not optimally dialysed. Dialysis-related inflammation caused by catheter-related infections, dialysate back leak, non-biocompatibility with dialyzer, increased oxidative state, accumulation of proinflammatory substances such as advance glycosylated end-products may likely increase the MIS in this group of patients, and thereby increase the prevalence of MICS.[10]

In this study, there was a significant association between the degree of renal function and MICS. There was a negative correlation between MIS and eGFR. These findings are in keeping with previous reports.[19,27] The possible explanation for these findings is that as CKD worsens, there is more accumulation of uremic toxins, advanced glycosylated end products, anorexigenic substances that contribute to MICS. This shows that malnutrition and inflammation start early in the course of CKD and may worsen with progression of the disease. Therefore, it underscores the need for early assessment for MICS and intervention before patients commence RRT.

There was no significant association between MICS, age and gender. This is in keeping with the findings of previous studies.[19,28] It was observed that MICS was significantly more common in less educated CKD patients. This may suggest a relationship between MICS and socio-economic class as reported in a previous study.[1] We also found that MICS was significantly associated with some cardiovascular risk factors such as hypertension and dyslipidemia. Treatment of dyslipidaemia and blood pressure to target may reduce inflammatory component of the MICS.

There was a negative correlation between MIS and haematocrit value in this study. This supports studies that have implicated the role of inflammation in the pathophysiology of anaemia in CKD by causing hyporesponsiveness to erythropoietin stimulating agents and haemoglobin variability.[13,29]

Renal dieticians should be actively involved in the management of CKD, especially in the early stages. Campell *et al*[30] showed that following the nutritional management guidelines recommended by dieticians significantly improved the nutritional status of CKD patients.

The limitation of this study is the relatively small sample size; however, the strength lies in the fact that this study used MICS, an assessment tool that assessed both malnutrition and inflammation unlike majority of previous studies in Africa that used other criteria to assess only malnutrition.

In conclusion, MICS was common in pre-dialysis CKD population. It was significantly associated with hypertension, dyslipidaemia, educational level, haematocrit and estimated glomerular filtration rate in pre-dialysis CKD patients. Early diagnosis and treatment may reduce poor cardiovascular outcomes in them. Therefore, we recommend routine assessment and management of MICS in pre-dialysis patients in order to reduce their cardiovascular risk and improve their quality of life.

ACKNOWLEDGEMENTS

The authors acknowledge the registrars of the nephrology unit and Tinat the outpatient clinic assistant who assisted in the enrollment of participants for this study.

Final Support

The study was paid for by the researchers.

Conflict of Interest

The authors have no conflict of interest.

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