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Assessment of dietary energy and protein intake in chronic kidney disease patients: A single centre study.

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Abstract.

Objectives: Nutrition is often neglected as an important management strategy in Chronic Kidney Disease patients and malnutrition is an important determinant of morbidity and mortality. We investigated the energy and protein intake of Nigerian CKD patients and determined the association of energy intake with malnutrition.

Methods: A cross-sectional analysis of dietary intake was conducted using 24hour dietary recall and three-day diary records. For malnutrition, anthropometric and biochemistry tests were performed.

Results: Mean energy intake was 32.08±4.44 kcalkg^{-1} d^{-1} and 38.63±4.01 kcalkg^{-1} d^{-1} in CKD patients vs controls respectively (P<.001). The mean protein intake was lower in patients with CKD patients (0.6±0.12 g kg^{-1} d^{-1}) vs the controls (0.77±0.08 g kg^{-1} d^{-1}) (P <.001). The energy intake was inadequate in 69% of CKD patients. Inadequate protein intake was observed in 60% of pre-dialysis patients and in 100% of the Haemodialysis patients. Patients with inadequate energy intake were 1.7 times more likely to be malnourished compared to those on an adequate intake (95% CI:1.156- 2.594).

Conclusion: We identified low energy and protein intake in our CKD population. Attention should be paid to the nutrition of CKD patients.

Keywords: energy, protein, intake, chronic kidney disease

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Évaluation de l'apport de l'alimentation énergétique et protéique chez les patients atteints d'insuffisance renale: une étude monocentrique

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Résumé
Objectif: Nous avons étudié l'apport énergétique et protéique de patients nigérians atteints d'IRC et déterminé l'association entre l'apport énergétique et la malnutrition.

Méthode: Une analyse transversale de l'apport alimentaire a été réalisée à l'aide d'un rappel alimentaire de 24 heures et d'enregistrements de journaux sur trois jours. Pour la malnutrition, des tests anthropométriques et biochimiques ont été effectués.

Résultats: L'apport énergétique moyen était respectivement de 32,08 ± 4,44 $kcalkg^{-1} j^{-1}$ et de 38,63 ± 4,01 $kcalkg^{-1} j^{-1}$ chez les patients IRC par rapport aux patients témoins ($P < 0{,}001$). L'apport moyen en protéines était plus faible chez les patients atteints d'IRC (0,6 ± 0,12 $g\ kg^{-1} j^{-1}$) que chez les patients témoins (0,77 ± 0,08 $g\ kg^{-1} j^{-1}$) ($P < 0{,}001$). L'apport énergétique était insuffisant chez 69 % des patients atteints d'IRC. Un apport insuffisant en protéines a été observé chez 60 % des patients en pré-dialyse et chez 100 % des patients en hémodialyse. Les patients dont l'apport énergétique était insuffisant étaient 1,7 fois plus susceptibles de souffrir de malnutrition que ceux dont l'apport énergétique était suffisant. (IC à 95 % : 1,156-2,594).

Conclusion: Nous avons identifié un faible apport énergétique et protéique dans notre population CKD. Une attention particulière doit être portée à la nutrition des patients atteints d'IRC.

Mots -clés: Énergie, protéines, apport, maladie rénale chronique

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INTRODUCTION

Protein Energy Malnutrition (PEM) is a common problem in patients with chronic kidney disease (CKD) and affects a wide range (18 – 100%) of both pre-dialysis and dialysis patients. (1-4) PEM contributes significantly to morbidity with poor quality of life (QOL) and is a powerful predictor for increased mortality. (5, 6) PEM in CKD patients is overlooked by many clinicians as an important risk factor identified to stop the progression of the disease and to prevent cardiovascular complications. (6) One of the most important single causes of PEM in these patients is inadequate intake of nutrients especially energy and protein. (7, 8) Anorexia is the foremost cause of inadequate nutrients intake and is induced by the uremic milieu, the presence of comorbidities, inflammation, oxidative stress, hormonal disorders, and depressive illness. (8, 9) In addition to the above, inadequate dialysis, and dialysis-associated catabolism amongst others may cause inadequate intake in dialysis patients. (7-9)

Guidelines recommendation for dietary energy intake (DEI) for CKD patients ranges from 30-40 kcal/kg/day, while that for dietary protein intake (DPI) is 0.6-0.8 g/kg of ideal body weight/ day for pre-dialysis patients and ≥ 1.1 g/kg body weight/ day for dialysis patients respectively. (10, 11) These amounts are enough to prevent PEM and to replace losses of protein during dialysis in maintenance haemodialysis (MHD) patients. (12) Dietary intake and nutritional status begin to decline when the glomerular filtration rate, (GFR) is about 25-38m1/min/1.73m^2.(13) Nutrient intake is frequently below the recommended in patients with CKD with the energy intake usually averaging about 24-27kcal/kg/day while the protein intake varies.(13-15)

Severe dietary restrictions especially protein contributes to malnutrition in CKD patients. Low protein diets as recommended by guidelines are frequently prescribed for CKD patients as part of conservative management with the aim to slow progression and to ameliorate uremic symptoms as these diets are considered safe.(16) While this may be appropriate, it is important to assess the usual dietary intake of CKD patients before instituting these diets so as to prevent or worsen existing malnutrition in patients with already low intake. Regular assessment and monitoring of dietary intake and nutritional status identifies patients who are most at risk for malnutrition and require nutritional support not further dietary restrictions. (7) Prevention and treatment of malnutrition will slow the development of cardiovascular disease, CKD progression, and significantly reduce mortality before and after initiation of renal replacement therapy.(12)

To the best of the authors' knowledge, regular assessment and monitoring of nutritional status are not done for CKD patients in our environment and there is currently sparse documentation of the dietary nutrient intake as a measure of nutritional status in CKD patients in Nigeria. In view of these, we set out to determine the average dietary intake of energy and protein in CKD patients and to examine the association between energy intake and malnutrition in these patients. This study will serve as a baseline for further research on diet and will create interest in dietary intervention strategies for CKD patients in Nigeria.

MATERIALS AND METHODS

The study was a cross-sectional analysis of patients recruited at a tertiary centre in southern Nigeria over a period of 6 months. The study was approved by the institution's Research and Ethics committee and was done in conformity with the Helsinki Declaration of 1975. Informed consent was obtained from all the subjects before recruitment. We recruited stable pre-dialysis adult patients 18years and above, in CKD stages 4 and 5 with GFR of less than 30ml/min and patients who had been on regular MHD for at least two months. Patients with diabetes mellitus, HIV, any intercurrent illnesses, history of malignancy, thyrotoxicosis, severe gastrointestinal diseases, heart failure, nephrotic syndrome, severely oedematous patients, and patients with chronic liver disease were excluded. Consecutive patients who fulfilled the inclusion criteria were recruited. We recruited apparently healthy patients from the general outpatient department with no CKD as the comparison group (GFR > 60mls/min). We obtained demographic and clinical data from the subjects and the physician record using the designed protocol. We measured anthropometric indices such as body mass index (BMI), triceps skinfold thickness (TSF), mid-arm muscle circumference (MAMC). Blood samples were taken for serum albumin and creatinine. We calculated the GFR using the MDRD study equation. Details of the methods have been published elsewhere. (4)

Dietary intake assessment

We used a 24-hour dietary recall (24HR) to capture detailed information about all foods and beverages consumed by the participants in the past 24 hours. We augmented the recall with a 3-day dietary diary record which involved a patient writing down the description and quantification of all food and drinks consumed during a 3 day period using household measures e.g. spoon, cup, tins.(17) Record was taken on non-consecutive days and included week and weekend days, and for patients on MHD, one dialysis and one on non-dialysis day.(17)

We calculated the average calories and protein intake using food composition tables compiled by FAO. Food composition tables provide information on the nutritional components of foods such as proteins, carbohydrates, fats, vitamins and minerals based on chemical analysis. They are presented as food composition databases. We adopted that compiled by Oguntona for Nigerian foods. (18) Portion sizes of the consumed foods were converted to grams. We summed up the calorie and protein intake per day averaged from the 24HR and the 3-day diary record as kilocalories per kilogram body weight per day (kcal kg^{-1} d^{-1}) of expected weight and for the protein intake in grams per day(g/day) and grams per kilogram body weight per day (g kg^{-1} d^{-1}) of expected weight. The dietary assessments were conducted by a trained dietician and were conducted by the same dietician for all the patients.

We categorized the dietary intake into adequate and inadequate intake groups. We defined adequate intake of energy as consumption of at least 35 kcal kg^{-1} d^{-1} for all subjects <60 years old and at least 30 kcal kg^{-1} d^{-1} for subjects $\geq$60 years while inadequate intake was consumption of <35 kcal kg^{-1} d^{-1} of energy for subjects <60years and < 30 kcal kg^{-1} d^{-1} for subjects $\geq$ 60years. (11) Inadequate protein intake was less than 0.6 g kg^{-1} d^{-1} for pre-dialysis patients and for dialysis patients it was less than 1 g kg^{-1} d^{-1}. (11) For the control group, protein intake was inadequate if it was less than 0.8 g kg^{-1} d^{-1}. Malnutrition was present or absent and presence was defined in this study as any or a combination of BMI < 18.5 kg/m^2 .(19) TSF thickness and MAMC measurements of less than 90% of ideal standard,(20) and serum albumin < 3.5g/l.(21)

Statistical analysis

We analysed data using Stata 16.1 College Station, TX: StataCorp LLC statistical program. Continuous variables were expressed as mean with standard deviation (SD) and categorical variables as frequencies and percentages. Student's t-test was used to compare differences in means, and Chi-square test or Fishers exact tests were used to compare differences in proportions. We categorized dietary energy and protein intake as adequate vs inadequate and malnutrition as present or absent. We used stratified analysis to assess the association between dietary energy intake and malnutrition and adjusted for CKD status. A P-value less than 0.05 was considered statistically significant.

RESULTS

We analysed DEI and DPI in 70 patients, comprising of 35 CKD and 35 apparently healthy patients with no CKD as control. Among the patients with CKD 20 were on (MHD) and 15 were pre-dialysis. The mean eGFR for the CKD and the control patients were 15.50±8.63 and 94.38±28.74 ml/min/1.73m^2 respectively. The mean duration of illness for the CKD patients was 15.18±11.19 months while the mean duration on dialysis was 15.01±10.48 months. The frequency of HD was 2-3 times/week. All patients were on a standard bicarbonate dialysis regimen and used biocompatible polysulphone membranes. We have previously reported the characteristics of all the participants in a previous publication.(4)

The mean age was comparable at 41.03 ± 13.40 years in the CKD group and 42.46 ± 14.93 in the control group. Table 1 displays the mean DEI and DPI intake in participants. Both DEI and DPI were significantly lower in the CKD patients than in the control group. (P< .001). Malnutrition occurred more in the CKD patients compared to the control group (P< .001) (Table 1).

The mean BMI, %TSF and %MAMC were significantly lower in the dialysis patients compared to the pre-dialysis patients. The mean calorie and protein intake were below the recommended for all the groups of patients (Table 2). The mean protein intake in the MHD patients was 53% below the recommended value of 1.2 g kg^{-1} d^{-1} for patients on MHD. A higher proportion of dialysis patients were malnourished compared to the pre-dialysis patients. (Table 2)

Table 3 displays the mean nutrient intake stratified according to dietary adequacy in participants. Total of 40 participants had adequate DEI while 30 had inadequate intake and for DPI, 24 had adequate intake while 46 had inadequate intake. The CKD patients with inadequate DEI had lower intake than the control group with inadequate intake (29.98±2.87 vs 32±1.20). For the nutritional indices, as expected, the mean BMI, %TSF and %MAMC were significantly lower in patients who had inadequate intake. However, the albumin though lower in the inadequate group, was not significantly so. (Table 3)

Table 4 shows the distribution of participants according to the adequacy groups. A higher proportion of CKD patients had inadequate intake of energy than adequate (69 vs 31%). In the comparison group, only 17% had an inadequate energy intake. A higher proportion of the CKD patients had inadequate protein intake than the controls. (83 vs 49%) P<0.001. In the pre-dialysis patients, 2/3rd had protein intake below the recommended of 0.6 g kg^{-1} d^{-1} while in the MHD patients all had below the recommended intake of 1 g kg^{-1} d^{-1}. For the nutritional indices, 92% and 64 % of patients with low BMI and low %TSF thickness, respectively had inadequate energy intake. A higher proportion of participants with inadequate intake were more malnourished than those with adequate intake. (93 vs 43%) P<.001. (Table 4)

Table 5 displays the results of the association between energy intake and malnutrition. The adjusted risk of malnutrition in the study population was significant; RR1.7 (95% CI: 1.156- 2.594). Those who had inadequate DEI were 1.7 times more likely to be malnourished compared to those on an adequate DEI. (Table 5)

DISCUSSION

Energy intake

In this study, we assessed DEI and DPI among CKD patients and compared to patients with no CKD and with guideline recommendations. We also assessed the association of the DEI with PEM. We observed that a large proportion of our CKD patients (69%) had low or inadequate energy intake (mean, 29.98±2.87 kcal kg^{-1} d^{-1}) which did not meet the guideline recommendations of 35 kcal kg-1 d-1.(10, 11) Several other investigators have also reported low DEI in CKD patients.(14, 22-25) In pre-dialysis patients, the Modification of Diet in Renal Disease (MDRD) study, in the USA reported the mean DEI of 29.4±9.31 kcal kg^{-1} d^{-1}.(14) In the Chronic Renal Insufficiency Cohort (CRIC) study, the mean intake was 1830±820 kcal kg^{-1} d^{-1} and in the National Health and Nutrition Examination Survey (NHANES III) study, DEI was 20.9 ±1.0 kcal kg^{-1} d^{-1} in men and 20.2 ± 2.1 kcal kg^{-1} d^{-1} in women at GFR <30mls/min. (22, 23) More recently, in the PROGREDIR study in Brazil, 66.1% of the participants had an energy intake below the recommended. Median energy intakes was 25.0 kcal kg^{-1} d^{-1} (24). In MHD patients, a study in Italy reported a mean DEI intake of 24.9 ± 10.1 kcal kg^{-1} d^{-1} and that 73% had an energy intake <30 kcal kg^{-1} d^{-1}.(26) Gityamwi reported that 75% of their patients in Sub-Sahara Africa had low energy intake when compared with the recommended levels from the European Best Practice Guideline (EBPG).(25) Mean calorie intake in our CKD patients was better than that reported by the other studies, but it was not completely satisfactory, because most of the patients did not reach their recommended intake. The higher intake observed here may be as a result of over reporting of the intake by our patients.

Protein intake

Low mean DPI intake in relation to the KDOQI nutritional recommendations and in comparison to the non-CKD patients was observed in this study. Sixty per cent of the pre-dialysis patient had less than 0.6 g kg^{-1} d^{-1} (mean 0.48± 0.07 g kg^{-1} d^{-1}) and 100% of dialysis patients had lower than the recommended. Various amounts of protein intake were reported by various investigators in CKD patients. In the MDRD study among patients yet to begin haemodialysis, the mean DPI ranged from 0.84 ± 0.2 to 1.12 ± 0.8 g kg^{-1} d^{-1} between the different diet groups and according to GFR.(13) In the PROGREDIR study, median protein intake was 1.1 g kg^{-1} d^{-1} and 90.1% of their patients had a protein intake above the recommended amount for non-dialysis CKD patients. (24) The Italian study reported a mean protein intake of 0.64 ± 0.4 g kg^{-1} d^{-1} in their pre-dialysis patients and only (8.1%) had both adequate energy protein intake.(26) Amongst African patients on MHD, Gityamwi observed that 85%, of their patients, had inadequate DPI.(25) Why was protein intake lower in our patients compared to the MDRD study and the PROGREDIR study? The assessments methods in the studies may account for this. MDRD investigators used the urine urea method in addition to the dietary diary records while we used only the reported diary record method. These methods are considered more accurate than the diary method alone. The PROGREDIR study employed a food frequency questionnaire (FFQ) which is less recommended than the 2HR, because of attenuation with the FFQ.(27) CKD was more advanced in our patients than in the MDRD study warranting the lesser intake of protein observed in our population as the lower the GFR, the less the protein intake.(13) Aside uremic induced anorexia, other reasons may account for the inadequate intake of protein observed here. The mean DPI in our non-CKD patients was 0.77 ± 0.08 g kg^{-1} d^{-1} this is lower than the Recommended Dietary Allowance" (RDA) of protein which is 0.8 g kg^{-1} d^{-1} (28) for a healthy individual. While the average daily protein consumption of a typical American is about 1.3 g kg^{-1} d^{-1},(29) that of healthy Nigerians is lower at 0.66-1 g kg^{-1} d^{-1}.(30) therefore, lower protein intake in our population might be a reflection of the intake in the general population. Anecdotally, we observed that many of our CKD patients overzealously opt to consume too little protein in their diets, probably because of the dietary advice to limit such from their daily food rations which are already low in order to control uraemia and reduce progression.

In this study, the risk of malnutrition was greater in those who had inadequate energy intake compared to those on an adequate intake. Adjusted RR; 1.7 (95% CI: 1.156- 2.594). Inadequate intake of energy is one of the most central factors in compromising the nutritional status of CKD patients including our patients.(7, 8) Other factors such as uraemic toxins, restrictive diets, depression, inadequate dialysis in dialysis patients are others that could have accounted for the malnutrition observed here. Inadequate intake in our patients may also be due to socio-economic influences such as inability to buy food due to financial constraints as in a developing country there is a high prevalence of impoverishment among these patients. As no significant difference was observed in the mean DEI of the inadequately nourished CKD patients and controls (P= 0.106), and with the control subjects showing significantly higher and better nutritional status, could suggest that other factors other than inadequate dietary intake are responsible for malnutrition in our patients with CKD. Despite the dialysis therapy of 3 times (median 2.75) weekly in our patients, 100% of them still showed features of malnutrition. Dialysis was likely inadequate even though we did not document or standardize the adequacy of dialysis here. Dialysis imparts enormous economic constraints on our patients, which result in frequent default. Our study is limited by the small sample size owing to the challenge of gathering direct DI data, hence the findings cannot be generalized and the study being a cross-sectional study, the cause can only be inferred. The dietary intake reported by our patients may be under or over-reporting as there is a tendency for patients to overestimate food intake when their intake is poor and to underestimate it when it is good. So, caution must be used in interpreting and drawing conclusions from this highly subjective data. Samples were drawn for convenience rather than representativeness.

CONCLUSION

The recommended calorie and protein intake were not accomplished in most of our CKD population, especially in the MHD patients. It is important for clinicians to periodically assess and monitor the dietary intake and assess and the nutritional status of CKD patients so as to avoid malnutrition. The study calls for attention to individual dietary counselling, and the promotion of dietary approaches in patients with CKD to improve clinical outcomes in these patients.

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Table 1: Comparison of nutritional indices, dietary protein and energy intakes in participants.

Parameter	CKD[a] (n=35)	No CKD (n=35)	P value
Nutrient intake(mean)			
Energy intake kcal kg^{-1} d^{-1}	32.08±4.44	38.63±4.01	<0.001
Protein intake (g/day)	39.04 ±10.5	49.81±6.68	
Protein intake (g kg^{-1} d^{-1})	0.6±0.12	0.77±0.08	<0.001
Nutritional indices			
BMI[b] (kg/m^2)	20.3±3.74	25.95±3.74	<0.001
%TSF[c]	62.36±25.10	104.23±25.15	<0.001
%MAMC[d]	89.24±11.33	100.57±10.83	<0.001
Mean albumin g/dl	3.68±0.64	3.91±0.48	0.094
Malnutrition (%)	31(88.6%)	14(40%)	<0.001[e]

[a]CKD-chronic kidney disease [b]BMI-Body mass index, [c]TSF-Triceps skinfold thickness, [d]MAMC-mid-arm muscle circumference [e]Fischers exact, kcal kg^{-1} d^{-1}(kilocalories/kilogram/day), g kg^{-1} d^{-1}(gram/kilogram/day)

Table 2: Comparison of nutritional indices, dietary protein and energy intake in pre-dialysis and haemodialysis patients.

Parameter	Pre-dialysis(n=15)	MHD[a] (n=20)	P value
Nutrient intake(mean)			
Energy intake kcal kg^{-1} d^{-1}	33.48±4.15	31.03±4.46	0.1072
Protein intake (g/day)	34.67±6.46	42.57±11.21	
Protein intake (g kg^{-1} d^{-1})	0.53±0.12	0.64±0.13	0.0153
Nutritional indices (mean)			
BMI[b] (kg/m^2)	23.88 ± 3.54	20.64 ± 3.32	0.009
%TSF[c]	74.33 ± 25.91	53.39± 20.86	0.012
%MAMC[d]	95.64 ± 9	84.44± 10.66	0.002
Albumin g/dl	3.91 ± 0.65	3.52 ± 0.6	0.075
Malnutrition (%)	11(73%)	20(100%)	0.026[e]

[a]MHD- maintenance haemodialysis, [b]BMI-Body mass index, [c]TSF-Triceps skinfold thickness, [d]MAMC-mid-arm muscle circumference [e]Fishers exact, kcal kg^{-1} d^{-1}(kilocalories/kilogram/day), g kg^{-1} d^{-1}(gram/kilogram/day)

Table 3: Mean Nutrient intake and nutritional indices according to dietary adequacy in participants

Parameter	Adequate intake	Inadequate intake	P value
Nutrient intake (mean)			
Energy intake (kcal kg^{-1} d^{-1})			
CKD[a]	37.02±3.12	29.98±2.87	<0.001
Non-CKD	39.99±2.28	32±1.20	<0.001
P-value	0.002	0.106	
pre -dialysis	36.79 ± 3.09	30.7±2.29	<0.001
MHD[b] (20)	36.47±5.02	29.7±3.16	0.003
Protein intake (g kg^{-1} d^{-1})			
No CKD[a]	0.87±0.046	0.72±0.042*	<0.001
Pre- dialysis(15)	0.62±0.05	0.48±0.07	<0.001
MHD [b](20)	0	0.64±0.13	
Nutritional indices(mean)			
BMI[c](kg/m^2)	24.66±2.97	20.82±3.46	0.0027
%TSF[d]	82.42±23.9	53.19±20.05	0.0002
%MAMC[e]	92.81±9.99	86.20±10.74	0.018
Albumin g/dl	3.85±0.69	3.64±0.63	0.323

[a]CKD- chronic kidney disease [b]MHD- maintenance Haemodialysis, [c]BMI-Body mass index, [d]TSF-Triceps skinfold thickness, [e]MAMC-mid-arm muscle circumference, $kcalkg^{-1}d^{-1}$(kilocalories/kilogram/day), g $kg^{-1}d^{-1}$ (gram/kilogram/day)

Table 4: Distribution of nutrient intake and nutritional indices according to dietary adequacy

Parameter (n)	**Adequate intake**	**Inadequate intake**	**P value**
Nutrient intake(mean)			
Energy intake (kcal kg^{-1} d^{-1})			
CKD[a] (35)	11(31.4%)	24 (68.6%)	<.001
No CKD (35)	29 (82.9%)	6 (17.1%)	
Total	40	30	
Protein intake (g kg^{-1} d^{-1})			
CKD[a] (35)	6 (17.1%)	29 (82.9%)	0.005
No CKD (35)	18(51.4%)	17(48.6%)	
Total	24	46	
Energy intake (kcal kg^{-1} d^{-1})			
Pre-dialysis (15)	7 (47%)	8(53%)	0.093
MHD[b] (20)	4(27%)	16 (73%)	
Protein intake (g kg^{-1} d^{-1})			
Pre-dialysis (15)	6(40%)	9(60%)	0.003
MHD[b] (20)	0	20(100%)	
Nutritional indices			
Low BMI[c]	1(8.3%)	11(91.7%)	<.001
Normal	39(67.2%)	19(32.8)	
Low TSF[d]	16(35.5%)	29 (64.5%)	<.001
Normal	24 (96%)	1(4%)	
Low MAMC[e]	36(54.5%)	30 (45.5)	0.130
Normal	4 (100%)	0	
Low Albumin	10 (41.6%)	14 (58.4)	0.077
Normal	30 (65.2%)	16 (34.8)	
Malnutrition	17(42.5%)	28 (93.3%)	<.001[f]
No malnutrition	23(57.5%)	2 (6.7%)	

[a]CKD- chronic kidney disease [b]MHD- maintenance Haemodialysis, [c]BMI-Body mass index, [d]TSF-Triceps skinfold thickness, [e]MAMC-mid-arm muscle circumference, [f]Fischers exact, kcalkg-^{1}d-^{1}(kilocalories/kilogram/day), g $kg^{-1}d^{-1}$ (gram/kilogram/day)

Table 5: Association of energy intake with malnutrition

Calorie intake	Malnutrition			
	Crude RR	95% CI	Adjusted RR	95% CI
Inadequate	2.19	1.512-3.188	1.7	1.156- 2.594
Adequate	1		1	