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ORIGINAL

CARDIORESPIRATORY OPTIMAL POINT, BODY COMPOSITION AND BIOCHEMICAL MEASUREMENTS: A STUDY WITH TWINS

PUNTO ÓPTIMO CARDIORRESPIRATORIO, COMPOSICION CORPORAL Y MEDIDAS BIOQUÍMICAS: UN ESTUDIO CON GEMELOS

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ABSTRACT

The purpose of this study was to investigate the relationship of body composition and biochemical variables with the cardiorespiratory optimal point, as well as to observe the tendency of heritability. This is a descriptive study with a cross-sectional design with adult monozygotic and dizygotic twins. To obtain the COP values, the cardiopulmonary exercise test was performed using a treadmill ramp protocol. For body composition, dual energy absorptiometry and anthropometry were used. For inferences, the Spearman correlation and the Mann-Whitney hypothesis test were performed. The results showed that the body composition variables did not significantly correlate with the cardiorespiratory optimal point. The Cardiorespiratory Optimal Point and biochemical variablesdemonstrated a greater tendency to be influenced by environmental factors and the body composition variables showed a greater influence of heritability.

KEYWORDS: Cardiopulmonary exercise test. Heritability. Oxygen consumption. Body composition. Biochemical variables.

RESUMEN

El propósito de este estudio fue investigar la relación de la composición corporal y las variables bioquímicas con el POC, así como observar la tendencia de la heredabilidad. Estudio transversal con gemelos monocigóticos y dicigóticos adultos. Para obtener los valores del POC, la prueba de ejercicio cardiopulmonar fue realizada se realizó un protocolo con sobre cinta rodante. Para la composición corporal, se utilizaron la absorciometríade energía dual y la antropometría. Para las inferencias, se realizaron la concordancia de Spearman y la prueba de hipótesisMann-Whitney.Los resultados mostraron que lasvariables de composición corporal no se correlacionaron significativamente con el punto óptimo cardiorrespiratorio. El Punto Óptimo Cardiorrespiratorio y las variables bioquímicas en general demostraron una mayor tendencia a ser influenciados por factores ambientales. El comportamiento de las variables de composición corporal demostró una mayor influencia de la heredabilidad.

PALABRAS CLAVE: Prueba de ejercicio cardiopulmonar. Heredabilidad. Consumo de oxígeno. Composición corporal. Variables bioquímicas.

INTRODUCTION

In an environment of increased cardiovascular disorders, there is a need to investigate efforts to prevent and screen for cardiovascular risk factors. Exercise can act as a preventive strategy for the development or progression of heart disease, besides promoting a series of health benefits, such as control of obesity, hypertension, type 2 diabetes, and hypercholesterolemia, among others(Ekelund et al., 2012; Tarnoki et al., 2013). In addition, good cardiorespiratory fitness is a predictor of life expectancy in patients with or without heart disease(McKinney et al., 2016).

The cardiopulmonaryexercisetest(CPET) is a noninvasive procedure used to provide diagnostic and prognostic information, which assesses the individual capacity for dynamic exercise and provides relevant information for exercise prescription and performance assessment (Binder et al., 2008). Assessment protocols usually require the individual to perform a maximum effort to obtain different ventilatory data, such as maximal oxygen uptake (VO_2max), maximal oxygen pulse, anaerobic threshold , ventilatory equivalent of carbon dioxide (VE/VCO_2), and the curve generated by the ventilatory oxygen equivalent, among others(Calderón, Cupeiro, Peinado, & Lorenzo-Capella, 2020; Guazzi et al., 2016).

However, there are several limitations in the measurements of these variables, such as low reproducibility, different forms of calculation or identification, and the need to perform a truly maximum test, which depends on the motivation of both the evaluator and the individual being evaluated. Ramos et. al.(2012) proposed a variableto add prognostic value to a submaximal CPET, with particular utility in adults who are unable, or not motivated, to achieve maximum exercise, the CardiorespiratoryOptimal Point (COP). The COP is the moment when the minimum oxygen ventilatory equivalent (VE/VO_2) occurs. That is, it is the lowest value of this variable in a given minute of a CPET performed in a ramp protocol. The COP represents the best relation or integration between the respiratory and cardiovascular systems or ventilation-perfusion. In practice, the COP corresponds to the moment during the incremental exercise when there is the lowest ventilation to consume one liter of oxygen (Plínio S Ramos & Araújo, 2017).

Recent studies have shown the clinical applicability of the COP in diagnostic and prognostic assessments, as a submaximal variable of CPET, in athletes, healthy individuals, or those with various forms of chronic diseases (Abreu, 2017; Myers & de Araújo, 2018; Plínio S Ramos & Araújo, 2017; Plínio Santos Ramos, Sardinha, Nardi, & de Araujo, 2014). To date, the influence of genetic and environmental factors on COP is unknown, which could help in understanding and directing interventions and diagnoses through this variable. Moreover, the relationship of COP with body compositionand biochemicalvariables, used as indicators of cardiac risk or obesity in clinical practice and physical evaluations, has not yet been identified. Thus, the present

study aims to investigate the relationship of body composition and biochemical variables with COP, as well as to observe the tendency of heritability.

MATERIALS AND METHODS

Sample

The sample was obtained non-probabilistically from twins registered at the I Twin Festival of Rio Grande do Norte, held in 2016 at the Federal University of Rio Grande do Norte (UFRN), in partnership with the Brazilian Twin Registry(Ferreira et al., 2016).Individuals with physical disabilities or musculoskeletal limitations that prevented walking or running, subjects on obesity-related drug treatment, twins of different sexes, and individuals with positive responses to the Physical Activity Readiness Questionnaire (PAR-Q)were excluded from the study.

Given the exclusion criteria, a sample of 51 twin pairs was included (102 individuals, 72.5% females and 27.5% males), composed of 46 pairs of monozygotic twins (mean age 25.4 ± 5.69) and 5 dizygotic pairs (mean age 25.2 ± 3.74), all resident in the state of Rio Grande do Norte, Brazil (Cardoso-dos-Santos et al., 2018).

After signing the Informed Consent Form, an anamnesis questionnaire was applied to analyze health status and pre-existing diseases, and the PAR-Q to analyze readiness to perform physical activities. Zygosity in twins was determined using a validated zygosity questionnaire with 93.3% accuracy(Ooki & Asaka, 2004).

The study was approved by the Research Ethics Committee of the Onofre Lopes University Hospital, Natal/RN - Brazil. CEP/HUOL, CAAE 35573214.1.0000.5292, according to Resolution 466/12 of the National Health Council.

Physical assessment

The assessment of body composition was performed using Dual Energy X-ray Absorptiometry (DXA)(Mônica de Souza, Priore, & Sylvia do Carmo, 2009). Values of percentage of android fat distribution (%F android), percentage of gynoid fat distribution (%F gynoid), and percentage of total fat (%F total) were obtained. The following anthropometric measurements were evaluated: weight, height, waist circumference (WC), abdominal circumference (AC), and hip circumference (HC), and the body mass index (BMI)was calculated, according to the standardization from the International Society for Advancement in Kinanthropometry (ISAK)(Marfell-Jones, Olds, Stewart, & Carter, 2006).
The CPET was undertaken on a treadmill and expired gas analyses were carried out using a Cortex (Metalyzer® 3B) with a ramp protocol. Increments with progressive and continuous speed and inclination were applied, according to the individual capacity estimated for the subject, based on the American College of Sports Medicine (ACSM)(Thompson, Gordon, & Pescatello, 2009),

and seeking to reach the maximum oxygen consumption (VO_2max) in a test period of 8 to 12 minutes (Guazzi et al., 2016; Thompson et al., 2009). An initial velocity and inclination pattern was adopted for sedentary individuals of 3km/h and 0% inclination, and for physically active individuals of 4km/h and 0% inclination. In order for the individual to reach the maximum oxygen consumption predicted for age and sex, and according to their physical fitness, we used the following prediction formulas for speed and final inclination, considering sedentary trekking and active running (Thompson et al., 2009):

1- Trekking → VO_2 = Speed. 1.675+ 0.3015.Speed. Tilt +3.50;

2- Running → VO_2 = Speed. 3.35 + 0.15075. Speed. Tilt + 3.50

The COP is the minute in the CPET in which the minimum VE/VO_2 is recorded. In addition, othervariables related to this moment of the test were also analyzed, as follows: Time in which the COP occurred (Time);Metabolic Equivalent of Task (MET); Respiratory Exchange Rate Ratio (RER); Absolute Oxygen Consumption (VO_2 l/min^{-1}); and Relative Oxygen Consumption (VO_2 ml.kg^{-1}. Min^{-1}), referringtothemomentof COP.

Biochemicalanalysis

The biochemical examinations were performed at the Integrated Laboratory of Clinical Analysis, at the UFRN Faculty of Pharmacy, following the routine established at this service.On a day prior to the physical evaluation, the patients underwent venipuncture, after a 12-hour fast, to collect a peripheral blood sample without anticoagulant (10 mL) to determine the serum fasting glucose, total cholesterol, HDL cholesterol, and triglycerides. All dosages were performed using enzymatic-colorimetric assays and commercial kits (LabtestDiagnóstica-SA®) on Bio 2000 equipment (Bioplus®, Barueri/SP). The concentrations of LDL and VLDL cholesterol were obtained by applying the Friedewald formula(Friedewald, Levy, & Fredrickson, 1972).

Statistical analysis

Statistical analysis was performed using SPSS® version 20. For description of the data, the monozygotic (MZ) and dizygotic (DZ) twins were separated into A and B and arranged so that the former twin, A,presented a VO_2 max value (ml.kg^{-1}. min^{-1}) greater than or equal to twin B. The normality and homoscedasticity of the data distribution were verified by the Shapiro-Wilk test, and as the data presented non-parametric behavior, theyare described as median and interquartile range.

The sample was categorized according to COP without zygosity division, in which the group with COP <22 was categorized in a range with a low risk of all-cause mortality, the group with COP between 22-30 at a moderate risk, and, lastly, the group withCOP> 30 as the highest risk rating (Plínio S Ramos & Araújo, 2017). Intrapair agreement in the COP categories was also calculated by the Kappa test.

The Spearman correlation of the body composition and biochemical variables with the COP was calculated without dividing the sample.As an indicator of the influence of heritability, the Spearman intrapar correlation was verified in the MZ and DZ twins(Arden & Spector, 1997; Miyamoto-Mikami et al., 2018). For analysis of the correlations presented we used the Cohen parameter(Cohen, 1992), assuming r = 0.10 - 0.29 (weak correlation); r = 0.30 - 0.49 (moderate correlation)); r= 0.50 - 1 (strong correlation).For all analyzes a probability level of 5% was considered and the Mann-Whitney hypothesis test was used for the analysis.

RESULTS

Table 1 describes the characteristics of the MZ and DZ twins, respectively, in which it can be observed that there were no significant intrapair differences.
In tables 2, 3, and 4 the sample is categorized by the COP classification (Plínio S Ramos & Araújo, 2017), without the separation of siblings, in order to observe the behavior of the variables of the stress test, body composition, and biochemistry, in the risk categories. The <22 group is in a range with a low risk of all-cause mortality, and 22-30 in a moderate group. The third COP classification is above 30, however, no individuals in the sample of the present study were categorized in this classification. In this analysis, COP, METS, RER, and VO_2 ($ml.kg^{-1}.min^{1}$) were different between categories. In the Kappa test, only 23% (p = 0.04) of the twins were in the same COP categories.
Finally, the Spearman correlation was calculated for the COP of the total sample with the body composition and biochemical variables. Body composition measurements were not correlated with COP. Biochemical variables that demonstrated a relationship are as follows: HDL (r = 0.22; p = 0.03), LDL (r = -0.23; p = 0.02) , glucose (r = -0.29; p = 0.001); TG (r = - 0.22; p = 0.04). Table 3shows the intrapar correlations for MZ and DZ (Cohen, 1992).

Table 1. Description of the pair-separated monozygotic and dizygotic twins (A and B)

	Twin MZ A (N=45)		Twin MZ B (N=45)			Twin DZ A (N=5)		Twin DZ B (N=5)		
	Median	IQR	Median	IQR	p	Median	IQR	Median	IQR	p
Body Composition										
Weight (kg)	62.50	23.05	62.65	30.55	0.95	57.70	21.95	53.10	25.35	0.92
Height (m)	1.63	0.14	1.64	0.13	0.93	1.60	0.11	1.60	0.10	0.83
BMI (kg / m^2)	23.20	5.60	23.00	6.18	0.85	21.90	5.20	20.70	6.75	0.60
WC (cm)	73.00	14.75	72.50	19.00	0.98	71.00	14.25	65.60	17.75	0.53
AC (cm)	82.40	14.90	82.75	17.75	0.67	79.00	9.95	72.00	14.30	0.35
HC (cm)	95.50	13.25	94.00	16.13	0.94	96.50	9.15	92.00	13.60	0.40
%AF	27.2	17.7	30.9	17.5	0.24	22.60	14.35	30.20	9.35	0.25
%GF	34.70	14.30	35.30	13.15	0.26	32.20	17.55	36.60	11.15	0.75
%TF	29.90	12.85	32.10	10.80	0.14	27.60	13.85	31.10	9.80	0.46
CPET										
Time (hh: mm: ss)	00:02:20	00:01:12	00:02:00	00:01:20	0.93	00:02:00	00:01:05	00:02:50	00:02:40	0.60
COP	19.60	2.50	19.75	2.73	0.96	19.50	5.45	19.10	0.90	0.60
MET	4.10	0.80	3.80	1.55	0.19	4.70	1.15	4.60	1.30	0.35
RER	0.70	0.09	0.70	0.31	0.93	0.73	0.19	0.69	0.06	0.75
VO_2 (l/min^{-1})	0.89	0.32	0.89	0.40	0.65	0.87	0.79	0.85	0.37	0.75
VO_2 ($ml.kg^{-1}.\ min^{-1}$)	14.00	3.00	13.00	5.75	0.14	16.00	4.50	16.00	5.00	0.59
VO_2 max ($ml.kg^{-1}.\ min^{-1}$)	35.00	39.00	31.50	27.00	0.01	37.00	16.00	33.00	19.00	0.11
Biochemical measurements										
COL	162.00	46.00	162.00	48.00	0.67	173.00	40.50	181.00	36.50	0.75
HDL	42.00	27.00	38.00	27.00	0.54	43.00	11.00	39.00	9.00	0.34
VLDL	14.40	12.30	14.80	12.20	0.66	13.80	11.90	16.20	12.90	0.35
LDL	99.40	43.10	102.00	36.40	0.43	117.00	36.40	119.20	27.10	0.75
TG	76.00	66.00	74.00	62.00	0.81	69.00	59.50	81.00	64.50	0.35
GLI	86.00	14.50	87.00	17.00	0.78	83.00	17.00	91.00	15.50	0.92

Legend: IQR (interquartile range); BMI (Body Mass Index); WC (waist circumference); AC (abdominal circumference);); HC (hip circumference); % AF (percentage of android fat); % GF (percentage of gynoid fat); % TF (percentage of total fat); CPET (cardiopulmonary exercise test); COP (minimum VE/VO_2 in the exercise test); MET (Metabolic Equivalent of Task); RER (respiratory exchange rate ratio). COL (cholesterol Total); HDL (High Density Lipoproteins); VLDL (**V**ery **L**ow **D**ensity **L**ipoprotein); LDL (**L**ow **D**ensity **L**ipoprotein); GLI (Fasting glucose); TG (Triglycerides).

Table 2. Cardiopulmonary exercise test variables separated by COP categories without dividing the twins.

	Time (hh:mm:ss)		COP		MET		RER		VO_2 (l/min^{-1})		VO_2 (ml.kg^{-1}. min^{-1})		VO_2máx (ml.kg^{-1}. min^{-1})	
	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30
Median	00:02:20	00:02:30	19.40	23.65	3.90	4.35	0.69	0.76	0.86	0.92	14.00	15.50	34.00	35.50
IQR	00:01:10	00:01:50	2.30	2.33	1.20	0.93	0.06	0.10	0.35	0.54	4.00	3.75	11.00	6.50
p	0.66		0.00*		0.01*		0.00*		0.12		0.03*		0.67	

Legend: IQR (interquartile range); COP categories <22 (n = 83) and 22-30 (n = 16); COP (minimum VE/VO_2 in the exercise test); MET (Metabolic Equivalent of Task); RER (respiratory exchange rate ratio).

Table 3. Body composition variables separated by COP categories without dividing the twins.

	Weight (kg)		Height (m)		BMI		WC (cm)		AC (cm)		HC(cm)		%AF		%GF		%TF	
	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30
Median	62.50	60.40	1.62	1.67	23.00	23.20	30.00	29.05	36.30	32.75	30.95	28.20	73.00	72.50	81.80	80.15	95.50	93.25
IQR	28.20	15.08	0.13	0.10	6.50	4.03	17.28	17.78	13.78	6.53	13.48	6.75	18.00	13.88	15.50	13.78	14.00	11.63
P	0.95		0.29		0.50		0.99		0.63		0.47		0.44		0.24		0.30	

Legend: IQR (interquartile range); POC categories <22 (n = 83) and 22-30 (n = 16); BMI (Body Mass Index); WC (waist circumference); AC (abdominal circumference); HC (hip circumference); % AF (percentage of android fat); % GF (percentage of gynoid fat); % TF (percentage of total fat).

Table 4. Biochemical variables separated by COP categories without dividing the twins

	COL		HDL		VLDL		LDL		GLI		TG	
	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30	<22	22-30
Median	162.00	172.50	40.50	41.00	15.60	13.30	102.90	104.00	87.00	84.00	80.00	66.50
IQR	45.25	43.25	28.00	21.50	12.70	9.55	40.25	57.15	13.75	15.25	65.50	47.75
p	0.63		0.83		0.31		0.96		0.65		0.31	

Legend: IQR (interquartile range); POC categories <22 (n = 83) and 22-30 (n = 16); COL (cholesterol Total); HDL (High Density Lipoproteins); VLDL (**V**ery **L**ow **D**ensity **L**ipoprotein); LDL (**L**ow **D**ensity **L**ipoprotein); GLI (Fasting glucose); TG (Triglycerides).

Table 5. Intrapair correlation in monozygotic and dizygotic twins

	MZ (45 pairs)		DZ (5 pairs)	
	$r_{(s)}$	p	$r_{(s)}$	p
Weight (kg)	0.95**	0.001	0.90**	0.04
Height (m)	0.97**	0.001	0.80	0.10
BMI	0.89**	0.001	0.96**	0.001
WC (cm)	0.85**	0.001	0.82	0.09
AC	0.78**	0.001	0.82	0.09
HC	0.69**	0.001	0.56	0.32
%AF	0.83**	0.001	0.60	0.28
%GF	0.93**	0.001	0.90**	0.03
%TF	0.88**	0.001	0.80**	0.03
Time (hh: mm: ss)	0.33*	0.03	0.05	0.93
COP	0.12	0.43	0.41	0.49
MET	0.49*	0.001	0.05	0.93
RER	0.17	0.24	0.30	0.62
VO_2 (l/min^{-1})	0.63**	0.001	0.90**	0.04
VO_2 ($ml.kg^{-1}.\ min^{-1}$)	0.47*	0.001	0.05	0.93
VO_2 max ($ml.kg^{-1}.\ min^{-1}$)	0.89**	0.001	0.62	0.27
COL	0.87**	0.001	0.94**	0.01
HDL	0.83**	0.001	0.69	0.19
VLDL	0.81**	0.001	0.90**	0.03
LDL	0.78**	0.001	0.92**	0.03
GLI	0.78**	0.001	0.92**	0.03
TG	0.82**	0.001	0.90**	0.03

Legend: r (s): Spearman correlation; ** strong correlation; * Moderate correlation. BMI (Body Mass Index); WC (waist circumference); AC (abdominal circumference); HC (hip circumference); % AF (percentage of android fat); % GF (percentage of gynoid fat); % TF (percentage of total fat); COP (minimum VE/VO_2 in the exercise test); MET (Metabolic Equivalent of Task); RER (respiratory exchange rate ratio). COL (cholesterol Total); HDL (High Density Lipoproteins); VLDL (**V**ery **L**ow **D**ensity **L**ipoprotein); LDL (**L**ow **D**ensity **L**ipoprotein); GLI (Fasting glucose); TG (Triglycerides).

DISCUSSION

This study provides an original contribution in that it is pioneering in analyzing the relationship of COP with body composition and biochemicalmeasurements and the tendency of heritability. COP has been shown to be an important clinical variable that has an inverse relationship with all-cause mortality in healthy and sick individuals, thus presenting prognostic value and a new possibility for mortality risk assessment (Myers & de Araújo, 2018; Plínio S Ramos & Araújo, 2017). The COP was categorized by Ramos(2017)into three

groups, the first being characterized by a low forecast risk of mortality, the second with a moderate risk, and the last with a higher risk.

In tables 2, 3, and 4 the sample was analyzed by the COP categories, without separating the twins. A larger sample group was classified with a good prognosis, confirming the health of this sample. When analyzing the COP, we used other important measures that refer to this moment of the exercisetest, such as Time, MET, RER, VO_2 l/min^{-1}(Absolute), and VO_2 ml.kg^{-1}. min-^{1} (Relative). These parameters aid in the interpretation and understanding of the test intensity and the individual's aerobic conditioning (Guazzi et al., 2016). The values of COP, MET, RER, and relative VO_2presented significant differences between the categories of COP, showing a better aerobic and prognostic condition for individuals with POC <22. In addition, it can be noted from the RER value that these individuals tend to metabolize more lipids than the second category group, as well as which,the minimum VE/VO_2 was achieved at a lower intensity of the exercise test when compared to individuals in the second category (COP 22-30). This is because a low value of COP may represent a physiological advantage (Myers & de Araújo, 2018).

When analyzing the intrapair correlation of COP and CPET variables, we observed that Time, MET, and relative VO_2demonstrated a higher intrapair correlation in MZ (R_{MZ}), allowing inference that there is a greater tendency for genetics to influence these measures. On the other hand, COP, RER, and absolute VO_2,suggest a greater influence of environmental factors, due to the higher intrapair correlation in DZ (R_{DZ}). The intrapair correlation allows estimation of the genetic component or heritability of a factor(Livshits et al., 2016), and regardless of the p value, the intrapair correlation value is an important indicator of heritability (Borges et al., 2018; Miyamoto-Mikami et al., 2018; Zadro et al., 2017).

Although the intrapair correlation at the COP is not significant, there is an indication of a greater influence of environmental factors, due to the higher R_{DZ} value, however, further studies on heritability at the COP are necessary.To date, there are no COP studies in twins, however, as COP is a submaximal exercise variable, we can corroborate the systematic review with meta-analysis by Mikami et al.(2018)which presents studies in which submaximal resistance phenotypes demonstrate a weighted average for heritability of 0.49 (95% CI: 0.33–0.65), and despite substantial heterogeneity between studies, this indicates that genetic factors account for 44% to 68% of variability in aerobic resistance-related phenotypes (Miyamoto-Mikami et al., 2018). That is, 32% to 56% of variability may be influenced by the environment not shared between siblings.

This indication can also be extended to absolute VO_2, which at COP intensity is characterized as a submaximal exercise variable, in which case the environment seems to contribute to its values during the test. No studies have been performed on heritability for VO_2 intensity at the COP, however, when compared to soccer players (Myers & de Araújo, 2018), we observed that the value of VO_2 proved to be much lower in our sample, indicating that the individuals are at a low to moderate level of aerobic conditioning.

Relative VO_2 takes into account the individual's body mass, which enables the comparison of VO_2 between individuals with different body masses. The intensity of the COP demonstrated no differences between the siblings, however, at maximum intensity, we noticed a significant difference between the MZ twins, not occurring in the DZ. This behavior may have occurred due to the sample size in the DZ. However, regardless of the description of these values, the intrapaircorrelation showed a genetic influence for relative $VO_2$and absolute intensity of COP. These results are confirmed by classic twin studies, which show that genetics explain the differences in trainability levels of aerobic endurance characteristics (Bouchard, Hoffman, & Commission, 2011). A meta-analysis (Schutte, Nederend, Hudziak, Bartels, & de Geus, 2016) also found that the weighted average heritability estimate was 59% for absolute VO_2 max and 72% for relative VO_2 max, indicating that from childhood to early adulthood, genetic factors determine more than half of individual differences in VO_2 max. The metabolic unit - MET was used as a measure of effort intensity, as it can be used as a variable to indicate and compare the absolute intensity and energy expenditure of different physical activities (Faria Coelho-Ravagnani, Melo, Ravagnani, Burini, & Burini, 2013). Thus, the intrapair correlation of MET in COP intensity was higher in MZ, indicating that there is a genetic influence on these values. As this is a variable related to physical activity practice, we can corroborate the study by Mustelin(2012), which indicates that genetic factors contribute significantly to physical activity levels in young adults, as well as which,higher sports participation is associated with higher cardiorespiratory fitness and lower obesity, and these relationships are largely explained by genetic factors(L. Mustelin et al., 2011).

Body composition variables such as weight, height, WC, AC, HC, %AF, %GF, and %TFdemonstrated a greater influence of heritability, with R_{MZ} ranging from 0.69 to 0.97. These values corroborate other heritability studies, in which body composition measurements were shown to be significantly influenced by genetic effects, with heritability of 58% to 86%(Alonso, Souza, Oliveira, do Nascimento, & Dantas, 2014; Hopkins et al., 2010; L. Mustelin et al., 2011; Oliveira et al., 2014). However, BMI demonstrated a greater environmental influence due to a higher correlation in DZ (R_{DZ} = 0.96), indicating a greater capacity for modification in adults. As observed in the study by Oliveira et al., (2014), the heritability of BMI in post-pubertal individuals is moderate in males and low in females, demonstrating the greater environmental influence. Despite this behavior, there is controversy regarding the contribution of heritability to BMI. Borges et al. (2018) demonstrated a strong influence of heritability and greater intrapair correlation in MZ. In addition, other studies showed that genetic factors had a strong effect on BMI variation(K. Silventoinen, Hasselbalch, et al., 2009; Karri Silventoinen et al., 2016). These convergent results may occur due to the statistical method used, sample size, age, sex, and ethnicity (Borges et al., 2018; E. Costa de Sousa, 2016; Karri Silventoinen et al., 2016; Zadro et al., 2017). However, regardless of the value of heritability, there is a large environmental influence and it is therefore possible to adopt modification strategies for health gains over BMI.
The correlations of body composition variables with the COP were evaluated in order to expand the information on this important clinical variable. However, no associations with COP were observed for any body composition variables in the

current study. A low correlation was also observed in the study by Mustelin et al.(2011), who found that anthropometric measures of obesity were not associated with cardiorespiratory fitness variables. In addition, body composition measurements also demonstrated no differences between the categories of COP, possibly due to the small sample size in the second category, the absence of a sample in the final category, and the healthy characteristic of the sample.

The biochemical variables HDL, LDL, GLI, and TG presented weak, but significant, correlations with COP. In the COP categories, these variables did not present differences between the groups.Studies on physical activity and the metabolic profile show that regular physical exercise can result in a decrease in the concentration of total cholesterol and triglycerides and an increase in HDL in individuals with dyslipidemia (McKinney et al., 2016; Nassef, Nfor, Lee, Chou, & Liaw, 2019). In addition, a balanced diet associated with exercise has led to improvements in fasting blood glucose concentration and overall lipid concentration (Hernández-Lepe et al., 2019; Kawano et al., 2009; McKinney et al., 2016; Ooi & Ridzuan, 2016). These studies also point out that the intensity of the exercise can be an important factor for these modifications (He & Wang, 2019; Wood, Murrell, van der Touw, & Smart, 2019). Thus, the weak correlations or lack of associations in our study may be due to the low level of training of the general sample or to them being insufficiently active, the control of the diet was also not carried out.

In the correlation analysis, the majority of biochemical measurements indicated a greater influence of environmental factors, corroborating our previous study (Borges et al., 2018)where fasting glucose, total cholesterol, LDL, and triglycerides had low influence of the inherited component, with greater influence of the shared environment and the non-shared environment, indicating that health behavior is an important factor behind the genetic effects, generating metabolic differences(Ekelund et al., 2012; K. Silventoinen, Rokholm, Kaprio, & Sorensen, 2009).Regardless of the sample size, we compared MZ and DZ twins, which allows identification of a heritability trend through the intrapair correlation(Miyamoto-Mikami et al., 2018). In our study it was not possible to perform heritability analysis by structural equation modeling because of the sample size. This analytical approach typically decomposes the phenotypic variance into three components: genetic (A), common or shared environmental (C), and non-shared environmental (E) - ACE model(Neale & Cardon, 1992). Therefore we suggest further studies with a larger sample of MZ and DZ twins for more detailed analysis of the decomposition of these three components to confirm the percentage of environmental influence and non-shared environmentalinfluence on COP. In addition, we also suggest future studies with body compositionand biochemicalvariables in healthy and unhealthy populations in the different categories of COP.

CONCLUSION

The variables weight, height, BMI, waist circumference, abdominal circumference, hip circumference, % android fat,% gynoid fat, and% total fat did not significantly correlate with the cardiorespiratory optimal point.The

CardiorespiratoryOptimal Point and biochemical variables in generaldemonstrated a greatertendencytobeinfluencedbyenvironmentalfactors. The majority of body composition variables behaved with a greater influence of heritability.

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