21 - PHYSICAL TRAINING AND ANTHROPOMETRIC AND CARDIORESPIRATORY ADJUSTMENTS

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INTRODUCTION

Physical training is a systematic and progressive method, with application of physical exercise, which focuses on the goal of each subject that wants to improve his physical fitness. For this purpose, different training promote specific neurophysiological, morphological and metabolic adaptations, when such changes occur immediately and/or long-term in the skeletal muscle, and are realized as one of the major organic responses promoted by exercise (MEDEIROS; SOUSA , 2009). Considering such adaptations and as was pointed out by HOOD et al. (2006), human muscle is a smooth organic tissue that has an outstanding adaptive capacity as its main feature.

The fast progress in knowledge about the metabolic adaptations promoted by physical activity and the consequent understanding of these adaptations is relevant to the public as well as for future research in this area. This is because it provides evidence for better targeting of exercise programs, both in sports and in health promotion.

On the other hand, studies are currently focused on the implementation of reliable tests for the functional evaluation, so with the structuring of the training methodology (BARBANTI; TRICOLI; UGRINOWITSCH, 2004). Among the evaluations used to analyze certain body variables, it is possible to highlight the anthropometry and ergospirometry, with the first focused on the evaluation of body size and definition of the individual's profile, turning this analysis into a relevant component to the standard of health and fitness of the individual (HEYWARD, 2004).

The ergospirometry evaluates the cardiovascular, pulmonary and metabolic responses during the course of a physical effort test, analyzing the interactions between the capture systems, transport and metabolism of oxygen (O2) (SERRA, 1997). The test consists of applying a method of direct evaluation of monitored variables and that seeks for more accurate results, with the maximization of performance in cardiorespiratory and metabolic responses, which occur when using ergometers that are similar to the sporting gesture performed during the training sessions. Thus, the test provides accurate information about the maximal oxygen consumption (VO2máx.), which represents the individual's aerobic power and has great clinical and sports utility (Yazbek et al., 2001).

It is proposed, therefore, to relate anthropometric variables with metabolic and physiological responses of military recruits and athletics athletes, when subjected to physical exertion and compare the performance of the two groups.

MATERIALS AND METHODS

Participated in this cross-sectional study 28 subjects, twenty recruits and eight athletes (six males), with a mean age of 18.35 (± 0.489) and 23.50 (± 6.761), respectively. Individuals evaluated voluntarily joined the research by signing an informed consent. Part of subjects (athletes) were involved in the project "Correlation between blood chemistry profile and performance of athletes in the spirometric trial of Bruce and in specific tests using infrared spectroscopy", proposed and approved by the Ethics Committee in Research of the University of Santa Cruz do Sul through Protocol 2146/08. While the recruits were subjects of the end-of-course paper "Nutritional evaluation and food consumption related to the metabolic profile of recruits for military service", in which the study protocol was approved by the same Ethics Committee (Case No. 2501/10).

Data collection consisted of anthropometric, ergospirometric and serum biomarkers. To the subjects it was recommended bland diet and rest for the 24 hours before the test, and initially submitted to anthropometric evaluation, blood pressure and resting heart rate. After that, the subjects were positioned on the treadmill (ergometer), connected with the system of spirometry (respiratory gases analysis). After the start of the test on the treadmill, every three minutes and until the end of the test was done the finger-stick blood collection, beyond collecting fresh whole blood before and after the stress test. Also during the test, heart rate was recorded every 20 seconds with digital frequency meter and blood pressure measured every 3 minutes with a mercury sphygmomanometer.

In anthropometric dimension it was evaluated the Body Mass Index (IMC-kg/m2), calculated by the ratio of weight (kg)/height (m2) and classified according to the World Health Organization (BOUCHARD, 2003). The body composition was assessed with body fat percentage (BF%) obtained by the sum of cutaneous folds (ΣDC), using the Lange compass. For the estimation of body density was used Jackson and Pollock and for calculating the body fat percentage, the Siri equation, observing the classification of POLLOCK and WILMORE (2003). In addition, it was measured the waist circumference (WC) and hip circumference (HC) for waist/hip ratio (WHR) (HEYWARD, 2004), in which they were classified according to the World Health Organization (1997) and HEYWARD and STOLARCZYK (1996), respectively.

In cardiorespiratory evaluation, subjects underwent a stress test, using the Bruce protocol on treadmill. Throughout the whole evaluation, values of heart rate (HR), blood pressure (BP), oxygen consumption (VO2) and carbon dioxide production (VCO2) were monitored and recorded, and from the last two variables, it was estimated the respiratory quotient (RQ). The values of the respiratory variables were obtained by the TEEM 100 gas analyzer and the classification of those met the guidelines of the American College of Sports Medicine (1995).

The digitized data were tabulated in a spreadsheet (Excel, Microsoft Office 2007) and analyzed using the Statistical Package for Social Sciences for Windows (SPSS - version 18.0), using the mean, standard deviation, Student's t-test and Pearson's Correlation Test with $p < 0.05$. Evaluations were performed at the Laboratory of Physical Activity and Health (LAFISA) University of Santa Cruz do Sul (UNISC).

DISCUSSION AND RESULTS

As it can be seen in Table 1, the groups showed statistically significant variations in body measurements, when considering the average age, WHR and BF%. In the group analysis, it is seen that the athletes showed greater variability (SD) in the results, while the military ones were more homogeneous regarding anthropometric profile.

Table 1. Anthropometric characteristics of the group studied.

Variables	Military $\bar{x}$ (SD)	Athletes $\bar{x}$ (SD)	p
Age (years)	18,35 (0,489)	23,50 (6,761)	0,001
BMI (kg/m²)	22,5395 (1,87037)	21,2938 (2,19666)	0,994
WC (cm)	73,9650 (3,16681)	71,8750 (5,41578)	0,210
WHR	0,8065 (0,02870)	0,6850 (0,27985)	0,004
BF%	8,8005 (2,56791)	9,8375 (4,99648)	0,005

BMI = Body Mass Index; WC = Waist Circumference; WHR = Waist/Hip Ratio; BF% = Body Fat Percentage; $\bar{x}$± SD = mean ± standard deviation.

Table 2 shows that the average results of VO2 max. did not present statistic difference between the two groups, with slight superiority in VO2 max. of the athletes. By observing the data from RQ and maximum time spent to reach RQ ≥ 1, it was noticed that the results did not show statistically significant differences. These point out to the similarity of training results in cardiorespiratory fitness of both groups when subjected to the stress generated by the stress test.

Table 2. Cardiorespiratory characteristics of the subjects evaluated.

Variables	Military $\bar{x}$ (SD)	Athletes $\bar{x}$ (SD)	p
$VO_{2\ max.}$ (ml/Kg/min.)	44,4485 (8,51824)	46,1175 (7,33227)	0,961
RQ máx.	1,2601 (0,17334)	1,2650 (0,10365)	0,297
Time RQ = 1*	8,55 (3,000)	8,25 (3,991)	0,387

VO2 máx. = maximum oxygen consumption; RQ = respiratory quotient;

* - Indicates the period when the subject reached RQ ≥ 1, predominant use of anaerobic metabolic pathways for energy generation (values in minute).

From the results, it was classified the anthropometric and cardiorespiratory profile, which allowed to observe that both the military and athletes are characterized with indexes most recommended to the health in relation to BMI and BF%, different from WHR in which the military showed a lower cardiovascular risk. It was also observed, regarding the VO2 max. that the ratings were better for the athletes, however with no significant differences between groups (Table 3).

Table 3. Classification of variables measured in the evaluations

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Variables	Classification	Military % (n)	Athletes % (n)	p
BMI	Low weight	0,0% (0)	12,5% (1)	0,231
	Recommended range	95,0% (19)	87,5% (7)	
	Overweight	5,0% (1)	0,0% (0)	
BF%	Excellent	20,0% (4)	62,5% (5)	0,169
	Good	60,0% (12)	25,0% (2)	
	Above the Average	15,0% (3)	12,5% (1)	
	Average	5,0% (1)	0,0% (0)	
Cardiovascular risk WC	Normal	100,0% (20)	100,0% (8)	-
Cardiovascular risk WHR	Low	75% (15)	57,1% (4) *	0,373
	Moderate	25,0% (5)	42,9% (3) *	
$VO_{2\ máx.}$	Excellent	10,0% (2)	25,0% (2)	0,393
	Above the average	40,0% (8)	50,0% (4)	
	Average	50,0% (10)	25,0% (2)	

BMI = Body Mass Index; BF% = Body Fat Percentage; WC = Waist Circumference; WHR = Waist/Hip Ratio; VO2 máx. = maximum oxygen consumption.

* - Lack of the WHR value of one of the subjects.

In order to be able to analyze and/or compare the performance of groups, the anthropometric variables were correlated with the cardiorespiratory ones (Table 4). In correlation coefficients of anthropometric variables, when compared with the cardiorespiratory, it was observed that in athletes they were more strongly related, being positive with the WHR as well as with the time taken to reach RQ ≥ 1 and negative with the WHR and VO2 max. . As for the other variables, in this group of subjects showed moderate correlations, both positive and negative. As for military correlations, there were similar to those athletes, but with less force correlation.

Table 4. Correlation of anthropometric with cardiorespiratory variables

	Military				Athletes			
	BMI	**WC**	**WHR**	**BF%**	**BMI**	**WC**	**WHR**	**BF%**
$VO_{2\ max.}$	-0,262*	-	0,285*	-0,259*	-	-	-0,702***	-
Time RQ=1	-0,178*	-0,109*	0,146*	-	-0,328**	-0,412**	0,794***	-0,465**
RQ max.	0,230*	0,215*	-0,229*	0,150*	0,407**	0,369**	0,154*	-

*Weak correlation (r = 0 to r = 0,3); ** Regular correlation (from r = 0,3 to r = 0,6); ***Strong correlation (from r = 0,6 to r = 0,9); r – Pearson's linear correlation; p – significance level (p < 0,05); VO2 max. – Maximum oxygen consumptions; BMI = Body Mass Index; WC = Waist Circumference; WHR = Waist/Hip Ratio; BF% = Body Fat Percentage.

From the results of this study, it is considered that, although military recruits have shown mean age lower than the athletes, they presented lower levels of physical fitness, in agreement with Teixeira and Pereira (2009), saying that at lower age ranges the performance is optimized. These considerations were also evident in the strong associations between anthropometric and cardiorespiratory responses to exercise, which presented higher in athletes, indicating the importance of maintaining positive anthropometric profiles, optimizing cardiorespiratory performance (ANGELS and OLIVEIRA, 2008). Thus, data lower on WC and WHR may have contributed to sports performance (ROSS et al. 2000), indicating a direct relationship between body composition and cardiorespiratory performance (QUEIROGA; FERREIRA; ROMANZIN, 2005). In this direction, it can be inferred that the inadequacy of anthropometric variables may have a limiting effect on the performance of subjects (NETO; CESAR, 2005). In this sense, the understanding of metabolic adaptations promoted by physical activity, as well as the direct relationship between anthropometric and cardiorespiratory performance is relevant in directing physical fitness programs.

CONCLUSIONS

After analyzing the results it is observed significant relationship between the anthropometric variables and the physiological and metabolic responses, towards the physical effort, having more positive responses on the athletes' performance. These results demonstrate the importance of different physical training in promoting specific energy adaptations to the physical fitness proposed to each group.

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PHYSICAL TRAINING AND ANTHROPOMETRIC AND CARDIORESPIRATORY ADJUSTMENTS

ABSTRACT

Physical training is a systematic and progressive method, with the application of specific exercises, which seeks to improve people's anthropometric profile and cardiorespiratory capacity. The study focuses on the application of reliable tests in the functional evaluation, including the anthropometric and ergospirometric. It is proposed, therefore, to analyze the correlation between anthropometric variables and physiological and metabolic responses to exercise, of recruits and athletes, comparing the performance of these groups. Participated in this cross-sectional study 28 subjects, twenty recruits and eight athletes (six men), with a mean age of 18.35 (± 0.49) and 23.50 (± 6.76), respectively. Data collection consisted of anthropometric measurements that comprise body mass index (BMI), waist circumference (WC), waist/hip ratio (WHR) and body fat percentage (BF%). Additionally, it was applied the cardiopulmonary exercise test with Bruce protocol, conducted on a treadmill, using TEEM-100 gas analyzer, and observed the responses of oxygen consumption (VO2) and carbon dioxide production (VCO2), from which it was estimated the respiratory quotient (RQ). In the data analysis it was used the statistical package SPSS (18.0), through the mean, standard deviation, Student's t-test and Pearson's Correlation Test, with $p < 0.05$. The results indicated that both groups showed statistically significant differences in mean age, WHR and BF%. In the indexes of correlation between anthropometric with cardiorespiratory variables, it was observed that with the athletes they were more strongly related, yet with the military ones there were similar correlations, but with less force. After analyzing the results it was observed significant relationship between the anthropometric variables and the physiological and metabolic responses, towards the physical effort, having more positive responses on the athletes' performance. These results demonstrate the importance of different physical training in promoting specific energy adaptations to the physical fitness proposed to each group.

KEYWORDS: energy metabolism, athletic performance, physical fitness.

ÉDUCATION PHYSIQUE ET AJUSTEMENTS ANTHROPOMÉTRIQUES ET CARDIORESPIRATOIRES

RÉSUMÉ

L'entraînement physique constitue un processus systématique et progressif, avec l'application des exercices spécifiques , qui vise à améliorer la condition anthropométrique et la capacité cardiorespiratoire des personnes. L'étude se concentre sur l'application de tests fiables dans l'évaluation fonctionnelle, entre lequelles les anthropométriques et spirometriques. Nous proposons donc d'analyser la corrélation entre le variables anthropométriques et les réponses physiologiques et métaboliques de l'effort physique, des recrues et des athlètes, en comparant les performances de ces groupes. Ont participé à cette étude transversale 28 sujets, vingt recrues et huit athlètes de rendement (six du sexe masculin) avec une moyenne d'âge de 18,35 (± 0,49) et 23,50 (± 6,76), respectivement. La collecte des données consistait en mesures anthropométriques qui composent un indice de masse corporelle (IMC), le tour de taille (TT), rapport taille / hanche (RTH) et le pourcentage de graisse corporelle (% G). En outre, nous avons appliqué le test d'effort spirometrique , avec protocole de Bruce, tapis roulant avec analyseur de gaz couplé TEEM 100, et on a observé les réactions de la consommation d'oxygène (VO2) et la production de dioxyde de carbone (VCO2), à partir desquelles on a estimé le coeficient respiratoire (RQ). Dans l'analyse des données, nous avons utilisé le logiciel statistique SPSS (18,0) par la moyenne, l' écart-type, le test t de Student et la corrélation linéaire de Pearson, avec $p < 0,05$. Les résultats ont indiqué que les deux groupes ont montré des différences statistiquement significatives, à travers l'âge moyen, RTH et % G. Dans les coefficients de corrélation des variables anthropométriques avec les cardiorespiratoires, il a été observé que dans ces athlètes qu'elles étaient plus fortement liés, déjà avec les militaires il y a eu des corrélations similaires, mais avec moins de force. Après avoir analysé les résultats sont observés la relation significative des variables anthropométriques avec les réponses physiologiques et métaboliques devant l'effort physique, des réponses plus positives sur la performance du groupe d'athlètes. Ces résultats montrent l'importance des différentes entraînements physiques dans la promotion d'adaptations énérgetiques spécifiques au travail physique proposé à chaque groupe.

MOTS-CLÉS: métabolisme énergétique, la performance sportive, la condition physique.

ENTRENAMIENTO FÍSICO Y ADAPTACIONES ANTROPOMÉTRICAS Y CARDIORRESPIRATORIAS

RESUMEN

El entrenamiento físico constituye un método sistemático y progresivo con aplicación de ejercicios específicos, que busca mejorar el perfil antropométrico y la capacidad cardiorrespiratoria de las personas. El estudio tiene como enfoque la aplicación de pruebas fidedignas en la evaluación funcional, entre ellas las antropométricas y ergoespirométricas. Se propone así analizar la correlación entre variables antropométricas y respuestas fisiológicas y metabólicas al esfuerzo físico de reclutas y atletas, comparando el desempeño de estos grupos. Han participado en este estudio transversal 28 sujetos, siendo veinte reclutas y ocho atletas de rendimiento (seis hombres), con promedio de edad de 18,35 (±0,49) y 23,50 (±6,76), respectivamente. La recolecta de datos ha constado de las medidas antropométricas que componen índice de masa corporal (IMC), circunferencia de la cintura (CC), relación cintura/cadera (RCC) y porcentaje de grasa (%G). Adicionalmente, se ha aplicado la prueba ergoespirométrica con protocolo de Bruce, en cinta caminadora con analizador de gases TEEM 100 acoplado, siendo observadas las respuestas del consumo de oxígeno (VO2) y producción de dióxido de carbono (VCO2), a partir de los cuales se estimó el coeficiente respiratorio (CR). En el análisis de los datos se ha utilizado el paquete estadístico del SPSS (18,0), a través del promedio, desvío estándar, prueba t de student y correlación linear de Pearson, con $p < 0,05$. Los resultados han indicado que los dos grupos han presentado distinciones estadísticamente significativas en el promedio de edad, RCC y %G. En los índices de correlación de las variables antropométricas con las cardiorrespiratorias se ha observado que, en los atletas, estas han sido más fuertemente relacionadas. Sin embargo, en los militares hubo correlaciones similares, aunque con menor fuerza. Tras analizar los resultados, se observa relación significativa de las variables antropométricas con las respuestas fisiológicas y metabólicas ante el esfuerzo físico, respuestas más positivas en la performance del grupo de atletas. Esos resultados denotan la importancia de los distintos entrenamientos físicos en la promoción de adaptaciones energéticas específicas al trabajo físico propuesto a cada grupo.

PALABRAS-CLAVE: metabolismo energético, desempeño atlético, aptitud física.

TREINAMENTO FÍSICO E ADAPTAÇÕES ANTROPOMÉTRICAS E CARDIORRESPIRATÓRIAS

RESUMO

O treinamento físico constitui um método sistemático e progressivo, com aplicação de exercícios específicos, que busca melhorar o perfil antropométrico e a capacidade cardiorrespiratória das pessoas. O estudo tem como foco a aplicação de testes fidedignos na avaliação funcional, entre os quais os antropométricos e ergoespirométricos. Propõem-se assim, analisar a correlação entre variáveis antropométricas e respostas fisiológicas e metabólicas ao esforço físico, de recrutas e atletas, comparando o desempenho destes grupos. Participaram deste estudo transversal 28 sujeitos, sendo vinte recrutas e oito atletas

de rendimento (seis homens), com média de idade de 18,35 (±0,49) e 23,50 (±6,76), respectivamente. A coleta de dados constou das medidas antropométricas que compõem índice de massa corporal (IMC), circunferência da cintura (CC), relação cintura/quadril (RCQ) e percentual de gordura (%G). Adicionalmente, aplicou-se o teste ergoespirométrico, com protocolo de Bruce, em esteira com analisador de gases TEEM 100 acoplado, sendo observadas as respostas do consumo de oxigênio (VO2) e produção de dióxido de carbono (VCO2), a partir dos quais se estimou o quociente respiratório (QR). Na análise dos dados utilizou-se o pacote estatístico do SPSS (18,0), através da média, desvio padrão, teste t de student e correlação linear de Pearson, com $p < 0,05$. Os resultados indicaram que os dois grupos apresentaram diferenças estatisticamente significativas, na média de idade, RCQ e %G. Nos índices de correlação das variáveis antropométricas com as cardiorrespiratórias, observou-se que nos atletas estas foram mais fortemente relacionadas, já nos militares houve correlações similares, porém com menor força. Após analisar os resultados observa-se relação significativa das variáveis antropométricas com as respostas fisiológicas e metabólicas frente ao esforço físico, respostas mais positivas na performance do grupo de atletas. Esses resultados denotam a importância dos diferentes treinamentos físicos na promoção de adaptações energéticas específicas ao trabalho físico proposta a cada grupo.

PALAVRAS-CHAVE: metabolismo energético, desempenho atlético, aptidão física.