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The Predictive Capacity of Bioelectrical Impedance Parameters at Frequencies of 5, 20, 50, 100, and 200 kHz to Identify Vector-Associated Febrile Syndromes in the Emergency Room of the Hospital Civil de Guadalajara.

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INTRODUCTION

The febrile syndrome (FS) of unknown etiology represents an important challenge for diagnosis since there are more than 200 causes of febrile illness. Fever is a cardinal sign of an acute phase inflammation; as a response to multiple inflammatory molecules that activate the hypothalamic thermoregulatory center. Fever is a clinical sign that does not represent a serious condition by itself but can occur as a result of viral or bacterial pathologies and fever syndromes are associated with a change in cellular integrity that results in modifications of the cell's bioimpedance properties.

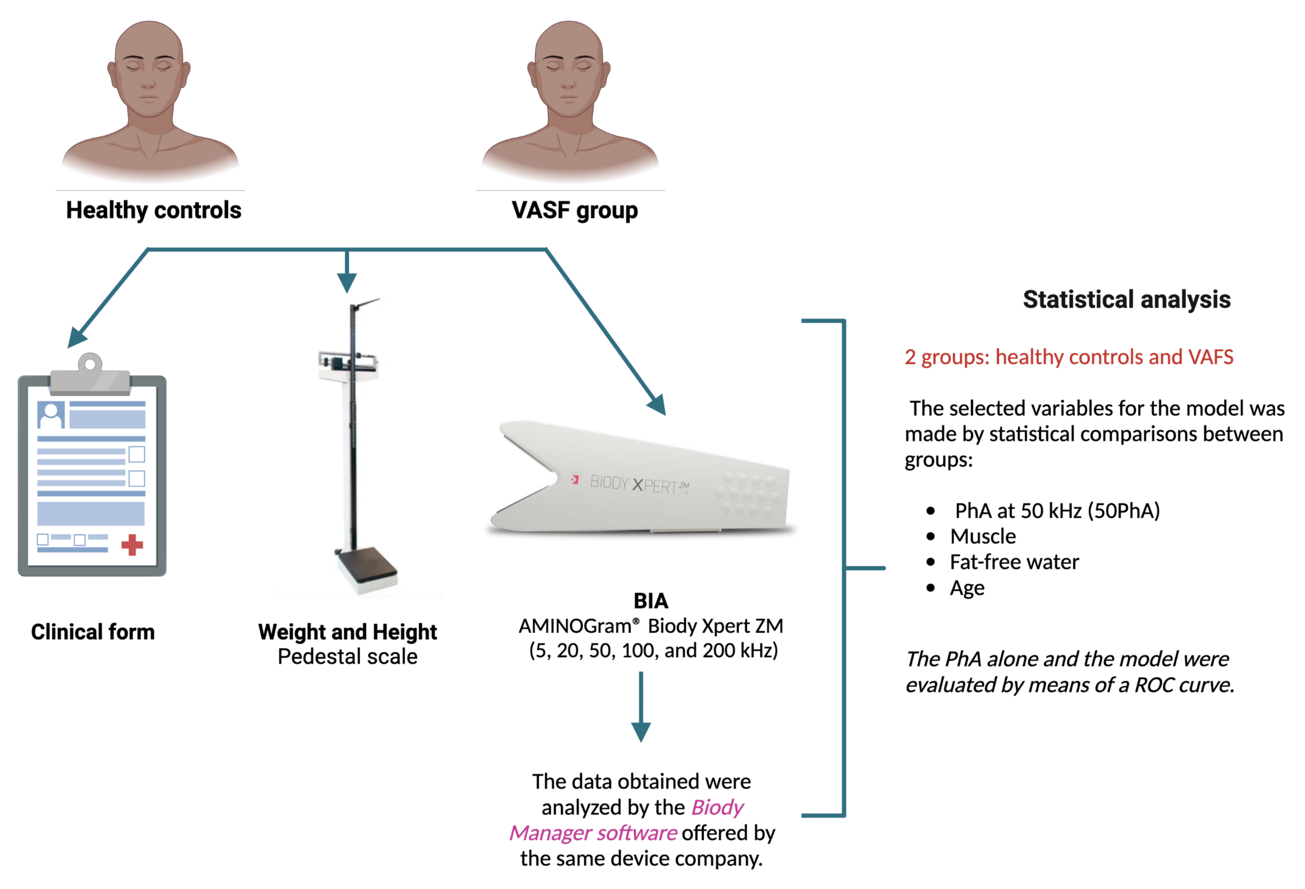
BIA is used to analyze cellular integrity, hydro electrolyte balance, and body cell mass, obtained from the parameters resistance (R) and capacitive reactance (Xc), through the application of an alternating electric current at multi-frequency at 5, 20, 50, 100 and 200 kHz [5]. Once R and Xc are obtained, the phase angle (PhA) can be calculated by the following equation: arc tangent (Xc/R) (180/π); this BIA indicator is useful in the clinical prognosis of patients with various pathologies .

During febrile illnesses such as vector-associated febrile syndrome (VAFS), cell membrane damage causes changes in the water volumes of each body compartment, resulting in alterations in BIA parameters such as intracellular water (ICW), extracellular water (ECW), PhA and the 5kHz/200kHz ratio . Some VAFS, such as dengue, zika, can result in severe febrile syndromes leading to death if not intervened early, especially in patients with altered water and electrolyte status. At this point, BIA can be useful for detecting severe febrile syndromes with the advantage of being a noninvasive, speedy, and inexpensive technique. Therefore, the BIA can be a tool for performing triage in the emergency room.

OBJECTIVES

Evaluate the ability to predict Vector-Associated Febrile Syndrome by Bioelectrical impedance analysis parameters.

METHOD



Graphic of methodology used to capture healthy controls and patients in the emergency room

RESULTS

	VAFS		Healthy controls	
Characteristics	**n**	**Mean**	**n**	**Mean**
Age (years)	23	37.9 ± 12.3	23	36.3 ± 9.1
Weight (kg)		72.41		73.53
Height (cm)		163.17		157.69
BMI (kg/m²)		27.07 ± 5.26		27.86 ± 7.5
Fat mass (%)		31.38 ± 9.2		32.09 ± 7.9
Muscle mass (kg)		24.49 ± 4.5		21.93 ± 4.9
Total water (L)		34.28 ± 5.3		33.60 ± 6.0
Fat-free water (L)		30.63 ± 4.9		29.96 ± 5.5
Extracelular water (%)		42.99 ± 3.4		41.85 ± 1.6
Intracelular water (%)		57.63 ± 1.4		58.14 ± 1.6
Phase angle at 50 kHz (°)		5.9 ± 0.62		6.7 ± 0.64
Impedance at 5 kHz (Ohms)		0.661 ± 113		0.733 ± 96
Impedance at 20 kHz (Ohms)		0.625 ± 105		0.689 ± 93
Impedance at 50 kHz (Ohms)		0.587 ± 97		0.640 ± 93
Impedance at 100 kHz (Ohms)		0.559 ± 94		0.610 ± 90
Impedance at 200 kHz (Ohms)		0.538 ± 88		0.584 ± 89
5kHz/200kHz impedance ratio		0.783 ± 0.15		0.787 ± 0.02

Table 1. Body composition characteristics of patients and healthy controls, obtained by BIA

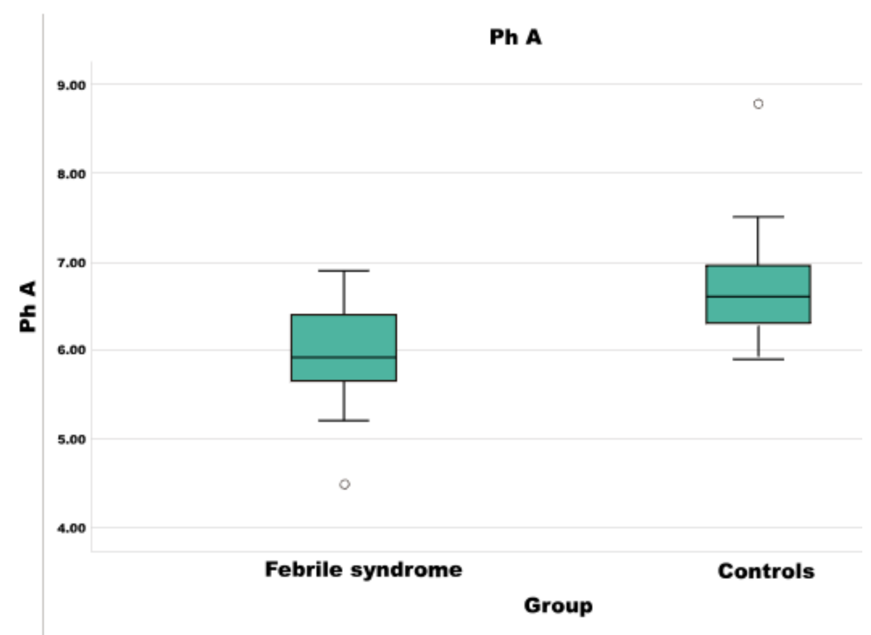


Fig. 1. Phase angle (PhA) of the febrile syndrome group and healthy controls group obtained through BIA

BIA parameters	p
Male	1.0
Female	1.0
Age (years)	0.657
Weight (kg)	0.836
Height (cm)	0.285
BMI (kg/m2)	0.680
Fat mass (%)	0.779
Muscle mass (kg)	0.075
Total water (L)	0.688
Fat-free water (L)	0.666
ECW (%)	0.158
ICW (%)	0.269
50PhA (°)	**< 0.001***
Impedance at 5 kHz (Ohms)	0.316
Impedance at 20 kHz (Ohms)	0.299
Impedance at 50 kHz (Ohms)	0.594
Impedance at 100 kHz (Ohms)	0.504
Impedance at 200 kHz (Ohms)	0.718
5kHz/200kHz impedance ratio	0.911

Table 2. p-value. Comparison of BIA parameters between groups (Student t-test)

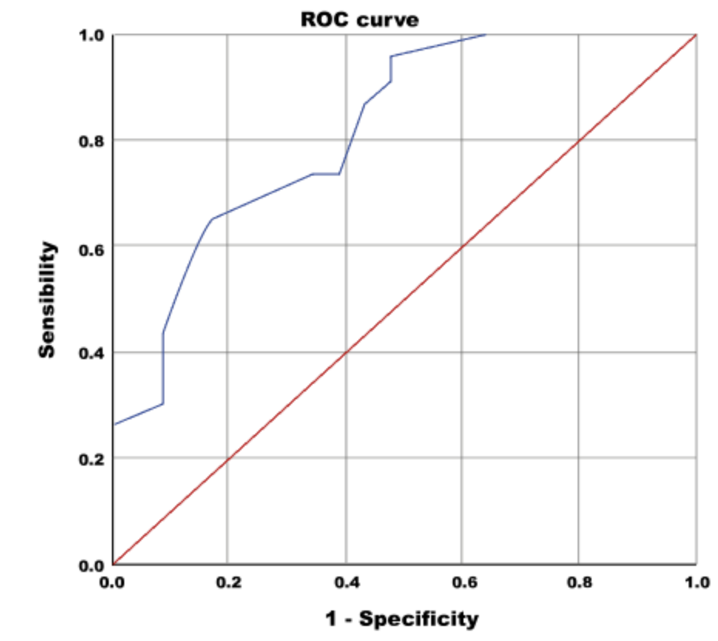


Fig. 2. The phase angle at 50 kHz between VAFS patients and healthy controls was the only variable that showed statistically significant differences in the analysis with Student's T-test. AUC: PhA = 0.818

BIA parameters	p	OR
Muscle mass (kg)	**0.016***	0.430
Fat-free water (L)	**0.042***	1.544
50PhA (°)	**0.004***	40.030

Table 3. P-value and OR of BIA parameters between groups (logistic regression model)

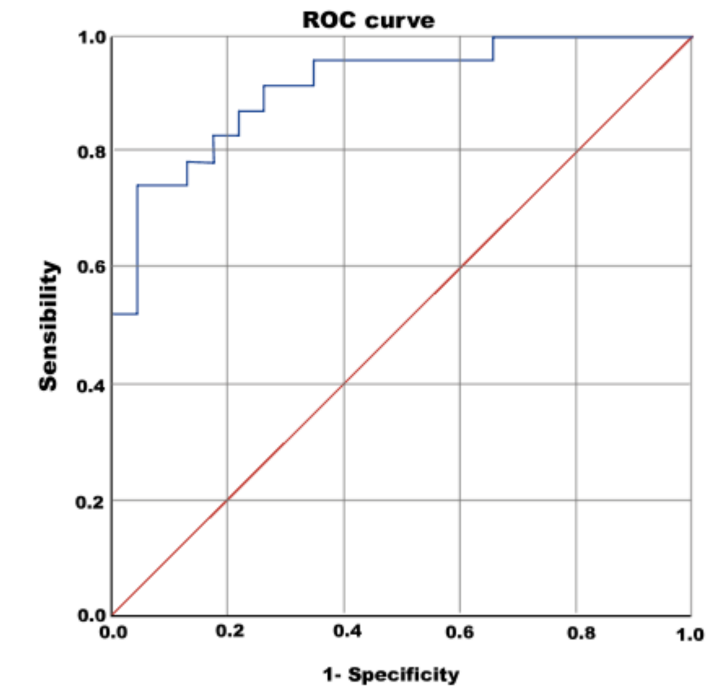


Fig. 3. The PhA value of ≤ 5.9 was the cut-off point for predicting severe VAFS. The predictive model included muscle mass, fat-free water and PhA, obtained an AUC = 0.913.

DISCUSSION

Bioelectrical impedance measurement is fast, easy-to-use, noninvasive, and low-cost, that offers an assertive body composition assessment that is critical in the diagnosis and evaluation of different pathologies and alterations of celular water giving an acceptable potential in the prediction of severe cases during the diagnosis of VAFS. The cut-off point of PhA obtained by Cornejo-Pareja et al. for non-surviving COVID-19 is lower than that obtained in this study for severe VAFS. PhA was measured directly in the present study, and we found differences between the control and cases. This may mean that direct measurement helps discriminate pathological states without standardizing the PhA with a control group. Considerable evidence has shown that phase angle is an independent prognostic factor for diagnosing acute and chronic disease and monitoring and predicting clinical outcomes of severity or risk of death. In the case of VAFS.

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