Gender Differences in Response to Hemodialysis Treatment: Determinants and Clinical Correlates. Findings from Two Tertiary Health Centers in Southwest Nigeria

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ABSTRACT

Background: The physiologic and hormonal differences between males and females could be impactful on dialysis treatment. The differential response is further heightened by differences in socioeconomic, cultural, educational, and genetic makeup.

Aim: We compared the determinants and correlates of the dialysis dose in the two sexes.

Methodology: It was a two-center, hospital-based prospective study in which 1248 dialysis sessions were studied. Participants' sociodemographics, clinical findings, pre and post-dialysis renal biochemistry and hematocrit results and prescribed dialysis doses were documented and the dialysis dose (urea reduction ratio and urea clearance as a unit of its distribution volume) were calculated.

Results: Dialysis sessions of 232 participants were studied. The majority (61.6%) were males, but the females were older (50.3 $\pm$ 9.1yrs versus 48.7 $\pm$ 6.4yrs. Compared with females, the males had higher educational attainment (P<0.001), more sessions (P=0.002), erythropoietin doses (P<0.001), blood flow rate (P<0.001) and ultrafiltration volume (P=0.003). Intradialytic hypotension (IDH) was more common in females (P<0.001) while intradialytic hypertension (IDHT) was commoner in males (P=0.04). The dialysis dose was higher in men (P=0.02). Dialysis termination was more common with females (P<0.001). The independent predictors of dialysis dose were SPO_2, predialysis albumin and PCV, dialysis duration, blood flow rate and frequency of EPO use. The correlation between Kt/V and URR was very strong (r=0,895, P<0.001).

Conclusion: Males received more dialysis and erythropoietin treatment and had higher dialysis doses. IDH and dialysis termination were commoner in females while males had more IDHT, higher ultrafiltration volume, more permanent dialysis catheters. Dialysis formulation should therefore reflect gender disparity in order to address the imbalances.

Keywords: *Gender differences, hemodialysis, urea reduction ratio, intradialytic hypotension, intradialytic hypertension.*

INTRODUCTION

Chronic kidney disease is on the increase worldwide and dialysis as the commonest form of renal replacement therapy (RRT) is associated with conditions that could limit its effective delivery. Some of these conditions could be exaggerated or suppressed in one gender [1]. Gender differences in procuring or accessing dialysis treatment could be closely related to educational attainment, cultural

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differences and economic opportunities. Women are comparatively disadvantaged particularly in Nigeria and many low-income nations (LINs) [2]. Females have less muscles mass and total body water (TBW) but more body fat compared with males. Ritz et al, found an inverse relationship between TBW and body mass index (BMI) but a direct relationship between TBW and extracellular fluid volume (ECFV). Females and the obese therefore are at higher risk of dehydration [3]. The impact of the relationship between the body fluid composition and age, BMI and body fat readily comes to mind during dialysis ultrafiltration. The lesser TBW in females could be a risk for recurrent IDH and ischemic kidney injury, known to worsen mortality rate among dialysis patients [4]. Dialysis dose has been reported to be higher in males in many studies while some have found higher doses in females [5,6]. The comparative health survival advantage of women in the general population is reported to be lost during dialysis treatment [7].

Most studies on gender differences in dialysis have been on the relationship between intradialytic events and mortality risk. As a way of filling the knowledge gap, this study compared on a gender basis, patients socio-demographics, renal biochemical parameters, the prescribed dialysis and intradialytic events, and accessed their impact on the delivered dialysis dose in a low-income nation (LIN). We also determined the correlation between the URR and the Kt/V.

We hypothesize that the dialysis dose delivered to females is less than that delivered to males, due to gender differences in socio-demographics, renal biochemical parameters, the prescribed dialysis and intradialytic eventis.

PATIENTS AND METHODS

A two-centre comparative study carried out at the dialysis suites of Federal Medical Centre Abeokuta and Babcock University Teaching Hospital, Ilishan-Remo. Two hundred and thirty-two participants with chronic kidney disease (CKD) in end-stage according to the KDOQI 2015 criteria who met the inclusion criteria, gave informed consent and had.1248 dialysis sessions were studied [8].

The sample size was calculated from the formula for a cross sectional study using a previous study's prevalence [9].

All participants had at least a month of maintenance hemodialysis (MHD) treatment before being recruited into the study. Data retrieved from the case notes were age, gender, etiology of CKD, frequencies of erythropoietin injections and dialysis sessions, and intra dialysis complications. Anticoagulation was with intravenous heparin 5,000 IU, for every 0.1 increase in international normalized ratio (INR) above 1.3, heparin dose was reduced by 500 IU. The composition of the dialysate fluid was the same .for all dialysis sessions.

Patients with infections, malignancies or renal graft were excluded.

A maximum of six sessions for each participants was studied and data from each session was used in the data analysis. Socio-demographic data was taken. The height was measured with a SECA standiometer and the weight was taken with a SECA weighing scale, without shoes and on very light clothing. The predialysis pulse rate, BP and SPO_2 were taken and repeated half-hourly throughout dialysis in order to detect possible itradialytic events. The BP was taken after 5 minutes of rest with the back and the arm for measurement rested on a support. While prescribing dialysis, the clinical history, vital signs and predialysis biochemical parameters were taken into consideration.

About 1-2ml of blood was withdrawn through the internal jugular vein (IJV) catheter (to confirm patency) and discarded. The pre-dialysis samples for electrolytes, urea and creatinine, and haematocrit (HCT) were taken before flushing through catheter lines with heparinized saline. Blood was taken from newly sited femoral lines (as part of our dialysis protocol). For AV fistula, samples were taken from a peripheral vein in the contralateral arm. Participants were connected through the arterial and then venous portal. Whenever the BFR was altered during dialysis, BFR for that session is calculated.

At the end of dialysis time, dialysate flow was stopped and BFR was reduced to 100ml/min. Five minutes after stopping dialysate flow, blood was taken from the arterial portal for analysis of post-dialysis renal biochemistry serum electrolytes (allowing cardiopulmonary and access recirculation, and not dependent on precise timing of blood sampling) and then for HCT [10].

The Daugirdas second-generation logarithmic formula,

Kt/V = -In(R - 0.008 * t) + (4-3.5 * R) * UF/W, (where * denote multiplication and 0.008 denote urea generation term) was used to calculate the delivered dose using the Kt/V [11].

The urea reduction ratio (URR) was calculated from the formula:

$$\frac{\text{(predialysis urea minus post-dialysis urea) X 100}}{\text{Pre dialysis urea.}}$$

The URR and Kt/V were related by the formula, Kt/V = In (1-URR), where In is natural log

Though the URR and the Kt/V were both used as measures of dialysis doses in this study, in the multivariate regression model, the Kt/V was used as the outcome of interest.

Serum renal biochemical analysis was determined using an autoanalyzer (Roche Diagnostics GmbH, Mannheim Germany) while the serum albumin was analyzed using the bromocresol green method.

Definitions

IDH was defined as intradialysis systolic BP fall of least 20 mmHg, with symptoms [12].

IDHT was defined as intradialysis systolic BP increase greater than 10 mmHg [13].

In this study, for simplicity and convenience, the dialysis dose was classified as:

Normal dialysis dose, Kt/V $\geq$1.2 and/or URR $\geq$65.0% [14]

Low dialysis dose, Kt/V <1.2 and/or URR <65.0% [14]

In this study, the cause of CKD was not based on renal histological findings. CKD-associated hypertension was defined as kidney disease complicating long standing hypertension, prevalent in the elderly and late middle age while chronic glomerulonephritis was defined as hypertension complicating kidney disease, common in the young and early middle age with or without preceding history of pharyngitis or skin sepsis.

Statistical analysis

Data was analyzed using SPSS 22. Continuous variables with normal distribution were presented as mean with standard deviation while variables that were not normally distributed were presented as median with ranges. Means were compared using student's t-test. Categorical variables were presented as proportions with frequencies and compared using Chi-square test or fisher's exact test.

Multivariate logistic regression analysis was used to determine variables that independently predicted inadequate dialysis dose in both genders. Spearman's correlation analysis was used to define the relationship between the Kt/V and the URR in males, females and in all participants. The P-value <0.05 was considered statistically significant.

The research followed the Declaration of Helsinki on ethical principles of human medical research. The Ethics Committee of the Federal Medical Centre, Abeokuta and Babcock University approved this study. The institutional ethical committee of Babcock University approved all study protocols (FMCA/470/HREC/03/2017 and BUHREC723/19). Accordingly, written informed consent was taken from all participants.

RESULTS

Two hundred and thirty-two participants (143 males and 89 females) took part in the study (Table 1). Participants had 1248 dialysis sessions. The mean age of the participants was 49.9$\pm$4.6 years (males 48.7$\pm$6.4yrs and females, 50.3$\pm$9.1yrs). A greater proportion of participants were middle-aged, (52.2%), had tertiary education, (59.1%) and had hypertension (38.8%) as the cause of CKD. A greater proportion of the males had HTN as the cause of CKD while a greater proportion of the females had CGN as the cause of CKD, P<0.001. In both genders, a greater proportion of participants were sponsored for treatment by their family. Post-Hoc analysis further showed that the significant association between gender and educational status (X^2-19.584, P<0.001) was found among females with primary education (Standardized residual=2.9). There was no significant association between gender and sponsorship of treatment.

The mean predialysis sodium, chloride, urea, creatinine and albumin were significantly higher in males than females, P=0.04, P=0.001, 0.001, P<0.001 and 0.04 respectively. The mean predialysis bicarbonate was significantly higher in males, P=0.04 (Table 2).

Post-Hoc analysis further showed that the significant association between gender and age (X^2-

9.938, P=0.007) was found among females **e"**60 years (Standardized residual=2.3). Post-Hoc analysis further showed that the significant association between gender and aetiology of CKD (X^2-16.229, P=0.001) was found among females with Diabetes (Standardized residual=2.7).

The proportion of terminated HD was more in females compared to males, P<0.001 (Table 3). A greater percentage of dialysis sessions with BFR <350ml/min was found with females than males, P<0.001. The mean ultrafiltration volume was significantly higher in males than females, P=0.003. Femoral vein access was the most commonly used for women but was second to internal jugular vein (IJV) in males, P<0.001. A significantly higher proportion of males had two or more dialysis session and erythropoietin injections weekly compared to females, P=0.002 and P<0.001 respectively. The mean age of initiation of dialysis was lower in males than females, 47.1 ± 5.4 years and 51.5 ± 6.2 years, P=0.03. Post-Hoc analysis further showed that the significant association between gender and type of dialysis catheter (X^2-18.952, P<0.001) was found among females with femoral catheters (standardized residual=2.9). There was no significant association between gender and aetiology of CKD.

The prevalence of IDH for females in this study was 3.7% as against 11.9% in males, P<0.001. The prevalence of IDHT in females was 22.8% as against 25.3% in males, P=0.04. The only case of intradialysis death was a female, 1 (100%) from IDHT, P<0.001. The mean Kt/V and URR for the study were higher in males than in females, P=0.02 and P=0.03 respectively (Table 4). Using the Kt/V, a greater proportion of sessions for both males and females had a very low dialysis dose, (<0.9). However, using the URR, a greater proportion of sessions for both males and females had low dialysis dose, (50-64.9).

Univariate analysis showed the relationship between the delivered dose and participants' characteristics (Table 5). Variables in the univariate model with P<0.025 were entered into a multiple regression model to determine independent predictors of dialysis dose using backward elimination to adjust for confounders (Table 6). We compared the determinants and correlates of the delivered dose in the two sexes using a multivariate regression model which showed predialysis SPO_2 (OR-2.023, CI-0.14-2.74, P=0.03), predialysis creatinine (OR-1.88, CI-1.11-4.42, P=0.01), dialysis duration (OR-2.042, 2.34-6.92, P=0.001) and BFR (OR-2.33, CI-1.86-4.2, P=0.001) as independent associates of the delivered dose (Table 6). The correlations between the dialysis doses (Kt/V and URR) were strongly positive among females (r=0.897, P<0.001), males (r=0.882, P<0.001) and in the study population (r=0.881, P<0.001).

Table 1: Demographic and clinical characteristics of the study population

Variables	All participants N=232 (%)	Males N=143 (%)	Females N=89 (%)	P-value
Age group, *(years)*				
18-39	53 (22.8)	34 (23.8)	19 (21.3)	0.04
40-59	121 (52.2)	75 (52.4)	46 (51.7)	
≥60	58 (25.0)	34 (23.8)	24 (27.0)	
Etiology of CKD				
Hypertension	90 (38.8)	61 (42.7)	29 (32.6)	<0.001
CGN	88 (37.9)	52 (36.3)	36 (40.4)	
Diabetes	27 (11.6)	14 (9.8)	13 (14.6)	
Obstructive Uropathy	12 (5.2)	9 (6.3)	3 (3.4)	
Others	15 (6.5)	7 (4.9)	8 (9.0)	
Educational Status				
Primary	20 (8.6)	4 (2.8)	16 (18.0)	<0.001
Secondary	75 (32.3)	51 (35.7)	24 (27.0)	
Tertiary	137 (59.1)	88 (61.5)	49 (55.0)	
Sponsorship				
Self	85 (36.6)	54 (37.8)	31 (34.8)	<0.001
Family	100 (43.1)	56 (39.2)	44 (49.5)	
Organizations	47 (20.3)	33 (23.0)	14 (15.7)	

CKD-chronic kidney disease, CGN-chronic glomerulonephritis

Tale 2: Laboratory characteristics of the participants

Variables	Males Mean ± SD	Females Mean ± SD	P-value
Predialysis serum sodium, mmol/L	129.8 ± 6.7	126.6 ± 5.2	0.04
Predialysis serum chloride, mmol/L	100.1 ± 9.8	9.7 ± 7.7	<0.001
Predialysis serum potassium, mmol/L	5.7 ± 3.4	5.5 ± 3.7	0.5
Predialysis serum bicarbonatemia, mmol/L	17.9 ± 6.1	17.1 ± 6.9	0.04
Predialysis serum urea, mmol/L	18.4 ± 11.3	16.1 ± 5.1	0.001
Predialysis serum creatinine, mmol/L	612.7 ± 12.4	542.2 ± 8.7	<0.001
Predialysis serum PCV, %	26.2 ± 3.9	25.6 ± 2.1	0.05
Predialysis serum albumin, g/dL	32.1 ± 7.8	30.9 ± 4.6	0.04

PCV-packed cell volume, URR-urea reduction ratio

Table 3: Gender differences in the characteristics of the haemodialysis treatment

Variables	All sessions N=1248 (%)	Males N=818 (%)	Females N=430 (%)	P-value
Dialysis duration, hours				
<4	129 (10.3)	63 (7.7)	66 (15.3)	<0.001
4	1119 (89.7)	755 (92.3)	364 (84.7)	
Blood flow rate, mL/min, n(%)				
<350	381 (30.5)	202 (24.7)	179 (41.6)	<0.001
>350	867 (69.5)	616 (75.3)	251 (58.4)	
UFV, litre, **mean ± SD**	1.3 ± 0.4	1.4 ± 0.1	1.1 ± 0.5	0.05
Access type, n(%)				
Femoral	426 (34.1)	214 (26.2)	212 (49.3)	<0.001
Internal jugular	757 (60.7)	553 (67.6)	204 (47.4)	
AV fistula	65 (5.2)	51 (6.2)	14 (3.3)	
Dialyzer size, m^2, n(%)				
1.3	19 (1.5)	14 (1.7)	5 (1.2)	0.6
1.7	1229 (98.5)	804 (98.3)	425 (98.8)	
Frequency of HD, n(%)				
1	589 (47.2)	334 (40.8)	255 (59.3)	0.002
>2/week	659 (52.8)	484 (59.2)	175 (40.7)	
Frequency of Erythropoietin, n(%)				
1/week	614 (65.2)	392 (60.1)	322 (74.9)	<0.001
>2/week	634 (34.8)	26 (39.9)	108 (25.1)	
HD per CKD etiological factor, n(%)				
CGN	518 (41.5)	371 (45.4)	147 (34.1)	0.002
HTN	544 (43.6)	342 (41.8)	202 (46.9)	
Diabetes	105 (8.4)	61 (7.5)	44 (10.2)	
Others	81 (6.5)	44 (5.3)	37 (8.6)	
Age at HD initiation, Mean ± SD	44.7 ± 8.9	42.9 ± 5.4	48.1 ± 9.9	0.005

UFV-ultrafiltration volume, AV-arteriovenous, HD-hemodialysis, EPO-erythropoietin, CKD-chronic kidney disease, CGN-chronic glomerulonephritis, HTN-hypertension, CKD-chronic kidney disease, AV- arterovenous

Table 5: Univariate analysis of factors associated with low delivered dialysis dose (Kt/V)

Variables	All participants N=232 (%)	Kt/V <1.2 N= 208 (%)	Kt/V >1.2 N=24 (%)	P-value
Age, years				
16-39	53 (22.8)	47 (22.6)	6 (25.0)	0.04
40-59	121 (52.2)	109 (52.4)	13 (54.2)	
>60	58 (25.0)	52 (25.0)	5 (20.8)	
Sex				
Males	143 (61.6)	126 (60.6)	17 (70.8)	0.03
Females	89 (38.4)	82 (39.4)	7 (29.2)	
Aetiology of CKD				
Hypertension	90 (38.9)	82 (39.4)	8 (33.4)	0.01
Chronic glomerulonephritis	88 (37.9)	79 (38.0)	11 (45.8)	
Diabetes	27 (11.6)	25 (12.0)	2 (8.3)	
Others	27 (11.6)	22 (10.6)	3 (12.5)	
HD sessions	**All sessions 1248 (%)**	**Kt/V <1.2 N=1133 (%)**	**Kt/V >1.2 N=115 (%)**	**P-value**
BMI, kg/m^2				
<19.5	31 (2.5)	25 (2.2)	5 (4.3)	0.01
19.5-24.9	541 (43.3)	504 (44.5)	57 (49.6)	
>25.0	676 (54.2)	604 (53.3)	53 (46.1)	
SPO_2, %				
<95	864 (69.2)	810 (71.5)	54 (47.0)	<0.001
>95	384 (30.8)	323 (28.5)	61 (53.0)	
Systolic BP, mmHg				
<140	139 (11.1)	91 (8.0)	48 (41.7)	<0.001
>140	1109 (88.9)	1042 (92.0)	67 (58.3)	
Diastolic BP, mmHg				
<90	194 (15.5)	148 (13.1)	46 (40.0)	0.002
>90	1054 (84.5)	985 (86.9)	69 (60.0)	
Predialysis creatinine, µmol/L				
<500	512 (41.9)	450 (39.7)	62 (53.9)	0.03
>500	736 (58.1)	683 (60.3)	53 (46.1)	
Predialysis PCV, %				
<33	865 (69.3)	844 (74.5)	21 (18.3)	<0.001
>33	383 (30.7)	289 (25.5)	94 (81.7)	
Predialysis Albumin, g/dL				
<35	1096 (87.8)	1063 (93.8)	33 (28.7)	<0.001
>35	152 (12.2)	70 (6.2)	82 (71.3)	
Access type				
Temporary catheters	426 (34.1)	399 (35.2)	27 (23.5)	0.03
Permanent catheters	822 (65.9)	734 (64.8)	88 (76.5)	
Dialysis duration, hours				
<4	81 (6.5)	80 (7.1)	1 (0.9)	0.004
4	1167 (93.5)	1053 (92.9)	114 (99.1)	
Blood flow rate, mL/min				
<350	307 (24.6)	296 (26.1)	11 (9.6)	0.02
>350	941 (75.4)	837 (73.9)	104 (90.4)	
Dialyzer area, *m^2*				
1.3/1.4	33 (2.6)	27 (2.4)	6 (5.2)	0.004
1.7/1.8	1215 (97.4)	1106 (97.6)	109 (94.8)	
Ultrafiltration volume, *L*				
<3	630 (50.5)	588 (51.9)	42 (36.5)	0.020
>3	618 (49.5)	545 (48.1)	73 (63.5)	
Frequency of dialysis				
1/week	589 (47.2)	560 (49.4)	29 (25.2)	0.004
>2/week	659 (52.8)	573 (50.6)	86 (74.8)	
Frequency of Erythropoietin,				
±1/week	634 (50.8)	630 (55.6)	4 (3.5)	<0.001
>2/week	614 (49.2)	503 (44.3)	111 (96.5)	
Age at HD initiation	44.7 ± 8.9	45.1 ± 1.2	41.1 ± 5.6	0.03

CKD-chronic kidney disease, BMI-body mass index, BP-blood pressure, PCV-packed cell volume, HD-haemodialysis

Table 4: Gender differences in the dialysis dose

Variables	All sessions N=1248 (%) Mean ±SD	Males N=818 (%)	Females N=430 (%)	P-value
Mean Kt/V	1.02 ± 0.4	1.10 ± 0.7	0.9 ± 0.3	0.04
Mean URR, %	55.8 ± 4.0	57.6 ± 4.4	54.3 ± 3.2	0.03
Kt/V				
<1.2	1133 (90.8)	739 (90.3)	394 (91.6)	0.04
>1.2	115 (9.2)	79 (9.7)	36 (8.4)	
URR, %				
<65	1094 (97.7)	713 (87.2)	381 (88.6)	0.03
>65	154 (2.3)	105 (12.8)	49 (11.4)	

URR- urea reduction ratio

Tables 6: Multivariate Logistic Regression showing independent associates of inadequate delivered dose

Variables	OR	95% CI	P-value
Age	0.28	0.19-0.93	0.17
Sex	0.34	0.30-1.11	0.13
Predialysis SPO_2	2.023	0.14-2.74	0.03*
Systolic blood pressure	0.62	0.42-1.87	0.08
Diastolic blood pressure	0.48	91-1.62	0.13
Serum creatinine	1.88	1.11-4.42	0.04*
Packed cell volume	3.06	0.01-3.87	0.001*
Serum albumin	4.34	0.83-5.78	<0001*
Dialysis duration	2.042	2.34-6.92	0.001*
Blood flow rate	2.33	1.86-4.24	0.001*
Ultrafiltration volume	0.97	0.55-1.94	0.05
Frequency of dialysis	0.36	0.14-1.03	0.05
Frequency of erythropoietin	1.70	1.38-2.02	0.04*

OR- odd ratio, CI-confidence interval, SPO_2-percent oxygen saturation, GFR-glomerular filtration rate, SA-surface area

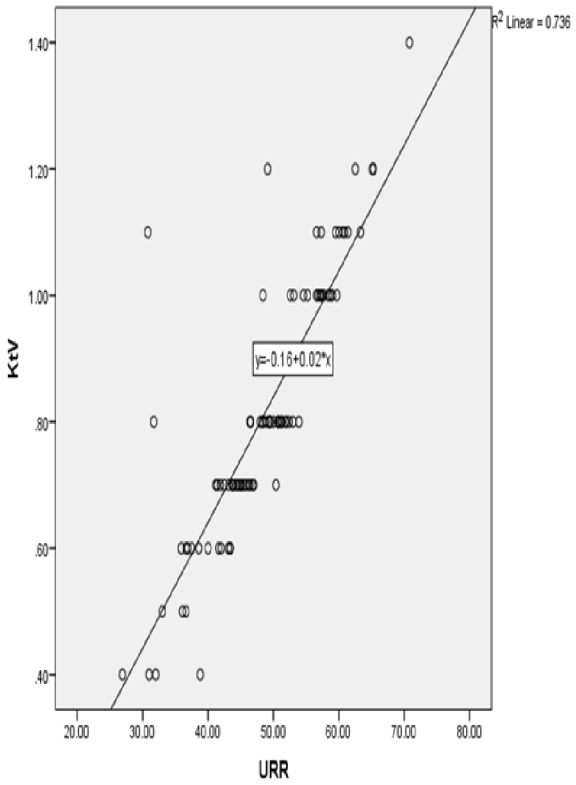

Figure 1a: There is a significant positive correlation between Kt/V and URR in female participants, r=0.879, P=0

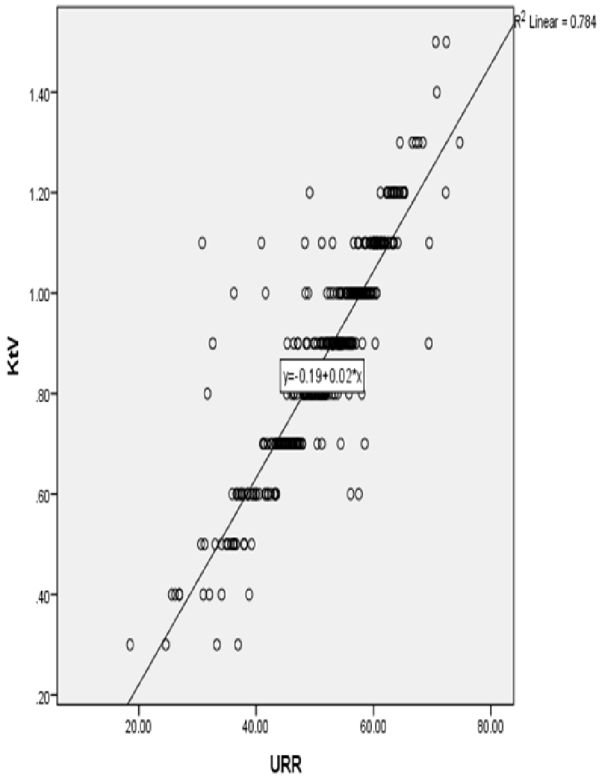

Figure 1b: There is a significant positive correlation between Kt/V and URR in male participants, r=0.882, P<0.01

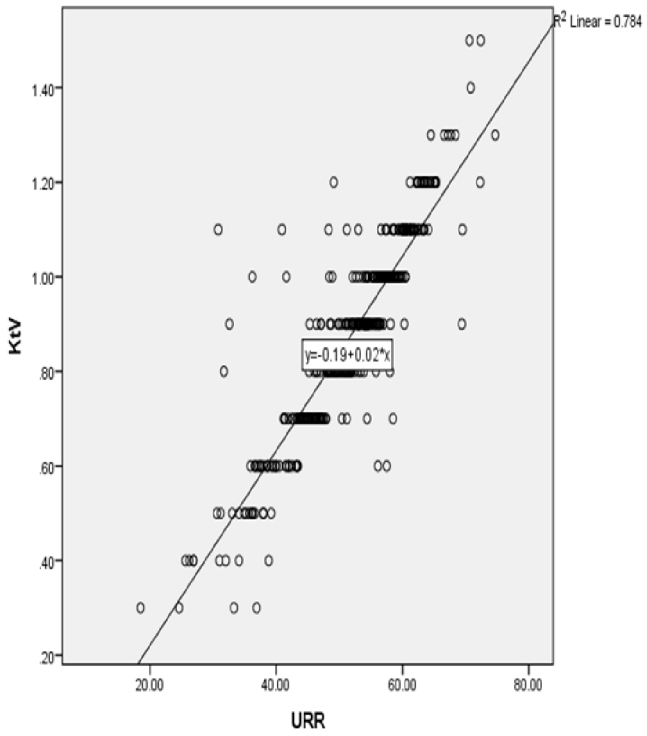

Figure 1c: There is a significant positive correlation between Kt/V and URR in all participants, r= 0.881, P<0

DISCUSSION

We found gender differences in the demographic, clinical presentation, laboratory profile and in the immediate responses to dialysis treatment among the participants. There was a male preponderance in the study population and this mirrors a previous study that reported more male predominance in the dialysis population [12]. This has been attributed to the well-reported fact that CKD is commoner in males [15]. In low-income and socioeconomically less-developed nations like Nigeria, cultural practices could further widen this gender gap as men, generally speaking, are more financially empowered than women, added to a culture-favoring health seeking attitude in them.[16] Though more males participated across all age groups, the percentage of females from sixty years upward increased. Though we didn't seek to access cardiovascular diseases associated with ESKD in our study, the widely reported increase in cardiovascular diseases in post-menopausal women cannot be entirely ruled out as a contributing factor to this pattern of presentation, as it could also play a part in the loss of the well-reported "females' survival advantage over males in population studies" during maintenance dialysis treatment [17]. Furthermore, the neurohormonal modulatory role of estrogens on the blood vessels, which is markedly reduced in post-menopausal women, could also play a contributory role.

The higher prevalence of hypertension associated CKD than CGN is in disagreement with previous studies in Nigeria and some nations in sub-Sahara Africa (SSA) which found CGN as the commonest cause of CKD [18]. It is however in agreement with recent findings by Okaka et al in Nigeria and studies in the western world that found hypertension, a more common cause of CKD than CGN [19,20]. Our study showed that females were less educated compared to males and this agrees with findings from previous studies [2,21]. The proportion of males that had sponsorship for dialysis treatment from statutory organizations was more than females. This could be attributable to men's higher educational status and local cultural practices that tends to favor the employment of males over females [2,16,21].

Predialysis, we found higher levels of serum markers of nitrogenous waste in males compared to females as reported in a previous study [19]. This could be multifactorial, as it could be from the known higher muscle mass in males compared to females. The progression of CKD being faster in males could explain this as this is usually accompanied by higher levels of nitrogenous waste [22]. Women are reported to be more in volunteer clinical trials [23] and they tend to be more compliant with treatment regimen when hurdles like finances are not present. The higher sodium found in males agrees with a study that reported a higher incidence of IDHT in males and a higher incidence of IDH in females who have lower serum sodium [24]. Facilitating water absorption with attendant effect on the intravascular volume forms the basis for increasing the dialysate sodium concentration as a way of managing IDH [25]. End-stage kidney disease, being a chronic inflammatory condition, a higher incidence of metabolic acidosis (MA) is expected among males and this explains the beneficial role of acidosis reflecting effective tissue response to ongoing inflammatory tissue damage. Our finding to the contrary, therefore, could be linked to findings that the female survival advantage in the general population is lost in MHD [26].

Females had a higher proportion of terminated sessions as was reported in a previous study as they had higher incidences of IDH (which is more associated with dialysis termination than IDHT) [27]. The percentage of women with low BFR was more than of men and this agrees with findings by Miller et al [28]. Higher blood flow rate facilitates solute diffusion from tissues to plasma. Since more solutes are cleared from the plasma than the tissues, increasing the BFR leads to higher plasma solute clearance and dialysis dose. The higher ultrafiltration volume in males could be related to factors that were either patient-related or iatrogenic in nature. Higher levels of uremic markers just before dialysis are associated with higher interdialytic weight gain (IDWG) and blood pressure increases. Increasing the ultrafiltration rate and volume can also be part of the management of excessive blood pressure rise during dialysis, though excessive UF has been identified as a risk factor for early death in dialysis patients [29].

Internal jugular vein access was the most used, moreso in men while the femoral access was the commonest among women. A major determinant of the type of access used was cost. On the average, a tunneled IJV catheter cost about 2-3 times, the femoral catheter. The lower economic power of females therefore limits their procurement of this access, as the unit protocols demand 'at a point

payment' hence some participants could only pay for temporary access despite the obvious economic advantage of the tunneled IJV over the femoral route over time [21,30]. The wider bore, lower thrombosis and infection rates of the tunneled IJV compared to the femoral, impacts positively on the dialysis dose [28,31]. The frequency of erythropoietin use was more in men than women in our study. This finding is not in agreement with Daza *et al* [33] and Ryta *et al* [33] who both reported higher erythropoietin use in women than men. Amid available resources, women tend to be more compliant with treatment regimen during illnesses compared with men [23]. Since many males and females failed to achieve the target 2-3/ week dose of erythropoietin in our study, it can also be inferred that females, being more economically disadvantaged, were unable to match the males in purchasing erythropoietin.

At the initiation of dialysis, women presented later compared to men as reported in a previous study [17,34]. The authors reported a 2-year gap (mean age of 61.9±14.6 and 63.1±14.5) at dialysis initiation for men and women respectively. In cultural practices not very favorable to women, as seen in many African cultures like Nigeria, we expect a widening of the gap, as we found a corresponding mean dialysis initiation age of 47.1±5.1 and 51.5±6.2 respectively. The prevalence of intradialysis hypotension and hypertension were 19.4% and 24.4% respectively. The higher prevalence of IDH in women and IDHT in men, mirror findings by Okoye *et al* and van Buren et al respectively [12,13]. Intradialysis hypertension tend to be easier to manage on the dialysis ward than IDH as usual regimen of increasing BFR, ultrafiltration rate and volume, and use of blood pressure-lowering drugs are more compatible with treatment goals and patient outcome [35]. However, in managing IDH, reducing BFR, ultrafiltration rate and volume, with saline infusion, the adjustment in positions, sodium profiling and the use of inotropes, can reduce the dialysis dose and lead to poor fluid and blood pressure management. The intradialysis death recorded in the study was however, from IDHT. Heckins *et al* [17] in a large-scale population study involving nations across many continents found intradialytic death to be commoner in males. Blood pressure increases, result from the excessive adrenergic drive from an overactive RAAS hence the predisposition to arrhythmias, some of which could be fatal [36].

The dialysis dose was lower than what obtains in the developed nations, just as the dialysis dose in women was less than men and this mirrors findings by El Sheikh *et al* who found in Egypt, higher dialysis doses in men [5]. This finding however disagree with those of Somji *et al* who reported higher doses in females [6]. The dialysis dose could be a product of the predialysis preparation and intradialysis handling of the procedure. Women could be more responsive to symptoms of dialytic events than men hence the threshold for intervention could be different for the gender groups with attendant effects on the delivered dose [37]. The comparatively lower weight of women (also seen in children and malnourished) is associated with a reduced urea distribution volume (UDV). From the single pool, $spKt/V_{urea}$ equation, the UDV has an inverse relationship with the dialysis dose [10]. Women should therefore have higher dialysis dose than men but the combined effects of more frequency dialysis, erythropoietin use, tunneled access, higher BFR and longer dialysis duration in men, tend to overwhelm this female predisposition to higher dialysis dose, hence our finding of higher dialysis dose in males. Besides, the higher fat deposit in females increases their plasma volume of distribution and would therefore be expected to lead to lower dialysis dose compared to men [38].

The strong positive correlation between the Kt/V and the URR agrees with findings by Virga Moret *et al* [39]. However the lesser correlation found in the females population could be related to the lesser TBW in females, as the incorporation of the post-dialysis weight, (which is related to the ultrafiltration volume) in the calculation for Kt/V gives a major contributory role to the ultrafiltration volume (which was less in females) in determining the dialysis dose as well as improving its reliability over the URR [40].

We encountered some limitations in our study. We did not determine the contribution of the residual kidney function to solute clearance. There could be some comorbidities that were unidentified but which could have impacted on the delivered dose. We also could not determine the dry weight of the participants, a knowledge of it would have helped us better in prescribing the dialysis dose.

CONCLUSION

There is a preponderance of males in the dialysis population. Though more males than females are reported to have CKD, their relatively higher proportion in the dialysis population in this study might be related to their higher educational attainment and economic empowerment, conditions that tend to favor better health-seeking attitude. The summation of late presentation for dialysis treatment, lower frequencies of erythropoietin use and dialysis treatment, lower BFR, ultrafiltration volume, and a higher frequency of femoral catheters in women, most likely explained the lower dialysis dose in them. A more effective dialysis treatment program should therefore take into cognizance the socioeconomic, cultural and educational status of individuals before commencement and throughout the duration of maintenance dialysis.

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