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Phase Angle and Cardiovascular Risk Factors in University Students

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Abstract. Bioelectrical impedance analysis (BIA) is an easy, safe, inexpensive and noninvasive method to evaluate body composition. Moreover, it allows the assessment of phase angle (PA), a biomarker reflecting cellular stability and hydration, which is also useful to assess nutritional status as well as a prognostic marker of clinical conditions and disease progression monitoring. The aim of this study is to determine the relationship between PA and cardiovascular risk factors in students at the University of Health of the State of Mexico. Body mass index (BMI), waist-to-hip ratio (WHR), waist circumference (WC), glucose, cholesterol, triacylglycerols, systolic and diastolic blood pressure (SBP and DBP) were considered risk factors. Ninety-seven students (18 males and 79 females) with an average age of 21 years from the bachelor's degrees of Medicine, Nursing, Physiotherapy and Gerontology were included in this study. The results show that the mean PA was higher in men than in women, and a normal range was identified according to the cut-off points for healthy adult population. Men and women with overweight were found by BMI. On the other hand, statistically significant differences were seen between men and women in triacylglycerols levels and WHR. Finally, PA presented a statistically significant positive correlation with triacylglycerols levels ($r=0.255$, $p=0.12$) and WHR ($r=0.248$, $p=0.014$). Therefore, there are cardiovascular risk factors related to PA, this biomarker may be a predictor of cardiovascular risk in apparently healthy young adults.

Keywords. Phase angle, cardiovascular risk factors, university students.

1 Introduction

Cardiovascular diseases cause approximately two-thirds of deaths worldwide, 80% of which occur in low- and middle-income countries [1]. In this way, cardiovascular risk factors have been found to be increasingly common in young adults and they can be manifested as high blood pressure, high blood glucose, hyperlipidemia, overweight, and obesity [2].

These cardiovascular risk factors can be related to lifestyle such an inadequate diet, physical inactivity, tobacco use, and harmful alcohol use [3].

In this case, bioelectrical impedance analysis (BIA) is an easy, safe, inexpensive and noninvasive method to use in clinical practice to assess body composition [4,5]. BIA provides reliable information about bioelectrical parameters like a phase angle (PA), which is the most accurate parameter from BIA which reflects nutritional status and body composition, and it has been associated with changes on cellular membrane integrity and alterations on fluid balance [6,7].

PA is an important screening tool used to identify patients at risk of the deterioration of their nutritional status, their functionality and their prognosis of mortality [8]. In fact, PA is directly proportionate to a system's reactance (Xc) and resistance (R) and lower PA values can be associated with selective membrane permeability, cell death and the worsening of disease. In

Table 1. Characteristics of university students

Characteristics	Men	Woman	*p*- value*
	Mean (SD)	Mean (SD)	
n (%)	18 (18.6)	79 (81.4)	
Age (years)	20.7 ± 1.6	20.8 ± 2.0	0.755
BMI (kg/m^2)	25.2 ± 4.6	25.0±3.9	0.816
Waist circumference (cm)	87.8 ± 10.6	83.7 ± 11.0	0.160
Hip circumference (cm)	99.7± 9.6	98.9 ± 8.7	0.745
WHR	.87 ± 0.03	.84 ± 0.05	**0.017**
PA (°)	7.7± 0.50	6.8 ± 0.50	**<0.001**
SBP (mmHg)	111.6 ± 8.0	104.0 ± 9.8	**0.003**
DBP (mmHg)	79.7 ± 9.1	73.7 ± 9.3	**0.016**
Glucose (mg/dl)	95.5 ± 10.6	94.8 ± 12.4	0.833
Cholesterol (mg/dl)	196.6 ± 32.8	200.5 ± 210.1	0.937
Triacylglycerols (mg/dl)	140.8 ± 62.9	111.4 ± 46.4	**0.026**

*Student *t* test, BMI: body mass index, WHR: waist-to-hip-ratio, PA: phase angle, SBP: systolic blood pressure, DBP: diastolic blood pressure

Table 2. Phase Angle Correlations (Pearson)

PA (°)	r	*p*-value*
Triacylglycerols (mg/dl)	0.255	**0.012**
WHR	0.248	**0.014**

*Pearson correlation, WHR: waist-to-hip-ratio, PA: phase angle

contrast, higher PA values represent greater amount of intact cell membranes and body cell mass and therefore adequate state of health [9]. Currently, this PA has gained interest in clinical research and health care, especially in young populations such as university students as a prognostic marker and disease progression monitoring [7,10,11]. The objective of this study was to determine the relationship between PA and cardiovascular risk factors in university students.

2 Material and Methods

In this cross-sectional study, 97 university students were involved (79 women and 18 men with an average age between 18 and 35 years) from the bachelor´s degrees of Medicine, Nursing, Gerontology and Physiotherapy undergraduate programs of the University of Health of the State of Mexico.

Anthropometric evaluation included standardized measures of weight, height, and body mass index (BMI). The last was calculated and categorized according to the WHO recommendations using height and gender as <18.5: underweight; 18.5-24.9: normal; 25-29.9: overweight; and ≥30.0: obese [12]. Waist-to-hip ratio (WHR) was calculated with a tape measure at the level of the umbilicus and of the hip circumference with the measuring tape around the greater trochanter. The equation to compute WHR was: WHR= Waist Circumference/ Hip Circumference. Participants were categorized according to their WHR as 'normal' (WHR<0.85 for women; <0.90 for men) or 'abdominally obese' when WHR was greater than 0.85 for women or 0.90 for men [13].

However, central-obesity was defined by waist circumference ≥ 80 cm for females, and ≥ 90 cm for males according to the International Diabetes Federation criteria (IDF) [14]. Body Composition was determined through bioelectrical impedance using a Biody XpertZM® apparatus (Aminogram SAS, La Ciotat, France) and data was stored in the Biody Manager® software (Aminogram SAS, La Ciotat, France). Phase angle (in degrees)

was calculated as follows: arctan Xc (reactance, ohms) / R (resistance, Ohms)* (180/π). We considered phase angle reference values between 6-7° in healthy population both genders [15].

In the baseline assessment, a fasting venous blood sample (fasting time ≥8 hours) was collected for each participant and biochemical test were evaluated using the following Spinreact kits: Glucose-LQ Ref.41012, Cholesterol-LQ Ref.41021 and Triacylglycerols -LQ Ref.41033), respectively; glucose, cholesterol and triacylglycerols. Altered serum concentrations were classified according to these criteria: glucose ≥100 mg/dl, total-cholesterol: ≥200 mg/dl and triacylglycerols: ≥150 mg/d. In addition, blood pressure was measured using a digital sphygomanometer.

High Systolic Blood Pressure (SBP) and High Diastolic Blood Pressure (DBP) were defined as ≥140 mmHg and/or ≥90 mmHg, respectively. This study was approved by the Institutional Ethics Committee of the University and informed consent was obtained from all participants.

Participant characteristics were compared by sex, presented as mean and standard deviations (SD) for quantitative variables and percentages for categorical variables.

Students t test was used to compare means. Pearson's correlation coefficients were calculated for relationships between phase angle and other variables. Statistical analyses were performed with SPSS 21.0 software and p values <0.05 were considered statistically significant.

3 Results and Discussions

There were a statically significant differences by sex in SBP (p=0.003) and DBP (p=0.016). Generally, men had a higher waist circumference (p=0.160), WHR (p=0.017), PA (p=<0.001), and triacyclglycerols (p=0.026) than women, whereas women had a higher cholesterol (p=0.937).

The differences observed between PA by gender could be explained, mainly due the important anatomical and functional differences regarding the detected muscle and adipose tissue distribution. Different studies have shown that the regional distribution of adipose tissue is the main factor that establishes the correspondence between adiposity and cardiometabolic risk [16, 17].

In this study population, overweight was identified considering BMI, this aspect is concerning because Malta et.al, states that each augmented BMI unit represents a raise in the probability of future coronary events, and this association worsens even more with aging [18].

On the other hand, central obesity was found in women by measuring waist circumference, similar findings were observed in a cohort study conducted in Texas from 2007 to 2010 with Hispanic adolescents.

The study reported a high prevalence of cardiovascular risk factors that included obesity, altered waist circumference and high blood pressure [19]. Additionally, in our investigation, women had higher cholesterol than men. However, these values are borderline, this result agreed with data from Morales, et. al. [20], in this study, university women had higher hypercholesterolemia prevalence than men.

The normal PA mean value was observed in this university students. Espinosa-Cuevas et. al. [21] conducted an analysis of BIA in 439 healthy subjects with a BMI>18 and <31 kg/m^2 that showed a mean PA of 7.3±0.9 in men and 6.4±1.0 in women, these results were similar in our investigation. It is important to mention that efforts have been made to established cut-off points of PA to study population characteristics.

Furthermore, we found a statistically significant positive correlation between PA and triacylglycerols (r= 0.255, p=0.002) in this population. Longo et. al. [22], also observed a positively correlation between these variables in a healthy adult population, where PA was analyzed by BIA. Barrea et. al. [23], reported in a study carried out with adults with and without psoriasis a direct association between PA and waist circumference, SBP and DBP, glucose, HDL-C, and triacylglycerols.

They also have shown the correlation between PA and WC, in contrast to our study, which WHR was correlated with PA (r= 0.255, p=0.002). This finding seems to be particularly interesting because WHR is positively associated with the risk of cardiovascular events [24,25]. However, further studies are needed to explain this result.

4 Conclusion

In conclusion, there are cardiovascular risk factors that are related to PA like high triacylglycerols levels and WHR in this apparently healthy adult population.

Therefore, PA determined by BIA could be a potential marker for the assessment of cardiovascular risk in young adults.

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