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Nutritional Assessment In Hemodialysis Patients : Influence of Method and Sex

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Abstract

Introduction: Several nutritional assessment methods are available. The objective of this study was to assess the nutritional status of chronic hemodialysis patients based on anthropometry, bioimpedance and albuminemia.

Patients and Method: A cross-sectional study was conducted in two hemodialysis units, having included patients regularly on dialysis, with no history of hospitalization during the last month and consenting. The nutritional evaluation was based on the collection of anthropometric markers, the determination of body composition by bioelectrical impedance analysis and the determination of albuminemia.

Results: 68 hemodialysis patients (46.7 years old, 51.5% women) analyzed. The prevalence of undernutrition was 47.1% (95% CI [34.8 – 59.6]) according to BMI, 25% (95% CI [15.3 – 37.0]) according to brachial circumference, by 10.3% (95% CI [4.2 – 20.1]) according to the percentage of ideal weight, by 11.8% (95% CI [5.2 – 21.9]) according to the FM, by 55.9% (95% CI [43.3 – 67.9]) according to the LM index and by 10.3% (95% CI [4.2 – 20.1]) according to serum albumin . Similarly, the prevalence of obesity varied from 8.8% (95% CI [-1.8 – 22.4]) according to BMI and from 36.8% (95% CI [24.7 – 48 ,9]) according to the FM. According to bioimpedance, women on hemodialysis were more exposed to malnutrition than men. Impedance nutritional parameters were thus strongly correlated and agreement with anthropometric parameters in the diagnosis of undernutrition and obesity.

Conclusion: Due to its availability and simplicity, bioelectrical impedance analysis (BIA) has considerable potential as a complement to conventional anthropometric techniques for assessing the nutritional status of hemodialysis patients.

Keywords: Undernutrition; Obesity; Hemodialysis patients; Nutrition; Sex

Introduction

Chronic hemodialysis (CHD)patients have high risk for malnutrition due to anorexia, dietary restrictions, physical inactivity, chronic inflammation, comorbidities and metabolic disorders [1]. An assessment of undernutrition and obesity is necessary for future nutritional advice given by nephrologists and dieticians to CHD patients [2]. The prevalence of protein-energy malnutrition varies from 20 to 75%, partly depending on the characteristics of the population studied, but also on differences in methodology and diagnostic criteria. Obesity is also common [3, 4]. A few studies have simultaneously

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assessed the prevalence of undernutrition and obesity in CHD patients [5, 6]. They reported an overlap between malnourished (protein-energy wasting) and obese (excess energy) patients, indicating a likely problem in nutritional assessment methodologies [2]. Several of these methods have, however, been reported useful in HDC patients such as subjective global assessment, comparison of anthropometric and serum biochemical parameters, as well as changes in body composition assessed by dual-photon X-ray absorptiometry (DEXA), a computed tomography or bioimpedance [7 – 13]. In this study, we sought to assess the nutritional status of a CHD patients from anthropometry, bioimpedance and albuminemia.

Methods

A cross-sectional study was conducted from July 18 to 28, 2018, in two (2) hemodialysis units of the nephrology department of the University Hospital Center Aristide Le Dantec. All patients were targeted. We included, patients on hemodialysis for more than 3 months, on a regular basis (2 or 3 sessions per week), aged at least 18 years. Patients hospitalized within the last month, those with a medical implant (pacemaker, orthopedic nail, total hip replacement) and those who could not stand on the impedance scale, were not included. We excluded also, patients who had decided to withdraw from the study. Oral consent was obtained from all patients after a clear explanation of the protocol in the local language. The study received the approval of the Research Ethics Committee of the Cheikh Anta Diop University of Dakar (CER/UCAD).

The nutritional assessment was based on anthropometric markers, body composition determination by bioelectrical impedance analysis (BIA) and serum albumin. The ideal weight was calculated using the Lorentz formula [14] modified and taking age into account: ideal weight (kg) = 50 + [(height (cm) – 150) / 4] + [(age (years)) – 20) / 4]. The ideal weight percentage was calculated from the ideal weight to weight ratio. Body mass index (BMI in kg/m2) was calculated by dividing weight (kilograms) by height squared (meters). Waist circumference (WC) and mid-upper arm circumference (MUAC) measurements were taken with a tape measure and are expressed in cm. A single-frequency foot-to-foot bioelectrical impedance analyzer (SF-BIA, TANITA® model BC-730, 50 kHz, Japan) was used. The measurement is made after the end of the mid-week session, according to the recommendations issued by the European Society of Clinical Nutrition and Metabolism (ESPEN) [15]. The fat mass index (FMI, in kg/m2) and the lean mass index (LMI, in kg/m2) were calculated by dividing the fat mass (FM) and the lean mass (LM) respectively, by height squared [16]. The serum biochemical parameters had been carried out in the month of the weighing.

Various parameters of undernutrition studied : BMI (value less than 20 kg/m2 [15]), percentage of ideal weight (value less than 80% [17]), MUAC (value less than 22 cm [15]), FM (value less than 10% of body weight [15]), LMI (value less than 15 kg/m2 for women and 17 kg/m2 for men [15]) and serum albumin (value less than 35 g/L [18]). Parameters of obesity studied were: BMI (value greater than 30 kg/m2 [19]) and FM (value greater than 30%).

Statistical analysis: data were entered using EXCEL® software version 2013 (Microsoft®, Albuquerque, USA) and analyzed using SPSS® software version 21.0 (IBM®, Endicott, USA). The anthropometric and impedance measurements were compared to the reference standards of the impedance data and to the reference standards established for the general population. Mann-Whitney, Kruskal Wallis, chi-square, Fisher and Pearson tests were used. The results were considered significant for an alpha risk threshold of 5% ($p < 0.05$). In order to determine the agreement between the methods for estimating the prevalence of obesity and undernutrition, we divided the patients into two groups (obese/non-obese, undernourished/normal). Cohen's kappa (κ) measures the level of agreement between two raters or judges who each classify items into mutually exclusive categories: agreement, here, meaning that a patient diagnosed undernourished (or with normal nutrition) or obese (or not obese) using a method also has been diagnosed undernourished (or normally nourished) or obese (or non-obese) using another method. The strength of agreement was interpreted as follows [20]: almost perfect agreement (κ = 0.81–1.00), substantial (κ = 0.61–0.80), moderate (κ = 0.41–0.60), fair (κ = 0.21–0.40), slight (κ = 0.00–0.20), and poor (κ < 0.00).

Results

Sixty eight (68) CHD patients (mean age of 46.7 years, 51.5% women, mean duration on dialysis of 83.04 ± 48.1 months). The main causal nephropathy was hypertensive nephropathy in 29/68 patients. The baseline characteristics are summarized in Table I.

The mean BMI was 21.7 ± 5.1 kg/m2. According to the WHO classification, 33/68 had a normal BMI, 20/68 patients were lean including 2/68 cachectic patients, 7/68 patients were overweight and 6/68 patients were obese. Thirty-two patients had a BMI of less than 20 kg/m2 (see Figure 1). Mean MUAC was 25.5 ± 5.6 cm. The average weight was 64.9 ± 16.1 kg or 104.0 ± 22.0% of ideal weight. The mean FM was 17.6 ± 12 kg or 25.9 ± 13.9% of body weight. The mean LM was 45.4 ± 14.3 kg with an mean LMI of 15.4 ± 4.4 kg/m2. Albuminemia was measured in 32 patients with an mean of 38.9 ± 5.1 g/l.

The linear correlation between anthropometric nutritional markers, impedance markers and serum albumin was studied (see Table II). Figure 2 shows the variation in the prevalence of undernutrition in the population studied according to the nutritional marker (anthropometry, BIA, serum albumin)

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Table 1: Baseline characteristics of chronic hemodialysis patients

	Parameters	Women (n = 35)	Men (n = 33)	p
General				
	Age (years)	48 ± 14	45 ± 14	0,297
	Dialysis duration (months)	87 ± 50	79 ± 46	0,432
	Nephropathies			0,468
	Vascular (%)	40,0	48,5	
	Glomerular (%)	22,9	24,2	
	CIN (%)	11,4	18,2	
	No indeterminate (%)	20,0	6,1	
	PKD (%)	5,7	3,0	
	Vascular access			0,480
	Catheter (%)	20,0	27,3	
	AV Fistula (%)	80,0	72,7	
	Dry weight (kg)	62,1 ± 17,3	66,1 ± 14,5	0,075
	Kt/V$^{=45}$	1,32 ± 0,18	1,30 ± 0,17	0,836
Anthropometric				
	Ideal weight (kg)	61,3 ± 3,8	62,9 ± 4,5	0,072
	BMI (kg/m^2)	22,2 ± 5,8	21,1 ± 4,2	0,628
	MUAC (cm)	25,9 ± 6,5	24,9 ± 4,2	0,882
BIA				
	Fat mass (%)	29,8 ± 11,3	21,7 ± 15,3	0,002
	Lean mass index (kg/m^2)	15,1 ± 3,3	15,7 ± 5,3	0,005
Biologic				
	Hemoglobin (g/dl)	8,9 ± 1,9	9,4 ± 1,4	0,146
	CRP (mg/l)	14,8 ± 26,5	12,0 ± 17,9	0,947
	Kalemia (mEq/l)	4,9 ± 1,1	4,7 ± 1,0	0,710
	Phosphataemia (mg/l)	29,6 ± 12,0	30,5 ± 10,4	0,540
	Albumine$^{=32}$ (g/l)	37,5 ± 3,6	40,4 ± 6,3	0,105

Albuminie=45 : made at 32 patients. Kt/V=45 : made at 45 patients. AV fistulas : arteriovenous fistula. BMI : body mass index. CNI : chronic interstitial nephropathy. MUAC : mid-upper arm circumference. PKD : polycystic kidney disease.

Table 2: Correlation between anthropometric and bioelectrical impedance nutritional parameters

	Fat Mass		Lean Mass Index	
	r	p	r	p
Ideal weight (%)	0,939	0,000	0,625	0,000
BMI	0,514	0,000	0,488	0,000
MUAC	0,611	0,000	0,470	0,000
Albumine	-0,008	0,966	0,241	0,184

Table 3: Prevalence of malnutrition according to different methods and sex

	Women (n = 35)	Men (n = 33)	p
Undernutrition			
FM < 10 %	5,7 %	18,2 %	0,144
BMI < 20 kg/m^2	40%	54,5 %	0,331
BMI < 18,5 kg/m^2	34,3 %	28,6 %	0,799
LMI < ♀15 ♂17 kg/m^2	82,3 %	27,3 %	0,000
MUAC < 22 cm	28,6 %	21,2 %	0,580
< 80 % of Ideal Weight	17,1 %	3, 0 %	0,107
Albumine$^{=45}$ < 35 g/L	11,4 %	9,1 %	0,433
Obesity			
BMI > 30 kg/m^2	14,3 %	3,0 %	0,199
FM > 30 %	51,4 %	21,2 %	0,013

Same as Table I

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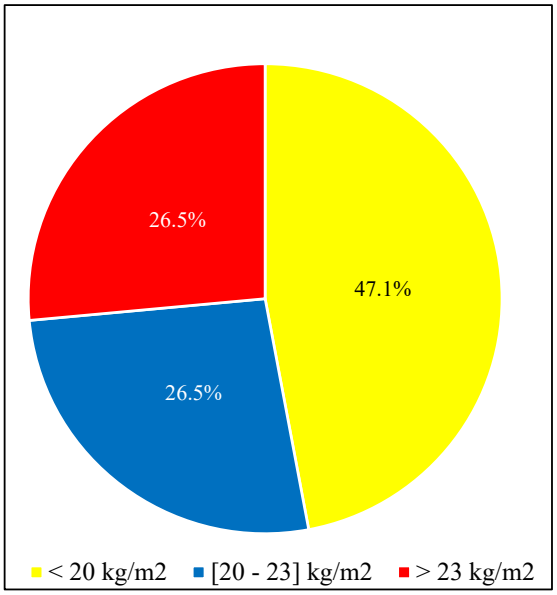

Figure 1: Distribution of patients according to their body mass index (BMI).

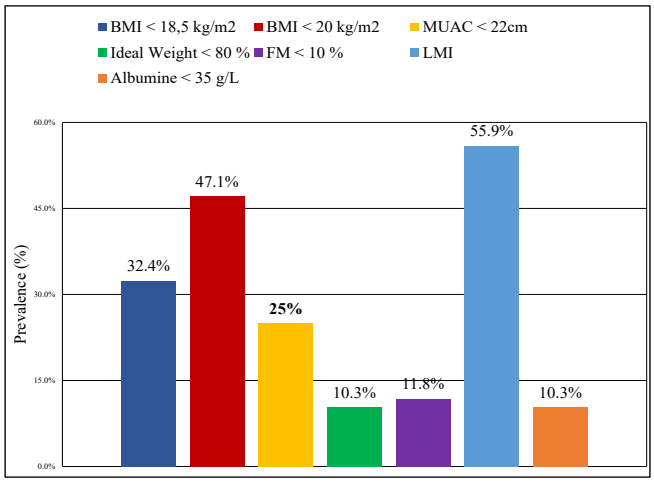

Figure 2: Prevalence of undernutrition according to nutritional markers.

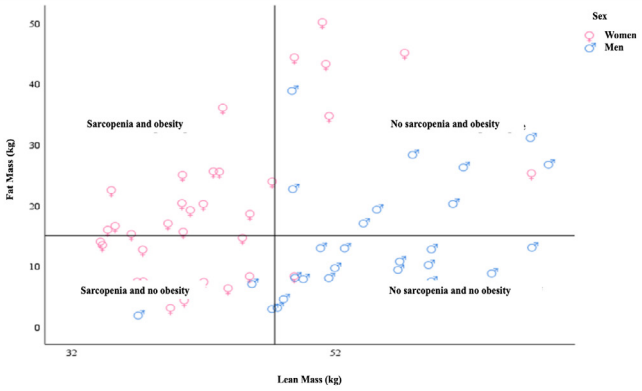

Figure 3: Non-linear plot of fat mass and lean mass of chronic hemodialysis patients. The horizontal and vertical axes indicate the medians of fat and lean mass in the population.

used. It was 47.1% (95% CI [34.8 – 59.6]) based on BMI (threshold of 20 kg/m2), 25% (95% CI [15.3 – 37 .0]) according to MUAC, 10.3% (95% CI [4.2 – 20.1]) according to ideal weight, 11.8% (95% CI [5.2 – 21. 9]) according to FM, 55.9% (95% CI [43.3 – 67.9]) according to LMI and 10.3% (95% CI [4.2 – 20.1]) according to serum albumin. Table III illustrates the prevalence of undernutrition and obesity in patients by sex and by different assessment methods.

Agreement in diagnosis of undernutrition by FM was fair with BMI (< 20 kg/m2 [$\kappa = 0.261$ and $p = 0.001$]), BMI (< 18.5 kg/m2 [$\kappa = 0.275$ and $p = 0.006$]), MUAC ($\kappa = 0.381$ and $p = 0.001$) and slight with serum albumine ($\kappa = 0.075$ and $p = 0.025$). Diagnosis of undernutrition by LMI had a slight agreement with ideal weight ($\kappa = 0.166$ and $p = 0.013$), BMI (< 18.5 kg/m2 [$\kappa = 0.301$ and $p = 0.005$]), and a fair agreement with MUAC ($\kappa = 0.288$ and $p = 0.003$). The diagnosis of malnutrition by serum albumin was also slight agreement with ideal weight ($\kappa = 0.092$ and $p = 0.004$), BMI (< 18.5 kg/m2 [$\kappa = 0.107$ and $p = 0.018$]) and BMI (< 20 kg/m2 [$\kappa = 0.142$ and $p = 0.002$]).

The prevalence of obesity was 8.8% (95% CI [-1.8 – 22.4]) according to WHO criteria and 36.8% (95% CI [24.7 – 48 ,9]) according to FM. The diagnosis of obesity by FM (> 30%) had a fair agreement with WHO criteria ($\kappa = 0.210$ and $p = 0.013$) in the diagnosis of obesity.

Discussion

Assessing nutritional state of CHD patients is important and challenging. Indeed, they present an increased risk of malnutrition due to many factors, nutritional or non-nutritional, but changes in their body composition are frequent [21]. Also, there is no single criterion for identifying malnutrition, which sometimes delays the diagnosis [22]. It has been suggested to assess the nutritional state of CHD patients from several markers such serum biochemical parameters and body composition analysis (weight, anthropometry, bioimpedance, total body nitrogen and DEXA) [7]. In this study, we evaluated the prevalence of undernutrition and obesity in our patients by comparing different evaluation methods. Malnutrition is a significant cause of morbidity and mortality in CHD. Its prevalence would be between 25% and 80% in different studies [7, 22, 23] and this variability would be due to the different criteria used to diagnose the nutritional state and could also be attributable to the variation in demographic and cultural characteristics and the traditional eating habits specific to each country and each ethnic group. Oliveira et al. [22] reported a prevalence between 12.1 and 94.8% using different methods. In our study, it was also assessed differently and ranged from 10.3 to 55.9%. The lowest value was found during the evaluation by albuminemia and the percentage of ideal weight and the highest during the evaluation by IMM. The prevalence of obesity also varied according to the diagnostic criteria with the highest value during the evaluation

by FM in all patients and in men and women. BIA is thus a fast, non-invasive, cheap, safe method and can be done anywhere using a small portable device. It is therefore suitable for large-scale studies [24]. BIA data have been reported for white, African American, and Hispanic populations [25–28]. From a nutritional point of view, a high risk of malnutrition in CHD patients has been revealed in numerous studies that have used BIA [29]. In a study of 118 hemodialysis patients, SF-BIA was consistent with the gold standard, DEXA [30]. However, it can be affected by water status [12, 28]. In our study, BIA nutritional parameters were strongly and positively correlated with anthropometric markers. In addition, the agreement in the diagnosis of undernutrition and obesity was good according to a statistically significant kappa coefficient. Due to its availability and simplicity, BIA has considerable potential as a complement to conventional anthropometric techniques for assessing the nutritional status of hemodialysis patients. Our results show that the prevalence of malnutrition varied according to the evaluation method and sex in our patients. It was significantly higher in women when evaluated undernutrition by LMI and obesity by FM. Women are thus more exposed to undernutrition than men at the expense of a low LM in them. This relationship between a low LMI and female sex had already been highlighted by Rosenberger et al. in 748 patients [31]. Similarly, they are also more exposed to obesity in our cohort in relation to a high FM. This suggests the possible coexistence of protein malnutrition (reduced LM) and high adiposity (high MG). As shown in Figure 3, 31.4% of women are affected.

The limitations of our study were observational type, small sample size. But our results suggest that BIA has considerable potential in the nutritional assessment of our patients, due to its availability, simplicity and reliability.

Conclusion

Different methods of nutritional assessment lead to very different estimates of undernutrition and obesity. Our results indicate that the prevalence of malnutrition varied in CHD patients depending on the method of nutritional assessment but also on sex. Our results also indicate an average prevalence of undernutrition of 26.7% in CHD patients, while more than half had a low lean mass and 36.8% of them had a high fat mass. According to the BIA, women on hemodialysis were at greater risk of malnutrition than men and they had an overlap of reduced lean mass and high fat mass. In order to clearly identify the latter, we suggest simple measurements of lean mass and fat mass indices, available from bioelectrical impedance analysis, in order to establish better diagnostic strategies and nutritional care in CHD patients

Conflicts of interest

The authors declare no conflict of interest

Author contributions

Study design: Niakhaleen Keita, Maria Faye, Sidy Mouhamed Seck. Bibliography: Niakhaleen Keita, Maria Faye, Sidy Mouhamed Seck. Definition of the methodology: Niakhaleen Keita, Maria Faye, Moustapha Faye, Sidy Mouhamed Seck. Writing, co-writing or validation of the protocol: Niakhaleen Keita, Maria Faye, Sidy Mouhamed Seck. Steering: Niakhaleen Keita, Bacary Ba, Seynabou Diagne, Mansour Mbengue. Data analysis and validation: Niakhaleen Keita, Maria Faye, Moustapha Faye, Ahmed Tall Lemrabott, Sidy Mouhamed Seck. Manuscript writing: Niakhaleen Keita, Maria Faye, Moustapha Faye, Sidy Mouhamed Seck. Proofreading and validation of the manuscript: Niakhaleen Keita, Maria Faye, Moustapha Faye, Bacary Ba, Seynabou Diagne, Mansour Mbengue, Sidy Mouhamed Seck, Abdou NIANG, El Hadji Fary Ka.

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Not Applicable

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