Medica Hospitalia
Journal of Clinical Medicine
Med Hosp 2023; vol 10 (1) : 76–82

Original Article

The Correlation of Nutritional Status and Phase Angle in Hemodialysis Patient

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p-ISSN: 2301-4369 e-ISSN: 2685-7898
https://doi.org/10.36408/mhjcm.v10i1.795

Accepted: August 10th, 2022
Approved: February 13th, 2023

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Abstract

Background : Nutritional problem are often experienced by patients with chronic kidney disease (CKD) undergoing regular hemodialysis. There are various tools that can be used to evaluate nutritional status, such as the 7-point Subjective Global Assessment (SGA), nevertheless, malnutrition in these patients is still underdiagnosed and resulting in worse clinical outcomes. Phase Angle (PhA) as measured by multi-frequency Bioelectrical Impedance Analysis (BIA) may detect nutritional problem in early stage in order to start nutrition therapy early. The objectives of this study was to analyze correlation between nutritional status and PhA in CKD patients with regular hemodialysis.
Methods : The subject of this study were 39 CKD patients undergoing regular hemodialysis who met the inclusion and exclusion criteria. Nutritional status was evaluated by 7-point SGA, while PhA was measured by multi-frequency BIA. Correlation between variables analyzed by Spearman correlation test.
Results : Positive correlation was observed between nutritional status and PhA ($r = 0.64$; $p < 0.001$). There was a negative correlation between PhA and number of comorbids ($r = -0.381$, $p = 0.017$). PhA was not correlated with sex and hemodialysis duration.
Conclusion : There is positive correlation between nutritional status measured by 7-point SGA and PhA in CKD patients with regular hemodialysis.

Keywords : CKD, Hemodialysis, Nutritional Status, 7-point SGA, Phase Angle

INTRODUCTION

Patients with end-stage chronic kidney disease (CKD) need renal replacement therapy, either kidney transplant or regular dialysis, such as hemodialysis. Hemodialysis patient has a greater risk of nutritional disorder. However, nutritional disorders are often detected too late or even completely neglected in daily clinical practice. This will not only cause a lot of harm from a medical perspective such as poorer prognosis, complications, and quality of life, but also the economic aspect.[1] Various tools to evaluate nutritional status are available. One particular tool that is recommended for CKD patients is 7-point Subjective Global Assessment (SGA), which is a modified SGA and has been recommended by the National Kidney Foundation Kidney Disease/Dialysis Outcomes and Quality Initiative (NKF K/DOQI) to be used as a nutritional evaluation tool in CKD patient.[2] 7-point SGA is widely used because it has been validated and is commonly used in patients in nephrology departments.[1,2] However, various nutritional status evaluation tools including 7-point SGA require skilled examiners. Subjectivity between examiners often occurs which causes the difference in results.[3,4]

Phase Angle (PhA) is one particular measurement from multi-frequency bioimpedance analysis (BIA) which is obtained from the calculation between the reactants and the electric current resistance produced by the multi-frequency BIA, which is described in degrees. PhA can identify nutritional disorders at an early stage, thus nutritional disorders could be detected as early as possible. Early diagnosis allows nutritional intervention to be given at an earlier stage, consequently improve nutritional status, clinical conditions, and patient outcomes.[5,6] PhA value is considered normal range between 6° to 7°, even reaching 8.5° or more in athletes, while the PhA value below 5° associated with malnutrition.[7] In contrast to other nutritional status evaluation tools, the PhA examination does not depend on anthropometric results. It is a distinct advantage in patients who are difficult to measure an accurate anthropometric examination such as CKD patients who generally have a fluid overload.[8]

Previous studies reported that PhA had a close correlation with nutritional status in various groups of patients. However, studies related to the correlation between nutritional status and PhA in hemodialysis patients has not been widely studied in Indonesia. The researcher wanted to analyze the correlation between nutritional status as measured by the 7-point SGA and PhA in CKD patients undergoing hemodialysis at the hemodialysis unit of RSUP Dr. Kariadi.

METHODS

This study is a correlational study with secondary data. Subjects were CKD patients undergoing regular hemodialysis at the Hemodialysis Unit of RSUP Dr. Kariadi and have met the inclusion and exclusion criteria. The sample size was calculated using formula :

$$n = \left\{ \frac{(Z\alpha + Z\beta)}{0{,}5 \ln \{(1+r)/(1-r)\}} \right\}^2 + 3$$

with α = 5%, β = 20%, and r value based on previous research is 0.561. Based on these calculations, minimum sample size is 23 subjects.

The independent variable is nutritional status, while the dependent variable is PhA. The confounding variables that influenced the study and were to be measured were sex, number of comorbidities, and duration of hemodialysis. The inclusion criteria for this study were CKD patients undergoing hemodialysis at the Hemodialysis Unit of RSUP Dr. Kariadi in the study period, aged ≥18 years to <60 years, had BMI ≤30 kg/m^2, and complete medical record data. The exclusion criteria for this study were patients with anasarca edema, severe ascites, and patients who were pregnant.

Data with a nominal or ordinal scale are shown in terms of number (%), while data with a ratio or interval scale are shown in terms of mean ± standard deviation and median value [range of values]. Data normality test using Shapiro-Wilk. Data on nutritional status as measured by the 7-point SGA were not in normal distribution and hence analyzed with Spearman's correlation. The correlation of PhA with sex was analyzed using the chi-square test, while the correlation of PhA with the number of comorbidities and duration of hemodialysis was analyzed using the Spearman test. This research has received permission from the Health Research Ethics Committee of RSUP Dr. Kariadi with No. 1159/EC/KEPK-RSDK/2022. Data confidentiality is maintained according to the provisions of ethical clearance. Research-related costs are fully funded by the researcher.

RESULTS

There were 39 subjects who participated in this study, the majority of subjects were male (66.7%). The mean age was 49.4 ± 8.55 years. The youngest and oldest age ranges were 30 years and 59 years respectively. BMI cut-off in this study was <30 kg/m^2. The mean BMI in the subjects was 23.2 ± 3.42 kg/m^2 with a median value of 23.1 kg/m^2. More than half of the subjects were overweight, moreover, only 3 people or 7.7% were in the underweight group. Comorbid diseases recorded in this study were hypertension, diabetes mellitus, and cardiovascular disease. Nearly 85% of subjects had at least 1 comorbid, with hypertension being the most common. The mean duration of hemodialysis was 26.6 ± 27.1 months with the

TABLE 1
Subject Characteristics

Subject Characteristics	Mean ± SD	Median [value range]	(%)
Age (year)	49.4±8.55	52 [30–59]	–
Sex			
Male	–	–	26 (66.7)
Female	–	–	13 (33.3)
BMI (kg/m^2)	23.2±3.42	23.19 [18.22–29.11]	
Underweight	–	–	3 (7.7)
Normoweight	–	–	14 (35.9)
Overweight	–	–	10 (25.6)
Obese	–	–	12 (30.8)
Number of comorbidities			
Unknown	–	–	6 (15.4)
1 comorbidity	–	–	20 (51.3)
2 comorbidities	–	–	11 (28.2)
3 comorbidities	–	–	2 (5.1)
Type of comorbidities			
Hypertension	–	–	26 (66.7)
Diabetes mellitus	–	–	17 (43.6)
Cardiovascular disease	–	–	5 (12.8)
Duration of hemodialysis (month)	26.6±27.1	13 [1–96]	–
Nutritional status	3.9±1.03	4 [2–6]	–
Normal	–	–	3 (7.7)
Moderate malnutrition	–	–	33 (84.6)
Severe malnutrition	–	–	3 (7.7)
Phase angle	4.7±0.91	4.9 [2.9–6.3]	–

shortest being 1 month and the longest being 96 months. The mean value of nutritional status as measured by the 7-point SGA in this study was 3.9 ± 1.03 with a median value of 4. More than 90% of the subjects were malnutrition, and only 7.7% were in the category of normal nutritional status. PhA is the dependent variable in this study. The average PhA was 4.7 ± 0.91 with a mean value of 4.9. The lowest PhA value in this study was 2.9, while the highest PhA value was 6.3. The characteristics of the subjects are described in Table 1.

The correlational hypothesis test between nutritional status, measured by the 7-point SGA, and PhA using the Spearman test are shown in Table 2. The results obtained an r = 0.641 and p = <0.001. The p value <0.05 indicates a statistically significant correlation, with a conclusion that between nutritional status and PhA, there is a moderate positive correlation.

This study included 3 confounding variables to be analyzed, namely sex, number of comorbidities, and duration of hemodialysis. The correlation test between PhA as the dependent variable and sex is shown in Table 3, the correlation test between PhA and the number of comorbidities is shown in Table 4, and the correlation test between PhA and the duration of hemodialysis is shown in Table 5.

PhA analysis with sex using the chi-square test. PhA value <5° is associated with malnutrition, hence used as a limit for PhA value. However, this PhA values

TABLE 2
Correlation of Nutritional Status with Phase Angle

Variable	r	p
Nutritional status	0.641	<0.001
Phase angle		

TABLE 3
Correlation of Phase Angle with Sex

Sex	Phase Angle	
	< 5°	≥ 5°
Male	13 (50%)	13 (50%)
Female	7 (53.6%)	6 (46.2%)

X^2=0.000; df=1; p=1.000

TABLE 4
Correlation of Phase Angle with Number of Comorbidities

Number of comorbidities	Phase Angle (°)	r	p
0	5.53±0.82	-0,381	0.017
1	4.79±0.81		
2	4.30±0.96		
3	4.80±0.71		

TABLE 5
Correlation of Phase Angle with Duration of Hemodialysis

Variable	r	p
Duration of hemodialysis	0.030	0.858
Phase angle		

limit was obtained from studies with subjects who were dominated by Caucasian. There are no studies yet on PhA values for the Mongoloid like this study. Based on this test, p value >0.05 was obtained which indicated that there was no significant difference between the PhA values based on sex.

The Spearman correlational test between PhA and the number of comorbidities showed r = -0.381 and p = 0.017. The value of r = -0.381 indicates the opposite correlation between the two, and the value of p<0.05 indicates that there is a significant correlation between the number of comorbidities and PhA.

The Spearman correlation test between the duration of hemodialysis and PhA showed a value of r = 0.030 and a value of p = 0.858. The p value > 0.05 showed no significant correlation between PhA and the duration of hemodialysis.

DISCUSSION

The test results showed no significant difference between the PhA values and sex. The majority of the subjects were male. This data is similar to study in India and Israel in 2011 and 2014 respectively with the results of 69.6% and

63.2% of subjects were male.[9,10] More recent study in Medan, Indonesia and China also showed the results were not much different, with respectively 71.2% and 54.9% of the subjects being male.[11,12]

The subjects mean age is 49.4 ± 8.55 years. Studies on CKD patients with regular hemodialysis in India and Medan, Indonesia showed similar results with 49.5 years and 46.3 years for the male and female patient groups in India, while the mean age 46.1 years in Medan, Indonesia.[10,11] Studies in China and Israel showed higher mean age, 58.02 years and 68.7 years, respectively.[9,12] This difference could be due to age-related criteria, patients who are in the elderly group according to Indonesian law (have reached the age >60 years) are not included in this study.[13,14]

The mean BMI in this study is 23.2 ± 3.42 kg/m^2 with a median of 23.1 kg/m^2. The mean BMI in studies with CKD patients with regular hemodialysis in China and Medan, Indonesia showed similar results, 21.33 kg/m^2 and 21.45 kg/m^2, respectively. Slightly different results were obtained from Israel, with the subject's average BMI being 26.6 kg/m^2.[9,11,12] This difference is due to racial differences in each country which has a different BMI categorization as well. According to WHO, the normal BMI rate in Israel is between 18.5–24.9 kg/m^2, while in Indonesia and other Asia Pacific countries are 18.5–23.9 kg/m^2.[15]

This study used 7-point SGA to determine the nutritional status of CKD with regular hemodialysis. The results showed that 92.3% of the subjects were malnourished, although most of them were in moderate malnutrition. A study on CKD patients with regular hemodialysis in India and Medan, Indonesia also used SGA and its modifications to determine nutritional status. In a study in India, 96.9% of subjects were malnourished, while in a study in Medan, Indonesia, 65.4% of subjects were malnourished, and the majority of subjects were moderately malnourished.[10,11]

Statistical analysis in this study showed a positive moderate correlation. This is consistent with various previous studies, such as studies in China and Medan, Indonesia, which stated that there was a significant correlation between nutritional status and PhA. The nutritional disorder experienced in this study was disease-related malnutrition (DRM). DRM is associated with a decrease in body cell mass (BCM) and a shift of intracellular water (ICW) to extracellular water (ECW), resulting in a change in the ECW/ICW ratio. Thus, a decrease in BCM and a change in the ECW/ICW ratio causes lower PhA values.[11,12,16]

Several confounding variables may affect the PhA value. The confounding variables examined in this study were sex, number of comorbidities, and duration of hemodialysis. Study on healthy subjects in Brazil showed male has a better PhA value than female. This cannot be separated from the differences in free-fat mass (FFM) scores and ECW ratios which were higher in the male than in the female.[17] The statistical analysis between sex and PhA in this study was not significant. This might happen because subjects had at least one of the three comorbid diseases, namely hypertension, diabetes mellitus, and/or cardiovascular disease, and 92.3% of subjects were malnourished. CKD patients with regular hemodialysis are at high risk of malnutrition, even though malnutrition causes changes in body composition in the form of decreased muscle mass, fat mass, to impaired fluid status.[1] CKD patients with regular hemodialysis had significantly lower FFM and ECW ratios than healthy individuals.[12] In this study, subjects were CKD patients and the majority were malnourished, rather than in good health, which led to a non-significant correlation between sex and PhA in this study.

Data analysis in this study showed a negative correlation between the number of comorbidities and PhA, hence the higher the number of comorbidities, the lower the PhA value. This is similar to the previous study, that comorbidity will significantly worsen PhA values. Comorbidities are associated with inflammation, malnutrition, and worse functional capacity which will worsen PhA values.[16,18] Hypertension was the most common comorbid in this study followed by diabetes mellitus, with 66.7% of subjects having hypertension and 43.6% of subjects having diabetes. mellitus. Study in India showed similar characteristics regarding the type of comorbidity, with 72.7% of subjects having hypertension and 45.5% of subjects having diabetes mellitus.[10]

Duration of hemodialysis is one of the factors that affect the PhA value. The mean duration of hemodialysis in this study was 26.6±27.1 months. Similar characteristics were found in India with a mean duration of hemodialysis being 25.3 months and 24.9 months for male and female respectively, and another study in Medan, Indonesia showed a mean of 24.2 months. The study in Medan, Indonesia did not analyze the correlation between the duration of hemodialysis and nutritional status, while in this study and the study in India, the duration of hemodialysis did not show a significant correlation.[10,11] Contrast results were reported in Korea. A study in Korea reported the mean duration of peritoneal dialysis was 57.5 months, and had a significant correlation between the PhA value and the duration of peritoneal dialysis. This is following the previous explanation that hemodialysis aims to save lives and improve the quality of life for patients diagnosed with CKD, however, in the long term might contribute to several complications related to nutritional status such as muscle wasting and malnutrition.[19,20] The different results of PhA value and duration of hemodialysis in this study compared to study in Korea could be due to the tendency to delay the initiation of hemodialysis in the subjects of this study. A study conducted at RSUPN Dr. Cipto Mangunkusumo, Jakarta shows that there is a

tendency of up to 90% to delay referring ESRD patients who require initiation of hemodialysis. The poor mobilization ability and low adherence are the main factors for the delay.[21] RSUP Dr. Kariadi, similar to RSUPN Dr. Cipto Mangunkusumo, is a national referral center hospital, thus delays in the initiation of hemodialysis may also occur in the subjects of this study. The delay in referral made the hemodialysis initiation data in this study not reflect the actual condition of disease progression. Patients who require but do not undergo hemodialysis are associated with poor clinical outcomes such as increased morbidity and mortality.[22]

There are several limitations to this study. The wide age range is one of the limitations of this study. This study uses the criteria of adult age between ≥ 18 years to <60 years. Comorbid in this study were limited considering this study used secondary data. This causes some unknown comorbidities that might affect the analysis. Another limitation of this study is the initiation of hemodialysis was not investigated further. The delay in the initiation of hemodialysis can affect the analysis in this study, especially related to the duration of hemodialysis. The delay in the initiation of hemodialysis causes the recorded duration of hemodialysis to not accurately reflect the progress of the disease, which can lead to bias.

CONCLUSION

This study showed a positive correlation between the independent variables, nutritional status examined by the 7-point SGA, with PhA as the dependent variable. Results analysis showed no significant correlation between PhA with the duration of hemodialysis and sex. The only confounding variable in this study that showed a significant correlation with PhA was the number of co-morbidities in subjects.

The results indicate the high prevalence of nutritional disorders in CKD patients undergoing hemodialysis and the importance of PhA in identifying nutritional disorders. PhA examination can provide its clinical advantages, considering the difficulty of accurate anthropometric examinations in CKD patients, which are often undetected by other tools. A decrease in the PhA value could provide an early warning of nutritional disorder, hence, nutritional counseling and intervention could be given as early as possible.

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