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Upper-Body Muscular Endurance and Its Association with Aerobic Capacity in University Students of Physical Culture, Sport, and Recreation

Fuerza resistencia de miembros superiores y su asociación con la capacidad aeróbica en universitarios de cultura física, deporte y recreación

Resistência Muscular do Corpo Superior e sua Associação com Capacidade Aeróbica em Estudantes Universitários de Cultura Física, Esporte e Recreação

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ABSTRACT

Introduction: Upper-body muscular endurance (UBME) and aerobic capacity (AC) are essential components of physical fitness. Low levels of these components are related to cardiovascular disease. **Purpose:** To assess the association between UBME and AC levels in college students of physical culture. **Methodology**: Analytical cross-sectional study carried out in 192 students (169 men, 23 women; median age 20 years). Every participant of the study signed written consent. UMBE was the dependent variable assessed by the push-up test, and AC was the main independent variable assessed using the 20 m shuttle run test. To analyze differences by sex, and academic semester, Fischer exact, Student's T, and U Mann-Whitney tests were applied. Descriptive, as well as bivariate and multivariate analysis, were realized using logistic regression models. **Results:** 82.29 % of participants had healthy levels of UBME. Respecting the academic semester, students had a higher probability of having healthy levels of UBME as semesters increased (OR: 1.23, 95 % CI: 1.06 to 1.44, p = 0.007). Concerning AC, 58.33 % of participants registered healthy levels. After adjusting by sex, age, socioeconomic level, and academic semester, maximum oxygen consumption (VO_2max), was associated with healthy levels of UBME (OR: 1.157, CI 95 %: 1.O71 – 1.249, p=<0.001). **Conclusions:** Students had a higher probability of presenting healthy levels of UBME as semesters of study increased, and those with a higheVO$_2$max were more likely to have healthy levels of UBME.

Keywords: Exercise test, physical endurance, physical fitness, student health

RESUMEN

Introducción: La fuerza resistencia de miembros superiores (FRMS) y la capacidad aeróbica (CA) son componentes esenciales de la condición física. Bajos niveles de estos componentes están relacionados con la enfermedad cardiovascular. **Propósito:** El objetivo de este estudio fue evaluar la asociación entre los niveles de FRMS y la CA en estudiantes universitarios de cultura física. **Metodología**: Estudio transversal analítico realizado en 192 estudiantes (169 hombres, 23 mujeres; mediana de edad, 20 años). Cada participante firmó el consentimiento informado. FRMS fue la variable dependiente y se valoró con la prueba de flexiones de brazo, y la CA fue la variable independiente y se evaluó usando la prueba de ida y vuelta de 20 m. Para analizar las diferencias por sexo y semestre académico, fueron utilizadas las pruebas exacta de Fischer, T de Student y U de Mann-Whitney. Se realizaron análisis descriptivos, bivariados y múltiples, usando modelos de regresión logística. **Resultados:** El 82.29 % de los participantes registraron niveles saludables de FRMS. Respecto al semestre académico, se evidenció una probabilidad más alta de tener niveles saludables de FRMS al incrementarse los semestres de estudio (OR: 1.23, 95 % CI: 1.06 to 1.44, p = 0.007). En lo concerniente a la CA, el 58.33 % de los participantes registro niveles saludables. Después de realizar ajustes por sexo, edad, nivel socioeconómico y semestre académico, el consumo máximo de oxígeno (VO_2máx), estuvo asociado con niveles saludables de FRMS (OR: 1.157, CI 95 %: 1.O71 – 1.249, p=<0.001). **Conclusiones:** Los participantes presentaron una mayor probabilidad de tener niveles saludables de FRMS, a medida que incrementaron los semestres de estudio, y aquellos con niveles de VO_2máx más alto, fueron más proclives a tener niveles saludables de FRMS.

Palabras clave: Aptitud física, prueba de esfuerzo, resistencia física, salud del estudiante

RESUMO

Introdução: A resistência muscular do corpo superior (UBME) e a capacidade aeróbica (AC) são componentes essenciais da aptidão física. Baixos níveis desses componentes estão relacionados a doenças cardiovasculares. **Propósito:** Avaliar a associação entre os níveis de UBME e AC em estudantes universitários de cultura física. **Metodologia:** Estudo transversal analítico realizado com 192 estudantes (169 homens, 23 mulheres; idade média 20 anos). Todos os participantes do estudo assinaram consentimento por escrito. UBME foi a variável dependente avaliada pelo teste de flexão de braço, e AC foi a principal variável independente avaliada pelo teste de corrida de vaivém de 20 m. Para analisar diferenças por sexo e semestre acadêmico, foram aplicados testes exatos de Fischer, t de Student e U de Mann-Whitney. Análises descritivas, bivariadas e multivariadas foram realizadas usando modelos de regressão logística. **Resultados:** 82,29 % dos participantes apresentaram níveis saudáveis de UBME. Respeitando o semestre acadêmico, os estudantes tiveram uma probabilidade maior de ter níveis saudáveis de UBME conforme os semestres aumentavam (OR: 1,23, IC 95 %: 1,06 a 1,44, p = 0,007). Em relação à AC, 58,33 % dos participantes registraram níveis saudáveis. Após ajuste por sexo, idade, nível socioeconômico e semestre acadêmico, o consumo máximo de oxigênio (VO2max) foi associado a níveis saudáveis de UBME (OR: 1,157, IC 95 %: 1,071 – 1,249, p <0,001). **Conclusões:** Os estudantes tiveram uma probabilidade maior de apresentar níveis saudáveis de UBME conforme os semestres de estudo aumentaram, e aqueles com um VO2max mais alto tiveram maior probabilidade de ter níveis saudáveis de UBME.

Palavras-chave: Aptidão física, resistência física, saúde do estudante, teste de esforço

Introduction

According to the World Health Organization (WHO), non-communicable diseases (NCDs) are responsible for 71% of the deaths that occur in the world, representing the leading cause of mortality globally. Cardiovascular diseases (CVD) are the cause of most deaths from NCDs (17.9 million deaths each year). The WHO has identified four modifiable behavioral risk factors that increase the risk of NCDs: tobacco use, unhealthy diet, harmful alcohol consumption, and physical inactivity (World Health Organization, 2018a).

According to the WHO, even though the scientific literature has shown that regular physical activity (PA) has essential health benefits, in the world, a quarter of the adult population and 81% of the adolescent population present physical inactivity (World Health Organization, 2020). The WHO global recommendations for PA for health stipulates that when an adult performs a "minimum of 150 minutes of moderate-intensity physical activity, or 75 minutes of vigorous-intensity physical activity, or an energy expenditure equal to or greater to 600 MET-minute-week has adequate levels of physical activity" (World Health Organization, 2022, p.3). Low levels of PA represent a negative impact on physical fitness (Collings *et al.*, 2017; Miko *et al.*, 2020; Myers *et al.*, 2019).

Physical fitness is an ability to execute daily functional activities with optimal performance, endurance, and strength to manage minimalist of disease, fatigue, stress and reduced sedentary behavior (Kapoor *et al.*, 2022). Additionally, physical fitness constitutes a multidimensional construct because it is composed of four main components or attributes: aerobic capacity, musculoskeletal capacity, flexibility, and body composition (Proschinger *et al.*, 2022).

Aerobic capacity (AC) considered by some authors to be the most important component of physical fitness (Chauhan and Kumar, 2023 & Welk et al., 2011) is defined as the maximal capacity of the cardiorespiratory system to supply energy to the skeletal muscles during sustained PA and to discard the products of fatigue (Caspersen *et al.*, 1985; Myers *et al.*, 2019).

Extensive scientific evidence has determined that low levels of this crucial component of physical fitness are associated with all-cause mortality, high risk of CVD, and death rates attributed to some types of cancer (Angström *et al.*, 2020; & Ross et al., 2016). The AC has been analyzed in the Latin American university population. A study carried out in a Chilean university determined that 60.89% of the sample registered a low level of this component (Carrasco *et al.*, 2014).

Another study carried out in Colombian and Mexican university students concluded that both groups did not have healthy AC levels (Pereira-Rodríguez *et al.*, 2018). In Peru, a study found that 40.9% of women and 35.6% of men achieved optimal results in the evaluation of cardio-respiratory resistance (Suazo-Fernández and Fernández-Dávila, 2017).

The low levels of AC established in these studies may be related to the high levels of physical inactivity of the university population widely reported in the scientific literature, which considers college students as a vulnerable population because, in general, they have a higher prevalence of behavioral risk factors associated with NCDs than the general population (Rangel-Caballero *et al.*, 2017).

Regarding musculoskeletal capacity, the IOM stipulates that it is a multidimensional construct that encompasses three related components: muscle strength, explosive strength, and endurance strength (Institute of Medicine, 2012). In the specific case of endurance strength, the IOM defines this concept as "the ability of a muscle or muscle group to perform repeated contractions against a constant external load for a prolonged period" (Institute of Medicine, 2012, p.155).

Push-up (PU) test has been widely used to assess upper body muscular endurance (UBME), two studies carried out in adolescents established that high levels of UBME were associated with low cardiometabolic risk (Agostinis-Sobrinho *et al.*, 2017; Burns and Brusseaud, 2016). At the university population, the PU test has been used in two studies to assess Brazilian and Chilean university students. In the case of the study, carried out in Brazil, 62% of the participants presented low levels of UBME (Corseuil and Petroski, 2010) Regarding the study carried out in Chile, performed on physical education students, the conclusion was that the levels of UBME decreased as the university studies progressed (Durán *et al.*, 2014).

The scientific literature has established a positive association between the maximum oxygen consumption (VO2max.) and the number of PU performed in physically active men (Yang *et al.*, 2019).

In the local context, a study established that the entire population (physical culture students), was physically active and had significantly higher average minutes of PA than those from other university programs (Rangel-Caballero *et al.*, 2015). In light of these results, assessing AC and UBME is the starting point to establish whether the values reported in terms of minutes of weekly PA in the previous study, by the population of university students of physical culture, sports and recreation reflect healthy levels of the different components of physical fitness. Knowing the levels of AC and UBME will

be crucial to determine whether future professionals in physical culture have healthy physical fitness levels.

This information is a fundamental aspect for the future exercise of their profession, considering the role in the implementation of policies aimed at promoting healthy lifestyles based on PA (Guerreiro-Scabar *et al.*, 2012), after all, they will have the mission of promoting healthy lifestyle habits, not only in the general population (Sánchez-Ojeda and Luna-Bertos, 2015), but also in the school context (Durán *et al.*, 2014). Considering this, the objective of this study was to establish the association between UBME and AC levels in university students of physical culture, sports, and recreation.

Methodology

An analytical cross-sectional study carried out on 192 students, between 18 and 24 years of age, from the Physical Culture, Sports, and Recreation Program of a private university in Bucaramanga, Colombia. The Research Committee of the Physical Culture, Sports, and Recreation Program approved this study (Acta N° 4,Abril 2017) . A convenience sampling was carried out, and a total of 247 students enrolled in the second academic period of 2017, finally, this study included a total of 23 women and 169 male students of legal age, who did not report cardiovascular, musculoskeletal, or metabolic risk through the questionnaire Par-Q (Shephard, 1988) and who voluntarily agreed to participate by signing the informed consent. Pregnant students did not participate in this study.

On the assessment day, firstly, participants signed the informed consent filled in the Par-Q questionnaire. After reviewing the necessary documentation and meeting the eligibility criteria, participants carried out a 15-minute general warm-up, which included joint mobility exercises, cardiovascular activation, and stretching. After the warm-up, the UBME and the AC were evaluated. Three professors from the Physical Culture, Sports, and Recreation Faculty applied the tests carried out in the facilities of the university with the supervision of the nursing staff of the Institution.

UBME was the dependent variable for this study assessed by the PU test since it does not require equipment and its demonstrated validity as well as reliability in university students (Meredith and Welk, 2007). For this assessment, the students assumed a prone position on the mat with their hands positioned below or slightly more open than the shoulders, the legs extended and slightly apart. To start, the students had to have their arms outstretched, their backs straight, and both men and women had the toes as a point of support, keeping their knees extended. From that position, the

participants performed the PU (as many repetitions as possible until fatigue) up to a 90 ° elbow joint angle, following a rate of 20 repetitions per minute, that is, one PU every three seconds. The criteria established in the Fitnessgram® battery administration manual was followed to assess and classify the levels of UBME as a dichotomous variable (Healthy zone / Needs improvement) (Meredith and Welk, 2007). Additionally, the number of PU or repetitions performed was arbitrarily divided into five categories (0 - 10, 11 - 20, 21 - 30, 31 - 40, ≥41) (Yang *et al.*, 2019).

AC was the main independent variable assessed using the 20-meter shuttle run test. This procedure implied that each participant, ran 20 meters in two directions, round trip, touching the baseline (located at the end of each end) at the same time as the sound signal emitted for a recording. The frequency of the sound signals increased by 0.5 km / h^{-1} every minute, starting with a speed of 8.5 km / h^{-1}. The test ended when the participant was unable to touch the line twice in a row before the signal or when he wanted to leave due to fatigue (Leger *et al.*, 1988). The last stadium or minute completed by participants defined AC determined as a continuous variable through the maximum oxygen consumption (VO_2max.) expressed in ml/kg^{-1}/min^{-1} and obtained through the Leger equation (Leger *et al.*, 1988) as a dichotomous variable considering the Fitnessgram® criteria (Meredith and Welk, 2007).

This study also analyzed other sociodemographic variables such as sex, age, socioeconomic level, and the current academic semester.

This study was conducted according to the Declaration of Helsinki of the World Medical Association (World Medical Association, 2013) and the Colombian Resolution 8430 de 1993 (Ministerio de Salud de la República de Colombia, 1993). Therefore, participants authorized participation in this study through the signing of the informed consent, which communicated the objective, the procedures to be carried out, voluntary participation, and the confidentiality of the data. Additionally, participants were identified by codes in the database.

Data Analysis

This study analyzed descriptive characteristics of participants, describing categorical variables using frequencies and percentages and in the case of continuous variables, depending on the distribution of the data, established by the Shapiro Wilk test, variables that presented a normal distribution were described with the mean and standard deviation and in those that did not present a normal distribution, the median and the interquartile range were reported. To determine a statistically significant

difference according to sex and academic semester, Fisher's exact, Student's T, and Mann-Whitney's U tests were used. Bivariate analyzes were performed between the UBME and each of the independent variables, and those that presented values of p <0.20 entered the multivariate models. Logistic regression models were used, using the dependent variable, such as dichotomous (Healthy zone/Needs improvement) to establish the factors associated with the outcome of interest in this study. The data taken from the information collected through the described procedures were entered into an Excel database, which was exported to the (Stata/SE16 Perpetual License) statistical program to generate the results.

Results

Most of the participants correspond to the male sex, they report a medium socioeconomic level, and they were studying the first part of the physical culture, sports, and recreation degree. The median age of students was 20 years (IR: 18 - 22) (Table 1).

Table 1
General characteristics of the study population (n = 192)

Characteristics	N	%
Sex		
Man	169	88.02
Woman	23	11.98
Socioeconomic level		
High	8	4.16
Medium	160	83.33
Low	24	12.50
Academic Semester		
First to fifth	126	65.63
Sixth to tenth	66	34.38
	Median/ Mean†	**IR/SD†**
Age	20	18 - 22
Upper-body muscular endurance (Number of push-ups)	24	18 - 33
Aerobic capacity (stadiums or minutes)	7.52†	2.06†
VO_2max (ml/kg^{-1}/min^{-1})	43.38†	6.26†

Notes. IR: Interquartile Range, SD: Standard deviation

Most of the participants had healthy levels of UBME. Regarding sex, no statistically significant difference was found. Regarding the number of repetitions, men performed more than women with a statistically significant difference. Concerning the academic semester, students from the sixth to the tenth semester registered healthier levels of UBME than their peers from the first to the fifth semester with a statistically significant difference (Table 2).

Additionally, a greater probability of having healthy levels of UBME was established as the academic semester increases (OR: 1.23, 95% CI: 1.06 to 1.44, p = 0.007).

Table 2

Upper-body muscular endurance stratified by sex and academic semester in students of physical culture, sport, and recreation (n = 192)

Component	Total n (%) o Median [IR]	Women n (%) o Median [RI]	Men n (%) o Median [IR]	P value
Upper-body muscular endurance (Number of push-ups)	24 [18 - 33]	17 [10 - 20]	26 [20 - 35]	0.0002
Upper-body muscular endurance *				
"Healthy Zone"	158 (82.29)	21 (91.30)	137 (81.07)	0.182
"Needs improvement"	34 (17.71)	2 (8.70)	32 (18.93)	
Upper body muscular endurance (Number of push-ups)				
0 – 10	15 (7.81)	7 (30.43)	8 (4.73)	<0.001
11 – 20	62 (32.29)	14 (60.87)	48 (28.40)	
21 – 30	57 (29.69)	2 (8.70)	55 (32.54)	
31 – 40	29 (15.10)	0 (0)	29 (17.16)	
≥41	29 (15.10)	0 (0)	29 (17.16)	
Component	**Total n (%) o Median [IR]**	**First to fifth semester n (%) or Median [IR]**	**Sixth to tenth semester n (%) or Median [IR]**	**P value**
Upper-body muscular endurance (Number of push-ups)	24 [18 - 33]	23 [17 - 33]	25.5 [20 - 33]	0.0662
Upper-body muscular endurance *				
"Healthy zone"	158 (82.29)	97 (76.98)	61 (92.42)	0.005
"Needs improvement"	34 (17.71)	29 (23.02)	5 (7.58)	

Upper-body muscular endurance (Number of push-ups)				
0 – 10	15 (7.81)	10 (7.94)	5 (7.58)	
11 – 20	62 (32.29)	47 (37.30)	15 (22.73)	
21 – 30	57 (29.69)	30 (23.81)	27 (40.91)	0.126
31 – 40	29 (15.10)	20 (15.87)	9 (13.64)	
≥41	29 (15.10)	19 (15.08)	10 (15.15)	

Notes. Fitnessgram® Criteria (Healthy Zone women ≥7 repetitions, men ≥18); IR: Interquartile Range

Just over half of the participants registered healthy AC levels. The percentage of men with a healthy zone of AC levels was higher than that of women, but no statistically significant difference was found. Regarding the Vo2max, the men presented a higher significantly mean than that of the women. Regarding the academic semester, although the percentage of students from the first to the sixth semester with healthy AC levels was higher, no statistically significant difference was found (Table 3).

Table 3

Aerobic capacity stratified by sex and academic semester in students of physical culture, sport, and recreation (n = 192)

Component	Total n (%) or Mean [SD]	Women n (%) or Mean [SD]	Men n (%) or Mean [SD]	P value
Aerobic capacity (stadiums or minutes)	7.52 [2.06]	5.69 [1.459]	7.76 [2.017]	**<0.001**
Aerobic capacity (stadiums or minutes)				
1 – 3	6 (3.12)	2 (8.69)	4 (2.36)	
4 – 6	48 (25.00)	12 (52.17)	36 (21.30)	**<0.001**
7 – 9	99 (51.56)	9 (39.13)	90 (53.25)	
10 – 12	39 (20.31)	0 (0)	39 (23.07)	
Vo2max (ml/kg^{-1}/min^{-1})	43.38[6.261]	37.95 [4.562]	44.12 [6.104]	**<0.001**
Aerobic capacity *				
"Healthy zone"	112 (58.33)	11 (47.83)	100 (59.17)	0.337
"Out of the healthy zone"	80 (41.67)	12 (52.17)	69 (40.83)	
Component	**Total n (%) or Mean [SD]**	**First to fifth semester n (%) or Mean [SD]**	**Sixth to tenth semester n (%) or Mean [SD]**	**P value**
Aerobic capacity (stadiums or minutes	7.52 [2.06]	7.63 [1.887]	7.30 [2.37]	**0.161**
Aerobic capacity (stadiums or minutes)				

1 – 3	6 (3.12)	1 (0.79)	5 (7.57)	
4 – 6	48 (25.00)	30 (23.80)	18 (27.27)	**0.291**
7 – 9	99 (51.56)	69 (54.76)	30 (45.45)	
10 – 12	39 (20.31)	26 (20.63)	13 (19.69)	
VO_2max (ml/kg^{-1}/min^{-1})	43.38[6.261]	43.79 [5.695]	42.58 [7.20]	**0.106**
Aerobic capacity*				
"Healthy zone"	112 (58.33)	77 (61.11)	35 (53.03)	0.281
"Out of the healthy zone"	80 (41.67)	49 (38.89)	31 (46.97)	

Notes. Fitnessgram® Criteria (Healthy Zone women ≥ 38.3 ml/ kg-1/min-1, men ≥44.1 ml/kg-1/min-1); SD: Standard Deviation.

After adjusting by sex, age, socioeconomic level, and academic semester, VO_2max was associated with healthy levels of UBME (Table 4).

Table 4

Association between upper-body muscular endurance and aerobic capacity in students of physical culture, sport, and recreation.

Characteristics	**OR Raw**			**OR adjusted by sex, age, socioeconomic level, and academic semester**		
Upper-body muscular endurance	**OR**	**CI 95%**	**P**	**OR**	**CI 95%**	**P**
Aerobic capacity (VO2max)	1.0902	1.024 – 1.160	0.046	1.1571	**1.071 – 1.249**	**<0.001**

Notes. CI: Confidence Interval

Discussion

This study allowed to establish not only UBME and AC levels in university students of physical culture, sport, and recreation, but it was also possible to determine a higher probability of having healthy levels of UBME as the academic semester increases and an association between UBME and maximum oxygen consumption. The analysis carried out in this study is very important in the educational context of the professional in physical culture, sport, and recreation, because its occupational profile is related to the assessment of physical fitness. Besides, it allows them to know whether they meet healthy standards in the analyzed components and raise awareness about maintaining adequate levels of physical fitness for future promotion in the work context.

Respecting UBME, 82.29% of the participating students registered healthy levels of this component of physical fitness. This number is higher than that established in a

study carried out in Brazilian university students, which determined that 38% of participants presented adequate levels of UBME (Corseuil and Petroski, 2010). A possible explanation for these differences is the high levels of weekly physical activity reported by students of physical culture, sport, and recreation that far exceed the figures of university students from other professional careers (Rangel-Caballero *et al.*, 2015), other studies carried out in Latin America confirmed this fact (Farinola *et al.*, 2012; Palma *et al.*, 2007; Pérez-Ugidos *et al.*, 2014).

The fact that most of the population participating in this study had healthy levels of UBME is a protective factor for their future health since scientific evidence indicates that levels of muscle strength are a significant predictor of weight gain over a period of 20 years (Mason *et al.*, 2007). Additionally, healthy levels of muscle strength in youth are inversely associated with cardiovascular disease and mortality from cardiovascular disease in middle age regardless of AC (Timpka *et al.*, 2014).

Regarding the number of PU performed, men had a significantly higher median of repetitions than that of the women, which is explained by hormonal factors that are the cause of sexual dimorphism that begins at puberty, remains throughout the life cycle, and determines higher levels of muscle strength in men than in women. Adult men have a higher lean and bone mass and lower fat mass than women. This difference in the whole body, between men and women, mentioned above, is even higher in the arms (Wells, 2007).

Respecting the academic semester, a higher probability of having healthy levels of UBME was established as the academic semester increases. This finding is contrary to what concluded a study carried out on Chilean physical education students, which determined that physical condition decreases as studies progress (Durán *et al.*, 2014). A possible explanation for the fact that students in sixth to tenth semesters present better levels of UBME could be the organization of the curriculum in the program. The subjects of deepening of the physical-sports area, like the methodology of strength training, could be a motivational aspect to carry out more physical activity of muscular strengthening.

Regarding AC, 58.33% of the participants in this study registered healthy levels. This result is superior to that established in Chilean university students, which determined that 39.11% of the participating population presented AC levels related to good health (Carrasco *et al.*, 2014). Concerning the maximum oxygen consumption (VO_2max.), the students of physical culture, sport, and recreation registered a mean of 43.38 (SD: 6.261) ml/kg-1/min-1. This number is higher than that determined in a comparative

study carried out in university students from Colombia and Mexico, which used the same test to assess AC and the same formula to estimate VO_2max., used in this study (Pereira-Rodríguez *et al.*, 2018).

The higher VO_2max registered by students of physical culture, sport, and recreation are explained in part, as mentioned above, by the high levels of PA reported by this population (Farinola et al., 2012; Palma *et al.*, 2007; Pérez-Ugidos *et al.*, 2014; Rangel-Caballero *et al.*, 2015). When comparing the results of this study with another one carried out in Chile on students of Physical Education Pedagogy, which assessed the AC through the minutes or stages completed in the 20-meter shuttle run test, very similar results can be observed (Durán *et al.*, 2014).

Concerning sex, the mean of VO_2max. of the participating men was higher than that of the women with a statistically significant difference. The fact described before is explained by the differences inherent in sex about the concentration of hemoglobin in the blood and body composition, which increases during puberty and adolescence and are partly linked to differences in reproductive hormones (Plowman and Meredith, 2013).

One of the most important findings of this study was to establish that students participating in this study who had a higher maximum oxygen consumption were more likely to present healthy levels of UBME. This finding is in line with the scientific literature that has been able to determine positive associations and correlations between the UBME and the AC (Mason *et al.*, 2007; Yang *et al.*, 2019).

A limitation of this study is its cross-sectional design; therefore, it was not established a causality of the analyzed variables, only an association.

In conclusion, almost all and a little more than half of the analyzed population registered healthy levels of UBME and AC, respectively. A higher probability of presenting healthy levels of UBME was established as semesters of study increased, and students with higher maximum oxygen consumption levels were more likely to have healthy levels of UBME.

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