Nutrition-related parameters of maintenance haemodialysis patients

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Abstract

Background and Aim: Maintaining good health in haemodialysis patients is a challenging task that helps to reduce morbidity and mortality. The prevalence of nutrition-related complications is uncertain in Sri Lankan maintenance haemodialysis population. This study was carried out as a baseline study to identify the common nutrition-related complications in maintenance haemodialysis patients.

Methods: A single-centre cross-sectional study was carried out on adult patients on maintenance haemodialysis in a tertiary care centre in the central part of Sri Lanka. Simple random sampling was used, and patients' clinical, anthropometric, body composition via bioelectrical impedance analysis (BIA), laboratory parameters and muscle power were assessed.

Results: We evaluated 114 patients, 87 (76.3%) were males, and the mean age was 52.6 (±12.3) years. Only 9 (7.9%) patients were underweight in the sample population, 77.2% had normal mid-upper arm circumference (MUAC), 81.6% had high muscle mass percentage in BIA analysis, and all patients had normal mid-arm muscle circumference (MAMC). But in 80.5% of patients hand grip power was lower than the cut off for sarcopenia according to EWGSOP2 recommendations. The prevalence of low serum albumin is 33.3% and 60.5% had anaemia. The majority had normocytic normochromic anaemia with high serum ferritin levels. Vitamin D deficiency or insufficiency was 91.2% and electrolyte abnormalities were very common; 57.9% had hypocalcaemia, 61.4% had hyperphosphatemia and all patients had hyperkalaemia.

Conclusions: Muscle mass was preserved in most patients in this population, but the muscle power was significantly low, along with a high prevalence of hypoalbuminaemia, anaemia, vitamin D deficiency or insufficiency, hypocalcaemia, hyperphospatemia and hyperkalaemia.

Highlights

- Muscle mass is preserved in most maintenance haemodialysis patients, but handgrip power was significantly reduced
- The prevalence of anaemia is high and most have normocytic normochromic anaemia
- Vitamin D deficiency or insufficiency is very common in maintenance haemodialysis patients
- This population has a high prevalence of hypocalcaemia, hyperphosphataemia and hyperkalaemia

Introduction

Chronic kidney disease (CKD) is defined as abnormalities of kidney structure or function, persist for three or more months, with health implications [1]. CKD prevalence is estimated to be 13.4% globally [2], and the most common causes of CKD are diabetes and hypertension [3]. The incidence of chronic kidney disease of unknown aetiology (CKDu) has emerged as a significant contributor to the CKD burden in Sri Lanka in the last two decades; in some districts of Sri Lanka, the prevalence of CKDu is 15.1-22.9% [4]. CKD is becoming a significant public health issue worldwide and in Sri Lanka; apart from the complications of CKD itself, it increases the risk of cardiovascular disease, bone mineral disease, infections, cognitive impairment, and adverse metabolic and nutritional consequences [3]. The stage of the disease determines the management of CKD; in end-stage renal disease (ESRD), a kidney transplant is considered the treatment of choice, but it takes time as the patient needs to find a compatible donor and sometimes, patients are not medically fit to undergo surgery. In these conditions, dialysis helps maintain some kidney functions and becomes essential to sustain life at some point of the disease [5]. Haemodialysis is the commonest form of

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dialysis therapy in nearly all countries [6]. As the residual function goes down in the kidneys, the frequency of haemodialysis needs to be increased to give the maximum benefit [7]. However, due to the lack of facilities and the high number of patients, almost all patients receive twice a week haemodialysis or less in Sri Lankan public sector hospital set up. This study was carried out to assess the nutritional status-related parameters in the Hanthana haemodialysis centre at the National Hospital, Kandy where patients receive twice a week haemodialysis. Protein-energy wasting and multiple other nutrition-related complications are common in maintenance haemodialysis patients [8]. One study found that life-threatening undernutrition is 20-36 % in maintenance haemodialysis patients in France [9]. In the Sri Lankan setup, apart from a few small scale studies, the nutrition-related data of maintenance haemodialysis patients is limited to find [10]. This study focuses on nutrition-related parameters of maintenance haemodialysis patients in a single centre tertiary care hospital in Sri Lanka to identify the common nutritional problems in the local setup.

Materials and methods

A descriptive cross-sectional study was carried out at the Hanthana haemodialysis centre in the National Hospital, Kandy, Sri Lanka, during the first half of 2020. The simple random sampling method was used to select study participants out of 154 registered maintenance haemodialysis patients. Dialysis duration less than six months and patients who were unable to cooperate with anthropometric measurements were excluded from the sample and 114 patients were selected to carry out the study.

Data collection

Data collection was done using an interviewer-administered questionnaire, individual patient clinic records maintained in the unit were used to get the past data like dialysis start date and other chronic diseases. Anthropometric measurements were taken, height was measured by stadiometer (Seca 213 stadiometer), weight and body composition (Skeletal muscle mass, total body fat and visceral fat) were measured by using an eight electrode bioelectrical impedance analyser (Omron Karada scan - HBF-375), skinfold thickness measured from Harpender's calliper (Baty International - Model C -136), a non-stretchable measuring tape (Korbond 160cm/60 inch) used to measure mid-upper arm circumference (MUAC) and digital handgrip strength monitor (Camry EH101 up to 90Kg) used to measure handgrip strength and measured in non fistulated arm. Three measurements were taken with at least 5 minutes of intervals between measurements. EWGSOP2 sarcopenia cutoff was used in this study [11]. The blood tests were carried out from a quality controlled tertiary care hospital laboratory. Data collection was carried out by MSc Human Nutrition qualified MBBS graduates.

Data analysis

All data expressed as mean +/- SD, unless otherwise stated. Inferential statistics were used to elicit associations. The bivariate analysis will be done to elicit associations between socio-demographic factors, nutritional status and the target variables. The significance of the associations will be sought statistically using the Chi-square test and the confidence level will take as 95% [α= 0.05]. A probability level [P value] of <0.05 will be considered as having a significant association. The odds ratio will be used to describe the strength of association. IBM Statistical Package for Social Sciences [SPSS] software 25 version will be used for the data analysis.

Results

Hundred and fourteen patients were recruited for the study; out of them 87 (76.3%) were males. The mean age of males is 53.0 (±11.7) years and in females, it is 51.1 (±14.1) years. The mean duration of dialysis in males and females is 2.1 (±1.8) and 1.8 (±1.1) years, respectively. All patients are in twice a week, four-hour per session dialysis schedule. The non-communicable diseases (NCD) prevalence is high in males compared to females.

Table 1.1. Age distribution of the patients

Age ranges (years)	*Males*	*Females*	*Total*
18 -30	3 (3.4%)	3 (11.1%)	6 (5.3%)
31- 40	12 (13.8%)	1 (3.7%)	13 (11.4%)
41-50	15 (17.2%)	10 (37.0%)	25 (21.9%)
51-60	30 (34.5%)	4 (14.8%)	34 (29.8%)
61-70	23 (26.4%)	5 (18.5%)	28 (24.5%)
>71	4 (4.6%)	4 (14.8%)	8 (7.0%)

Table 1.2. Non-communicable disease prevalence

NCD	*Males*	*Females*	*Total*
Hypertension	64 (73.6%)	20 (74.0%)	84 (73.7%)
Diabetes mellitus	37 (42.5%)	11 (40.7%)	48 (42.1%)
Dyslipideamia	16 (18.4%)	3 (11.1%)	19 (16.7%)
Ischaemic heart disease	19 (21.8%)	3 (11.1%)	21 (19.3%)
Stroke	1 (1.1%)	0 (0.0%)	1 (1.1%)

Body composition parameters

The majority of patients were in the normal body mass index (BMI) range, with only 9 (7.9%) from the sample in the underweight (BMI <18.5 kg/m^2) category. The average MUAC in males and females is 25.6 (±3.5) cm and 23.1 (±4.1) cm, respectively. Only 14 (16.1%) males and 12 (44.4%) females had MUAC less than 22 cm. Both males and females had relatively high values of skeletal muscle mass; in males, it is 33.7% (±4.2) and in females, it is 26.9% (±4.7). Seventy males (81.4%) had skeletal muscle mass over 30% and 23 (85.2%) females had skeletal muscle mass over 22%. None of the patients had a skeletal muscle mass index of less than 7 Kg/m^2.

Even though most males and females have high muscle mass, their handgrip strength is relatively low. The mean handgrip strength in males and females is 23.7 kg (±6.9) and 15.5 kg (±6.0), the majority of the study participants (92, 80.7%) handgrip strength is lower than the EWGSOP2 cutoff. Significantly in men, 89.6% had lower than 27 kg handgrip strength.

Bicep and tricep skinfold thickness (SFT) was measured in the sample. In males and females, bicep SFT is 5.4 mm (±3.3) and 5.3 mm (±3.3), respectively. Similarly, tricep SFT was 8.8 mm (±4.0) and 9.8 mm (±5.3). Total body fat in the body is 17.3% (±7.2) and 27.5% (±8.9) in males and females, respectively. Only 14 (16.3%) males had total body fat over 25% and 9 (33.3%) females had total body fat over 32%. Visceral fat levels in males and females were 9.6% (±5.6) and 5.8% (±5.1), respectively. Compared to females, more males had visceral fat over 13%; it is 21 (24.4%) in males and females, it is 3 (11.3%).

Table 2. Body composition parameters

		Males	*Females*	*Total*
BMI	< 18.5 kg/m^2	4 (4.6%)	5 (18.5%)	9 (7.9%)
	≥18.5 to ≤25 kg/m^2	53 (61.6%)	14 (51.9%)	67 (58.8%)
	>25 to ≤30 kg/m^2	21 (24.4%)	7 (25.9%)	28 (24.6%)
	>30 kg/m^2	9 (10.4%)	1 (3.7%)	10 (8.8%)
	Mean	24.2 (4.2)	23.0 (4.7)	24.0 (4.3)
MUAC (cm)		25.6 (3.5)	23.1 (4.1)	25.0 (3.7)
MUAC < 22.0 cm		14 (16.1%)	12 (44.4%)	26 (22.8%)
Skeletal Muscle%		33.7% (4.2)	26.9% (4.7)	32.1% (5.2)
Skeletal Muscle >30%		70 (81.4%)		
Skeletal Muscle >22%			23 (85.2%)	
SMMI (kg/m^2)		12.4 (1.6)	11.6 (2.0)	12.1 (2.0)
SMMI <7 (kg/m^2)		0.0 (0%)	0.0 (0%)	0.0 (0%)
Hand Grip Strength (kg)		23.7 (6.9)	15.5 (6.0)	20.9 (8.0)
Hand Grip Strength < 27 (kg)		78 (89.6%)		
Hand Grip Strength < 16 (kg)			14 (51.9%)	
Skin Fold Thickness (mm)				
Bicep SFT		5.4 (3.3)	5.3 (3.3)	9.1 (4.3)
Tricep SFT		8.8 (4.0)	9.8 (5.3)	5.4 (3.3)
MAMC (cm)		22.9 (3.0)	20.0 (3.2)	22.2 (3.2)
MAMC < 15 cm		0 (0.0%)	0 (0.0%)	0 (0.0%)
Total body fat %		17.3% (7.2)	27.5% (8.9)	
Total body fat > 25%		14 (16.3%)		
Total body fat > 32%			9 (33.3%)	
Visceral Fat %		9.6% (5.6)	5.8% (5.1)	8.7% (5.7)
Visceral Fat >13%		21 (24.4%)	3 (11.1%)	24 (21.0%)

BMI – Body Mass Index, MUAC – Mid Upper Arm Circumference, SMMI – Skeletal Muscle Mass Index, STF – Skin Fold Thickness, MAMC – Mid arm muscle circumference

Blood investigations

Multiple blood investigations are carried out to assess kidney-related parameters, iron status, serum protein level, vitamin levels and serum electrolytes.

Table 3. Blood Investigations

	Males	*Females*	*Total*
Serum Creatinine (SD) (µmol/l)	954.5 (±258.1)	816.9 (±335.5)	921.9 (±283.0)
Blood Urea (SD) (mmol/l)	17.5 (±6.0)	18.6 (±8.5)	17.8 (±6.7)
Blood Urea > 12.5 mmol/l	70 (80.5%)	22 (81.5%)	92 (80.7%)
Total Serum Protein (SD) g/dl	6.89 (1.13)	7.09 (0.77)	6.9 (1.0)
Serum Albumin (SD) g/dL	3.93 (2.64)	3.64 (0.38)	3.9 (2.3)
Serum Albumin < 3.5 g/dL	30 (34.5%)	8 (29.6%)	38 (33.3%)
Serum Haemoglobin (SD) g/dL	10.2 (1.5)	10.7 (1.2)	10.3 (1.4)
Serum Haemoglobin <11 g/dL	55 (63.2%)	14 (51.2%)	69 (60.5%)
MCV (SD) fl	91.3 (7.0)	95.0 (3.6)	92.2 (6.6)
MCV < 80 fl	5 (5.7%)	0 (0%)	5 (4.4%)
MCV > 100 fl	4 (4.6%)	1 (3.7%)	5 (4.4%)
MCH (SD) pg	28.3 (2.3)	29.6 (1.4)	28.6 (2.2)
MCH < 27 pg	17 (19.5%)	1 (3.7%)	18 (15.8%)
MCH > 31 pg	7 (8.0%)	4 (14.8%)	11 (9.6%)
MCHC (SD) g/dL	31.0 (0.8)	30.1 (5.3)	31.06 (0.77)
MCHC< 32 g/dL	76 (87.3%)	22 (81.5%)	98 (86.1%)
MCHC > 36 g/dL	0 (0.0%)	0 (0.0%)	0 (0.0%)
Serum Ferritine (SD) ng/mL	594.8 (508.1)	956.5 (771.1)	680.5 (597.6)
S. Ferritine < 100 ng/mL	4 (4.6%)	1 (3.7%)	5 (4.4%)
S. Ferritine > 500 ng/mL	43 (49.4%)	9 (33.3%)	52 (45.6%)
Serum Iron (SD) µ/L	12.5 (11.2)	13.0 (4.02)	26.8 (152.3)
Serum Iron <10.7 µ/L	44 (50.6%)	9 (33.3%)	53 (46.5%)
Serum Iron >30.4 µ/L	1 (1.1%)	0 (0.0%)	1 (0.9%)
Transferrin Saturation (SD)%	23.1 (10.7)	26.1 (11.4)	23.9 (10.9)
Transferrin Saturation <20%	42 (48.3%)	10 (37.0%)	52 (45.6%)
Transferrin Saturation >50%	2 (2.3%)	1 (3.7%)	3 (2.6%)
TIBC (SD) µ/L	49.6 (7.6)	50.5 (6.5)	49.8 (7.4)
TIBC <43 µ/L	11 (12.6%)	4 (14.8%)	15 (13.2%)
TIBC >80 µ/L	0 (0.0%)	0 (0.0%)	0 (0.0%)
Vitamin B12 (SD) pg/mL	544.2 (274.4)	630.1 (372.0)	564.5 (300.9)
Vitamin B12 < 180 pg/mL	2 (2.3%)	1 (3.7%)	3 (2.6%)
Vitamin D (SD) ng/mL	23.4 (10.5)	18.8 (2.6)	22.3 (9.5)
Vitamin D <20 ng/ml	37 (41.1%)	18 (64.3%)	55 (48.2%)
Vitamin D < 30 ng/ml	77 (88.5%)	27 (100%)	104 (91.2%)
PTH (SD) pg/mL	276.8 (226.2)	298.0 (314.9)	281.8 (248.7)
PTH < 150 pg/ml	30 (34.5%)	11 (40.7%)	41 (36.0%)
PTH > 300 pg/ml	32 (36.8%)	9 (33.3%)	41 (36.0%)

(Continued)

	Males	*Females*	*Total*
Serum Calcium (SD) mmol/L	2.11 (0.26)	2.22 (0.20)	2.13 (0.25)
Calcium < 2.2 mmol/L	54 (62.1%)	12 (44.4%)	66 (57.9%)
Calcium > 2.7 mmol/L	0 (0.0%)	0 (0.0%)	0 (0.0%)
Serum Sodium (SD) mEq/L	139.1 (4.3)	138.4 (4.6)	139.1 (4.4)
Sodium < 135 mmol/L	6 (6.9%)	7 (25.9%)	13 (11.4%)
Sodium > 145 mmol/L	4 (4.6%)	2 (7.4%)	6 (5.3%)
Serum Potassium (SD) mmol/L	5.4 (0.8)	5.5 (0.9)	5.39 (0.82)
Potassium < 3.5 mmol/L	0 (0.0%)	0 (0.0%)	0 (0.0%)
Potassium > 5.0 mmol/L	87 (100%)	27 (100%)	114 (100%)
Serum Phosphate (SD) mmol/L	1.69 (0.62)	1.53 (0.52)	1.65 (0.60)
Phosphate <0.81 mmol/L	6 (6.9%)	2 (7.4%)	8 (7.0%)
Phosphate > 1.45 mmol/L	56 (64.4%)	14 (51.9%)	70 (61.4%)

MCV – Mean Corpuscular Volume, MCH – Mean Corpuscular Haemoglobin, MCHC – Mean Corpuscular Haemoglobin Concentration, TIBC – Total Iron Binding Capacity

Discussion

This study assesses the nutrition-related parameters of maintenance haemodialysis patients in a tertiary care centre in Sri Lanka; this has generated vital insight into the patients' health and dialysis adequacy. The mean BMI and MUAC were within the normal range along with a high muscle mass percentage, but the handgrip power was very low and the majority fell below the EWGSOP2 cutoff for sarcopenia. Almost 1/3 had low serum albumin levels and low haemoglobin levels were noted in over 50% of the patients. The prevalence of vitamin D deficiency and insufficiency was over 90%. Electrolyte abnormalities were widespread, especially hyperkalaemia, hyperphosphataemia and hypercalcaemia.

According to a meta-analysis, the average BMI of maintenance haemodialysis patients in developed countries ranges from 24.2 to 26.9 kg/m^2 [12] [13]; even in the Sri Lankan setup, the average BMI is in the overweight range and almost one-third of patients belongs to overweight or obese category. The underweight rate is around 10% in this population which is lower than the Sri Lankan general underweight population rate [14]. Furthermore, all the patient's MAMC (Midarm muscle circumference) was within normal range. When it comes to body composition analysis, BIA is recommended to use in maintenance haemodialysis patients and the best time to use is 30 minutes after dialysis [15]. Total body fat percentages in both genders are in the normal range, but one-fourth of males had a high visceral fat percentage. Even though the majority of patients had good muscle mass, the muscle power is considerably low and 89.6% of males are below the cutoff for sarcopenia according to EWGSOP2 recommendations. It had a moderate negative correlation (-0.44) with age but had no significant correlation with skeletal muscle mass, MAMC, serum levels of creatinine, calcium, PTH, phosphate or albumin. Similarly, in another study, upper limb muscle strength had a negative correlation with age along with a moderate positive correlation with serum creatinine and muscle mass [16]. A combination of multiple causes negatively affects the muscle function in these patients.

Studies have found that low serum albumin levels increase the risk of mortality in maintenance haemodialysis patients [17]. The prevalence of low albumin levels in this population is 33.3% and the years on dialysis did not show a good correlation. Most other studies found that the prevalence of hypoalbuminaemia is lower than this in haemodialysis patients [18] [19] [20]. The majority, 60.5% had anaemia and out of anaemic patients, 59 (85.5%) had normocytic cells. Most other studies found to have a high prevalence of iron deficiency anaemia [21] [22] [23]; this study population are getting regular iron supplementation and erythropoietin injections according to the need, along with routine blood investigations. Only three anaemic patients had serum ferritin less than 100 ng/mL and 39 (56.5%) of anaemic patients had serum ferritin over 500 ng/ml. Moderate hyperferritinemia (500 - 2000 ng/ml) is mostly due to non-iron related causes; in this population could be due to inflammation, infections and malnutrition may play a role in this. There are 5 (4.4%) patients with serum ferritin levels over 2000 ng/ml in this population. It could be due to iron overload [24]. The activation of vitamin D occurs in the kidneys; multiple factors contribute to reducing serum vitamin D levels in dialysis patients, female gender, adiposity, proteinuria, poor oral intake, reduced skin synthesis and low physical activity are found to be associated with low vitamin D levels [25]. KDOQI guideline suggests supplement with cholecalciferol or ergocalciferol when there is a deficiency, but in this setup, the practice is to supplement active vitamin D analogues [15]. Even with supplementation of the active form of vitamin D, the prevalence of hypocalcaemia (57.9%) and hyperphosphatemia (61.4%) is very high. The PTH level of 16 - 65 pg/ml is considered to be normal in a healthy

individual. However, in dialysis patients, the normal range is considered to be between 150 - 300 pg/ml, which is two to nine times the upper limit of normal [26]. PTH level does not significantly correlate with serum calcium and phosphate levels.

Overweight and obesity are common in maintenance haemodialysis patients when compared to underweight. The majority were able to maintain muscle mass, but the muscle function has significantly reduced; identification of causes that lead to low muscle power will help reduce the sarcopenia-related problems. High ferritin levels and hypoalbuminaemia may be due to dialysis associated inflammation. Vitamin D supplementation needs to be evaluated and measures should be taken to reduce complications related to electrolyte abnormalities.

This will be a baseline assessment to identify the common problems in maintenance haemodialysis patients; even though the National Hospital, Kandy is the country's largest dialysis centre, doing it in multiple centres will help gain a more comprehensive idea. Assessment of inflammatory markers would have helped to interpret data. This study opens numerous areas to do further studies like vitamin D supplementation, proper management of electrolyte abnormalities, and reasons for low muscle function are few of them.

Conclusion

Regular dialysis is vital to keep end-stage renal disease patients alive; frequent assessment of physical and metabolic factors will help to identify early problems as the risk of complications is high in this population. Adequacy of dialysis, malnutrition, functional capacity, micronutrient and electrolyte abnormalities needs more closer follow up. Management of these patients requires a multidisciplinary approach and expert nutrition inputs may help to increase the survival of these patients.

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Author contributions

The authors contribution to the paper as follows: study conception and design: Hashan Amarathunga, Duminda Basnayaka; data collection: Hashan Amarathunga, Jayamini Pathiraja, Ayodya Kariyawasam; analysis and interpretation of results: Hashan Amarathunga, Jayamini Pathiraja; draft manuscript preparation: Hashan Amarathunga, Duminda Basnayaka. All authors reviewed the results and approved the final version of the manuscript.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical approval

Ethical clearance was obtained from the National Hospital Kandy Ethical Review Committee. (Ref No: NHK/ERC/45/2020) Administrative clearance was taken from the Director of the National Hospital, Kandy.

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