Revista de Ciencias Médicas y de la Vida
Universidad Da Vinci de Guatemala
Facultad de Ciencias Médicas y de la Vida

• e-ISSN: 2958-9533 • ISSN impresa: 2960-2696 •

Volume 3 (1-3) || Year 2025 || e046 **Original Article**

Phase Angle and Nutritional Status Assessment in Patients with Chronic Kidney Disease Undergoing Replacement Therapy at the Regional Hospital of Cuilapa, 2024

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ABSTRACT

Introduction: Phase angle is an important tool for assessing the progression of Chronic Kidney Disease and may outperform other nutritional measurements. It helps determine the patient's condition, enabling timely interventions aimed at reducing the risk of nutritional deterioration. **Objective:** To evaluate the contribution of combining body composition analysis through bioelectrical impedance, phase angle, and Body Mass Index in improving the classification of nutritional status in patients with Chronic Kidney Disease undergoing hemodialysis, hospitalized in the Internal Medicine and Surgery departments of the Regional Hospital of Cuilapa. **Method:** A descriptive cross-sectional study was conducted. All patients with Chronic Kidney Disease undergoing hemodialysis who were referred to the Nutrition Department during the two scheduled months were included. The operationalized variables were: bioelectrical impedance, Body Mass Index, weight, and height. A questionnaire on the requirements for performing bioimpedance, adapted to the study population, was applied. **Results:** 53% of underweight patients (BMI < 23 kg/m²) had phase angles between 2° and 5.2°, while 41.3% of patients with adequate BMI (23–27.5 kg/m²) had angles between 5.6° and 7°; 5.7% of overweight patients (BMI > 27.5) had a phase angle of 9.7°. **Conclusions:** Nutritional status assessment through bioelectrical impedance, focusing on body composition, is highly valuable for evaluating hospitalized patients with Chronic Kidney Disease on hemodialysis. The complementary use of phase angle allows for the identification of malnutrition that may be hidden due to the clinical characteristics of the patients. This approach contributes to a more complete and accurate evaluation than one based solely on Body Mass Index.

Keywords: Phase Angle; Nutritional Status; Chronic Kidney Disease; Body Mass Index; Hemodialysis

Open access
Submitted: 13/10/2024
Accepted: 05/07/2025
Published: 31/08/2025

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Ángulo de fase y medición del estado nutricional en pacientes con Insuficiencia Renal Crónica en tratamiento sustitutivo del Hospital Regional de Cuilapa, 2024

RESUMEN

Introducción: *el ángulo de fase es una herramienta importante para evaluar la progresión de la Enfermedad Renal Crónica y puede ser superior a otras mediciones nutricionales; así ayuda a determinar la condición del paciente, para poder tomar acciones oportunas con la finalidad de disminuir el riesgo del deterioro nutricional.* ***Objetivo:*** *evaluar la contribución de la combinación del análisis de la composición corporal mediante bioimpedancia eléctrica, ángulo de fase y el Índice de Masa Corporal en la mejora de la clasificación del estado nutricional de pacientes con Enfermedad Renal Crónica en tratamiento sustitutivo de hemodiálisis, ingresados en los servicios de encamamiento de Medicina Interna y Cirugía del Hospital Regional de Cuilapa.* ***Método:*** *Se realizó un estudio descriptivo de corte transversal. Se incluyeron a todos los pacientes con Insuficiencia Renal Crónica con tratamiento sustitutivo de hemodiálisis, inter consultados al Departamento de Nutrición durante los dos meses programados. Las variables operacionalizadas fueron: bioimpedancia eléctrica, Índice de Masa Corporal, peso y talla. Se aplicó un cuestionario sobre los requisitos para realizar la medición de bioimpedancia que aplican con la población del estudio.* ***Resultados:*** *el 53% de los pacientes con bajo peso (IMC < 23 kg/m²) se asociaron con ángulos de fase de 2° a 5.2°, el 41.3% con un IMC adecuado (23-27.5 kg/m²) mostró ángulos de 5.6° a 7°; mientras que el 5.7% de los pacientes con sobrepeso (IMC > 27.5) se vinculó a un ángulo de fase de 9.7°.* ***Conclusiones:*** *la evaluación del estado nutricional mediante bioimpedancia eléctrica, enfocada en la composición corporal, es de gran importancia para valorar a pacientes hospitalizados con Enfermedad Renal Crónica en tratamiento de hemodiálisis; el uso complementario del ángulo de fase permite identificar desnutrición que está oculta debido a las características clínicas de los pacientes. Este enfoque contribuye a una evaluación más completa y precisa que la obtenida al basarse exclusivamente en el Índice de Masa Corporal.*

Palabras clave: *Ángulo de Fase; Estado Nutricional; Enfermedad Renal Crónica; Índice de Masa Corporal; Hemodiálisis*

Angle de Phase et Évaluation de l'État Nutritionnel chez les Patients atteints d'Insuffisance Rénale Chronique sous Traitement Substitutif à l'Hôpital Régional de Cuilapa, 2024

RÉSUME

Introduction : *L'angle de phase est un outil important pour évaluer la progression de la maladie rénale chronique et peut être supérieur à d'autres mesures nutritionnelles. Il aide à déterminer l'état du patient, permettant des interventions opportunes visant à réduire le risque de détérioration nutritionnelle.* ***Objectif :*** *Évaluer la contribution de la combinaison de l'analyse de la composition corporelle par impédance bioélectrique, de l'angle de phase et de l'indice de masse corporelle à l'amélioration de la classification de l'état nutritionnel des patients atteints de maladie rénale chronique sous hémodialyse, hospitalisés dans les services de médecine interne et de chirurgie de l'Hôpital Régional de Cuilapa.* ***Méthode :*** *Une étude descriptive transversale a été réalisée. Tous les patients atteints d'insuffisance rénale chronique sous hémodialyse, orientés vers le service de nutrition pendant les deux mois programmés, ont été inclus. Les variables opérationnalisées étaient : impédance bioélectrique, indice de masse corporelle, poids et taille. Un questionnaire sur les exigences pour la réalisation de l'impédance bioélectrique, adapté à la population étudiée, a été appliqué.* ***Résultats :*** *53 % des patients en insuffisance pondérale (IMC < 23 kg/m²) présentaient des angles de phase entre 2° et 5,2°, tandis que 41,3 % des patients avec un IMC adéquat (23–27,5 kg/m²) avaient des angles entre 5,6° et 7° ; 5,7 % des patients en surpoids (IMC >*

*27,5) avaient un angle de phase de 9,7°. **Conclusions :** L'évaluation de l'état nutritionnel par impédance bioélectrique, centrée sur la composition corporelle, est d'une grande importance pour l'évaluation des patients hospitalisés atteints de maladie rénale chronique sous hémodialyse. L'utilisation complémentaire de l'angle de phase permet d'identifier une malnutrition qui peut être masquée par les caractéristiques cliniques des patients. Cette approche contribue à une évaluation plus complète et précise que celle basée uniquement sur l'indice de masse corporelle.*

***Mots-clés :** Angle de Phase ; État Nutritionnel ; Maladie Rénale Chronique ; Indice de Masse Corporelle ; Hémodialyse*

Ângulo de fase e avaliação do estado nutricional em pacientes com Insuficiência Renal Crônica em tratamento substitutivo no Hospital Regional de Cuilapa, 2024

RÉSUME

***Introdução:** o ângulo de fase é uma ferramenta importante para avaliar a progressão da Doença Renal Crônica e pode ser superior a outras medições nutricionais; dessa forma, auxilia na determinação da condição do paciente, permitindo ações oportunas com o objetivo de reduzir o risco de deterioração nutricional. **Objetivo:** avaliar a contribuição da combinação da análise da composição corporal por meio da bioimpedância elétrica, ângulo de fase e Índice de Massa Corporal na melhoria da classificação do estado nutricional de pacientes com Doença Renal Crônica em tratamento substitutivo por hemodiálise, internados nos serviços de Clínica Médica e Cirurgia do Hospital Regional de Cuilapa. **Método:** foi realizado um estudo descritivo de corte transversal. Foram incluídos todos os pacientes com Insuficiência Renal Crônica em tratamento substitutivo por hemodiálise que foram encaminhados ao Departamento de Nutrição durante os dois meses programados. As variáveis operacionalizadas foram: bioimpedância elétrica, Índice de Massa Corporal, peso e altura. Aplicou-se um questionário sobre os requisitos para a realização da bioimpedância, adequado à população do estudo. **Resultados:** 53% dos pacientes com baixo peso (IMC < 23 kg/m²) apresentaram ângulos de fase entre 2° e 5,2°, enquanto 41,3% dos pacientes com IMC adequado (23–27,5 kg/m²) apresentaram ângulos entre 5,6° e 7°; já 5,7% dos pacientes com sobrepeso (IMC > 27,5) apresentaram ângulo de fase de 9,7°. **Conclusões:** a avaliação do estado nutricional por meio da bioimpedância elétrica, com foco na composição corporal, é de grande importância para avaliar pacientes hospitalizados com Doença Renal Crônica em hemodiálise. O uso complementar do ângulo de fase permite identificar desnutrição que pode estar oculta devido às características clínicas dos pacientes. Essa abordagem contribui para uma avaliação mais completa e precisa do que aquela baseada exclusivamente no Índice de Massa Corporal.*

***Palavras-chave:** Ângulo de Fase; Estado Nutricional; Doença Renal Crônica; Índice de Massa Corporal; Hemodiálise*

Cite as:
Salazar-Castañeda DAO, Herrarte-Guzmán AG. Phase Angle and Nutritional Status Assessment in Patients with Chronic Kidney Disease Undergoing Replacement Therapy at the Regional Hospital of Cuilapa, 2024. Rev. Cienc. Med. Vida. 2025;3:e046.

INTRODUCTION

The phase angle is an important tool for assessing the progression of chronic kidney disease and may be superior to other nutritional measurements. Analyzing body composition, phase angle, and nutritional status by Body Mass Index in hospitalized patients with chronic kidney disease undergoing hemodialysis replacement therapy helps determine the patient's condition, which is important for taking timely action to reduce the risk of nutritional deterioration.

In recent years, different methods have been evaluated to assess nutritional status in patients with chronic kidney disease. However, there is still no method considered to be the gold standard. Therefore, researching nutritional status in relation to body mass index and phase angle values using electrical bioimpedance in patients with chronic kidney disease undergoing hemodialysis replacement therapy provided valuable information, especially regarding the risk of malnutrition.

Currently, there is an increase in the number of people suffering from chronic kidney disease who are undergoing replacement therapy. In Guatemala, according to the National Unit for the Care of Chronic Kidney Disease Patients (UNAERC), statistics on patients receiving hemodialysis treatment total 34,724 for the year 2023. (1) The annual mortality rate in that same year was 967 patients, (2) representing a percentage of 3%.

The Pan American Health Organization (PAHO) highlights that chronic kidney disease was the eighth leading cause of death in the Americas in 2019. Guatemala ranks third among countries with the highest rate of years of life lost due to premature death; chronic kidney disease accounted for 55.1% of deaths per 100,000 inhabitants.

Currently, the evaluation of these patients at the Cuilapa Regional Hospital is carried out in a similar way to that of patients without kidney disease, using a general methodology. Therefore, the research was based on analyzing a more specific and technical evaluation for patients with Chronic Kidney Disease undergoing replacement therapy in order to better identify reversible changes in patients. With the appropriate technology available in the Nutrition Department, it was used to perform body composition analysis, Body Mass Index, and phase angle parameters using electrical bioimpedance.

Phase angle and body mass index are widely used and recognized indicators for assessing nutritional status and health. The use of both methods provided a more comprehensive and detailed view of the research participants. Nutritional level was determined by obtaining the phase angle value using bioelectrical impedance.

The purpose of the research was to analyze data from patient assessments of body composition using bioimpedance and nutritional status using Body Mass Index, to obtain the classification of cut-off values for the association of nutritional status and cell membrane functionality when using and incorporating phase angle. This allows nutritional risk to be identified at the time of evaluation and interpretation of parameters using bioimpedance and viable alternative solutions to be generated to improve the clinical condition of patients during their hospital stay, by helping to obtain clear objectives for appropriate nutritional intervention.

The problem identified focuses on the lack of a specific nutritional assessment of the patient, which lacks important clinical information, as it does not provide details on body composition, including fat mass, fluids, and fat-free mass. The measurement system provided a comprehensive diagnosis of health status, using the phase angle indicator linked to nutrition level.

Based on the results obtained, a technical reference document was designed on phase angle and the use of electrical bioimpedance for nutritional diagnosis in patients with chronic kidney disease undergoing hemodialysis replacement therapy, with the aim of implementing it as part of the nutritional care process and thus helping to achieve better clinical outcomes.

METHOD

A descriptive cross-sectional study was conducted. The research was carried out at the Cuilapa Santa Rosa Regional Hospital during February and March of 2024. All patients with chronic renal failure undergoing hemodialysis (HD) replacement therapy who were referred to the Nutrition Department during the two months scheduled for the year were included. The sample consisted of 20 female and male patients aged between 30 and 60 years, selected by simple random sampling.

The operationalized variables were: electrical bioimpedance, body mass index, weight, and height. In addition, a questionnaire was used to assess the requirements for performing bioimpedance measurements on the study population.

Patients who did not meet the requirements for bioimpedance assessment were excluded based on the following exclusion criteria: patients who had eaten within 3 hours prior to assessment, women during their menstrual period, pregnant women, patients with implanted defibrillators or pacemakers, patients with large metal implants (knee, hip, etc.), and patients who did not wish to participate.

A data collection tool was developed that included a questionnaire with general questions in order to meet the requirements for performing electrical bioimpedance, anthropometric data, and body composition data. The questionnaire was validated by nutrition professionals using Moriyama criteria.

For data collection, the objective and procedure were explained to each patient; the informed consent form was presented and read aloud by the researcher, explaining to the patient that they could withdraw from the study at any time.

This was because it was taken into account that these are bedridden patients and taking their actual weight and height caused complications for the patients once they were in the ward. Subsequently, measurements were taken of the mid-arm circumference, starting at the upper vertex of the acromion of the scapula and ending at the olecranon of the ulna, and knee height, measured from the heel to the anterior surface of the thigh above the femoral condyles. A Seca measuring tape was used for this purpose, and waist circumference was measured from the midpoint between the costal margin and the iliac crest.

When calculating the estimated weight, it was compared with the dry weight reported by the hemodialysis unit, which was similar to the estimated data. If this was not the case, the patient's actual dry weight was considered; the Body Mass Index was classified according to the ideal BMI (kg/m²) guidelines for hemodialysis patients, based on the cut-off points described by Kalantar-Zadeh, K., et al. in 2018 [5]

Body composition was assessed using electrical bioimpedance; bioimpedance equipment (Seca mBCA 525) was used, as the assessment was performed after hemodialysis, and following standardized procedures by placing the electrodes in the supine position, at the height of the right and left ulna heads, at the height of the right and left second metacarpophalangeal joints, at the height of the ankle (between both malleoli), and at the height of the right and left second metatarsophalangeal joints. After entering the corresponding data, each patient was instructed to remain calm. Once the measurement was completed, the data obtained was collected and added to the database; at the end, the electrodes were removed and the procedure was concluded.

The phase angle was determined through electrical bioimpedance analysis, performed to obtain resistance and reactance measurements.

After obtaining the data, a qualitative analysis was performed, identifying differences and various changes in the body composition of each sample to obtain more accurate results. Likewise, one of the samples was detected as a false positive, and two of the samples were discarded due to technical failures in the bioimpedance evaluation process, resulting in incomplete data that could not be recovered. These were not considered in the quantitative analysis, which was obtained using the SPSS (Statistical Package for the Social Sciences) program, version 21 in Spanish, in order to discuss the results with statistical data.

This study was conducted in accordance with the ethical principles of non-maleficence, justice, autonomy, and beneficence. No participant was at risk of physical or psychological harm; the cultural differences of each participant were respected, information about the data collected was provided, and the implications of participation were explained. Participants were also informed that they could withdraw from the study at any time.

ANÁLISIS Y DISCUSIÓN DE RESULTADOS

A total of 17 patients with chronic kidney disease undergoing hemodialysis treatment were referred to the Clinical Nutrition Department during the estimated period. Seventy-one percent were male patients and 29% were female, with an average age of 49 years. The most representative age groups were those between 30 and 60 years old, accounting for 33.4% of the total.

23.5% had a glomerular filtration rate (GFR) of 8 mL/min/1.73 m², 5.9% had a GFR of 12

mL/min/1.73 m², and 14 had a GFR of 14 mL/min/1.73 m². All patients included in the sample had an GFR < 15 ml/min/1.73m2, which corresponds to the most advanced stage of chronic kidney disease. At this stage, the kidneys lose their ability to filter, eliminate waste, and remove excess fluid from the body, requiring the initiation of dialysis treatment.

Table 1 shows the description of patients according to phase angle values, with a phase angle value of 4.5° ±0.3 representing the highest percentage of the total sample (35.3%) with a frequency of 6 individuals. Another 6 individuals were found with phase angle values of 2.6° ±0.2 and 5.4° ±0.2, each representing 17.6% of the sample.

The results were related to the research conducted by Topete Reyes in 2019, (6) where patients with phase angle values within the normal range (5-7°) were compared; patients with chronic kidney disease had a phase angle <5° and a higher degree of malnutrition. On the other hand, Silva Duarte et al. in 2019 (7) obtained average phase angle values of 5.6±1.7° in patients with chronic kidney disease, results similar to the current research study. Similarities were also found with the findings of Rimsevicius et al

In 2016 (8), with average phase angle values of 4.9±1.1° when analyzing 99 patients with chronic kidney disease undergoing hemodialysis treatment aged between 58 and 72 years, despite the fact that the population sample in the studies is larger, they were related to the phase angle values obtained in the research.

Table 1. Distribution of patients according to phase angle

Phase Angle	Frecuency	Total Percentaje
1.4°	1	5.9%
3.1°	1	5.9%
6.9°	1	5.9%
7.1°	1	5.9%
9.7°	1	5.9%
2.6° ±0.2	3	17.6%
4.5° ±0.3	6	35.3%
5.4° ±0.2	3	17.6%

Table 2. Phase angle in relation to gender

Gender	Phase angle	Frecuency	Total Percentaje
Male	6.9°	1	5.9%
	7.1°	1	5.9%
	9.7°	1	5.9%
	2.6° ±0.2	3	17.6%
	4.5° ±0.3	5	29.4%
	5.4° ±0.2	1	5.9%
Female	1.4°	1	5.9%
	3.1°	1	5.9%
	4.5° ±0.3	1	5.9%
	5.4° ±0.2	2	11.8%

The results of this study revealed differences in phase angle values between the male and female populations, with the latter presenting a higher phase angle. This discrepancy differs from the evidence described in previous studies, especially in patients with compromised health, where it has been observed in most cases that women tend to have a lower phase angle compared to men. The difference found may be due to the composition and nutritional status of the samples included, with female participants presenting a more favorable condition.

The data collected on phase angle and its relationship to fat mass percentage are presented in **Table 3**, where the lowest phase angle values (1.4° and 3.1°) were seen most frequently in patients with fat mass percentages of 0.0% (5.9%) each. 6.9° with 25% fat mass, 7.1° with 2.5% fat mass, 9.7° with 10% fat mass (5.9%), 4.5° ±0.3 with results of 0.0% fat mass representing 11.8% of the total sample; Similarly, phase angle at 5.4° with fat mass percentage at 0.0 representing 17.6%.

Tabla 3. Phase angle in relation to the percentage of body fat

Phase Angle	Percentage of body fat	Frecuency	Total Percentaje
1.4°	0.0	1	5.9%
3.1°	0.0	1	5.9%
6.9°	25	1	5.9%
7.1°	2.5	1	5.9%
9.7°	10	1	5.9%
2.6° ±0.2	2.4	1	5.9%
	7.3	1	5.9%
	13.4	1	5.9%
4.5° ±0.3	0.0	2	11.8%
	8.5	1	5.9%
	10.9	1	5.9%
	15	1	5.9%
	16	1	5.9%
5.4° ±0.2	0.0	3	17.6%

A new finding observed in the research showed that there is a relationship between phase angle and fat mass, where low results, even zero readings in fat mass percentage, were associated with phase angle values less than 5°, and were also related to a phase angle value of 1.4°. This is not only attributed to the changes that overhydration produces in body composition, but it also demonstrates that, when cellular alteration occurs, fatty tissue is affected, since the cell membrane is an energy condenser, and when its capacity is reduced due to cell destruction or damage, the reading of adipose content gives absent results.

The phase angle values associated with nutritional status according to Body Mass Index classification for patients with chronic kidney disease on hemodialysis are shown in **Table 4**. The highest frequency of patients with a BMI in the underweight nutritional status was related to values of 2°, 4°, and 5.2° and a Body Mass Index of less than 23 kg/m², representing 53% of the total sample; while 41.3% obtained values between 5.6° and 7°, relating to an adequate nutritional status with a BMI of 23–27.5 kg/m²; and overweight nutritional status according to a BMI > 27.5 was associated with phase angle results of 9.7° (5.7%).

Tabla 4. Phase angle values corresponding to Body Mass Index classification

Phase Angle	Clasification	Total Percentaje
2°, 4°, 5.2°	Under weigth	53%
5°, 7°	Suitable	41.3%
9.7°	Overweight	5.7%

There were differences in some cases where patients had different phase angle values depending on their nutritional status, such as the patient with a Body Mass Index of less than 23 kg/m2 and a phase angle of 6.9°. It is known that the phase angle is related to muscle mass because it is a parameter that reflects body cell mass and cell membrane function. Since body cell mass consists mainly of muscle, changes in it and alterations in the membranes result in variations in phase angle values. Therefore, in hemodialysis patients, high phase angle values are associated with a better quality of life, better muscle quality, and a decrease in clinical worsening (9, 10, 11, 7). Regardless of BMI classification of nutritional status, it is important to assess and consider evaluation based on phase angle results.

In the literature review by Carreira J et al., (10) phase angle values in renal failure <4.5° are associated with an increased risk of mortality due to deterioration in nutritional status. Norman et al. and Segall et al. (12) also demonstrated that hemodialysis patients with lower phase angle values had a 4.1 times higher risk of mortality per year than patients with higher values. This is similar to the results obtained in the study, which revealed a small percentage of patients with a BMI of 25 and 26 kg/m2 with unfavorable phase angle results of 1.4° and 2.6°, which is considered to be at risk of morbidity and mortality.

Furthermore, Bosy et al. (9) demonstrated that there is a positive correlation between BMI and phase angle in underweight and normal-weight individuals. This is significant as it suggests that, in these groups, an increase in BMI is associated with an increase in phase angle. The identification of this correlation has important implications for clinical practice and research, as it suggests that not only BMI should be considered when assessing an individual's nutritional status, but also phase angle as a valuable complement.

In hospitalized patients with chronic kidney disease undergoing hemodialysis, a phase angle in the range of 5.6°-7° is associated with adequate nutritional status according to the Body Mass Index classification for hemodialysis patients. Therefore,

integrating phase angle assessment into routine evaluation facilitates more effective monitoring, which can also guide nutritional interventions, improving the quality of life and clinical outcomes of these patients.

Patients with chronic kidney disease undergoing hemodialysis treatment with a body mass index within the range of 23–27.5 kg/m² have better nutritional status related to a better phase angle.

Using the phase angle as part of the nutritional assessment process helps to propose possible therapeutic interventions more accurately, which contributes to improving the quality of life of hospitalized patients with Chronic Kidney Disease undergoing hemodialysis treatment.

CONCLUSION

The assessment of nutritional status using electrical bioimpedance, focused on body composition, is of great importance for evaluating hospitalized patients with chronic kidney disease undergoing hemodialysis treatment. The complementary use of phase angle allows for the identification of malnutrition that is hidden due to the clinical characteristics of the patients. This approach contributes to a more complete and accurate assessment than that obtained by relying exclusively on Body Mass Index.

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Conflict of interest
The author declares that there are no conflicts of interest between them, nor with the research presented.

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Funding
No specific funding was required for the research.