Revista Brasileira de Prescrição e Fisiologia do Exercício
ISSN 1981-9900 *versão eletrônica*

Periódico do Instituto Brasileiro de Pesquisa e Ensino em Fisiologia do Exercício
www.ibpefex.com.br / www.rbpfex.com.br

EFEITOS DO PERCENTUAL DE GORDURA CORPORAL NOS PARÂMETROS DE INTENSIDADE DURANTE UM TESTE INCREMENTAL BASEADO EM CORRIDA

Marcelo da Silva Marques[1], Whendel Mesquita do Nascimento[2]

RESUMO

O objetivo deste estudo foi avaliar a influência do percentual de gordura corporal (% GC) nos parâmetros de intensidade durante um exercício de corrida. Quatorze indivíduos do sexo masculino (20,5 ± 1,6 anos; 74,7 ± 13,3 kg; 172,1 ± 6,4 cm) foram divididos em dois grupos: Grupo 1 (% GC <12%; n = 7; 7,3 ± 4,0% GC) e Grupo 2 (% GC> 12%; n = 7; 25,6 ± 6,7% GC). Um teste progressivo em esteira foi realizado para determinar: captação máxima de oxigênio (VO_2 máx); Velocidade máxima (Vmáx); Frequência cardíaca máxima (FCmáx); Limiar anaeróbico (LAn) e os parâmetros de intensidade de velocidade em ∆25 (v∆25), ∆50 (v∆50) e ∆75 (v∆75). O %GC foi maior no Grupo 2 ($p<0,001$). O grupo 1 apresentou valores mais altos para todos os parâmetros de velocidade [vVO_2 máx ($p=0,002$); v25 ($p=0,016$); v50 ($p=0,004$); v75 ($p=0,002$); Vmáx ($p=0,002$) e para o VO_2 máx ($p=0,045$) quando comparado ao grupo 2. Valores mais altos de %GC parecem prejudicar os parâmetros de intensidade utilizados para a prescrição de exercícios de velocidade para adultos jovens.

Palavras-chave: Exercício físico. Corrida em Esteira. Indicadores de velocidade.

ABSTRACT

Effects of body fat percentage on intensity parameters during a running based incremental test

The aim of this study was to evaluate the influence of body fat percentage (BF%) on intensity parameters during a running based exercise. Fourteen male subjects (20.5 ± 1.6 years; 74.7 ± 13.3 kg; 172.1 ± 6.4 cm) were divided in two groups: Group 1(BF% < 12%; n = 7; 7.3 ± 4.0 BF%) and Group 2 (BF% > 12%; n = 7; 25.6 ± 6.7 BF%). A progressive treadmill test was performed to determine: Maximal Oxygen Uptake (VO_2 max); Maximal Velocity (Vmax); Maximal Heart Rate (HRmax); Anaerobic Threshold (AnT) and the velocity intensity parameters at ∆25 (v∆25), ∆50 (v∆50) and ∆75 (v∆75). The BF% was higher in Group 2 ($p<0.001$). Group 1 presented higher values for all velocity parameters [vVO_2 max ($p=0.002$); v∆25 ($p=0.016$); v∆50 ($p=0.004$); v∆75 ($p=0.002$); Vmáx ($p=0.002$) and for VO_2 max ($p=0.045$) when compared to group 2. Higher values of BF% seem to impair intensity parameters of velocity to exercise prescription in young adults.

Key words: Physical exercise. Treadmill running. Velocity indicators.

1 - Universidade de São Paulo-USP, São Paulo, São Paulo, Brasil.
2 - Divisão de Biotecnologia do Centro de Apoio Multidisciplinar-UFAM, Manaus, Amazonas, Brasil.

E-mail dos autores:
marcelomarques@usp.br
whendelmesquita@ufam.edu.br

Autor Correspondente:
Whendel Mesquita do Nascimento.
whendelmesquita@ufam.edu.br
Divisão de Biotecnologia do Centro de Apoio Multidisciplinar-UFAM.
Av. General Rodrigo Octávio Jordão Ramos, 3000.
Coroado I, Campus Universitário, Setor Sul, Bloco G.
Manaus, Amazonas, Brasil.
CEP: 69077.000.

Revista Brasileira de Prescrição e Fisiologia do Exercício
ISSN 1981-9900 *versão eletrônica*

Periódico do Instituto Brasileiro de Pesquisa e Ensino em Fisiologia do Exercício

w w w . i b p e f e x . c o m . b r / w w w . r b p f e x . c o m . b r

INTRODUCTION

During physical exercise practice, an increasing demand for energy provided by the oxidation of the substrates and removal of metabolic byproducts is expected (Hunter et al., 2018).

These dynamics occurs mainly in actives tissue, given the greater blood supply directed to these regions (Richard et al., 2004). Thus, some factors as the effort intensity and body composition can modulate this energetic demand.

In this sense, the effects of physical exercise on Body Fat Percentage (BF%) were already been extensively explored and well documented (Keating et al., 2017; Oliveira et al., 2017).

However, investigations concerning about the influence of BF% on exercise performance and intensity does not appear well established. Still, considering the worldwide prevalence of obesity has nearly to tripled since 1975 (World Health Organization, 2016), it is also important to understand the impact of BF% on performance and intensity during physical exercises.

Some recent studies investigate the effects of BF% in performance with different approaches to analyzing those possible impacts on oxygen consumption (Amani et al., 2010; Mondal e Mishra, 2017; Sharma, Kamal e Chawla, 2016) and cardiorespiratory fitness (Laxmi, Udaya, Shankar, 2014; Prabhu, Padmanabha e Doddamani, 2013) during physical exercise.

Highlighting the negative effect of BF% on physical performance, Mondal, Mishra (2017) analyzed the correlation between maximal oxygen uptake (VO_2 max) and BF% in 54 young adults (18-25 years) in a treadmill incremental test. The authors reported strong negative correlation ($r = -0.76$, $p<0.001$) between BF% and VO_2 max. In this sense, Coen et al., (2013) suggested that the BF% impairments on physical performance might be explained by a lower muscle oxidation capacity, influencing the efficiency of the degradation systems of the energy substrates, limiting energy obtainment and the fewer need of oxygen consumption by adipose tissue.

In a research conducted by Laxmi, Udaya e Shankar (2014), one hundred male subjects were submitted to an incremental treadmill test aiming to study the relation between body mass index (BMI) and VO_2 max. The results presented a significant negative correlation between BMI and VO_2 max ($r = -0.48$, $p<0.001$) and the authors advise that low cardiorespiratory fitness in young adults with increased body fat could be a factor for developing cardiovascular comorbidities later in middle age. Despite the investigations cited above, there is a lack of studies specifically designed to understand the effects of BF% on exercise intensity parameters.

Besides the BF%, might be important to know and control the intensity of the proposed exercise, mainly to prescribe efficiently (Hall et al., 2004; Mendes, Silva, Reis, 2012).

Among the different intensity parameters reported in the literature, VO_2 max and Anaerobic Threshold (AnT) have been proposed as variables of exercise prescription.

The VO_2 max is defined as the point at the increase in oxygen consumption does not accompany the increase in effort intensity (Denadai, 1995). AnT is based on the prediction of high blood lactate levels, according to the intensity of the effort, thus indicating a greater use of the glycolytic pathway for ATP resynthesis (Wasserman, Mcilroy, 1964).

With the evolution of research concerning about this parameters, new proposals emerged from VO_2 max and AnT. Therefore, velocity parameters at $\Delta 25$ ($v\Delta 25$), $\Delta 50$ ($v\Delta 50$) and $\Delta 75$ ($v\Delta 75$) became to be used as indicators of intensity for high-intensity exercises mainly because they are close to the maximum voluntary effort (Laffite et al., 2003).

Billat, Hamard, Koralsztein (2002) established that $v\Delta 25$ is the velocity in the midpoint between $v\Delta 50$ and the velocity associated with AnT (vAnT); $v\Delta 50$ is the velocity in the midpoint between vAnT and the velocity associated to VO_2 max (vVO_2 max); and the $v\Delta 75$ is the velocity in the midpoint between $v\Delta 50$ and vVO_2 max.

Despite the extensive use of these velocity parameters to exercise prescription, a few investigations have analyzed the effects of BF% no these parameters.

Thus, considering the applicability of intensity indicators to exercise prescription in different individuals, the aim of this study is to evaluate the influence of BF% on the intensity parameters for physical exercise prescription in young adults.

We hypothesized that the BF% would impair the velocity intensity parameters. However, due to the absence of data concerning BF% effects on intensity velocity

Revista Brasileira de Prescrição e Fisiologia do Exercício
ISSN 1981-9900 *versão eletrônica*
Periódico do Instituto Brasileiro de Pesquisa e Ensino em Fisiologia do Exercício
www.ibpefex.com.br / www.rbpfex.com.br

parameters, this hypothesis is proposed considering the impairments on oxygen consumption and cardiorespiratory fitness cited above.

MATERIALS AND METHODS

Participants

Fourteen male subjects were recruited for this study (20.5 ± 1.6 years; 74.7 ± 13.3 kg; 172.1 ± 6.4 cm).

They were undergraduate students from the Faculty of Physical Education and Physiotherapy of Federal University of Amazonas. Eligibility requirement included the following: young adult, male gender, classified as sedentary or lightly active according to International Physical Activity Questionnaire. Exclusion criteria were diagnosed or self-reported medical conditions that contraindicate participation in exercise protocol or limited body movement.

The first contact with the subjects was made personally and before taking part, all individuals were informed about the procedures, responsibilities, benefits, possible risks and eventual discomforts from their participation in this study. All procedures were in accordance with the guidelines laid down in the Declaration of Helsinki, and the study was approved by the Ethics Committee for Research with Human Beings (CAAE: 50906015.2.0000.502). The participants' were requested to sign an Informed Consent term and anonymity and confidentiality were assured.

Procedures

Each participant was invited to visit the laboratory just one time. First, anthropometric measurement and body composition evaluation test were conducted. Therefore, they were divided into two groups according to body fat percentage (BF%). Group 1 (n = 7) with an BF% < 12% and group 2 (n = 7) with an BF% >12% (Esmat, 2010).

After that, to measure the VO2max and determine the intensity variables, the subjects were submitted to a progressive treadmill test. The room where the procedures took place had a constant temperature (~24 C) and humidity (~50%) during the measurement and all subjects completed all measurement procedures.

In the laboratory, the height (in cm with a precision of 1mm) was measured with a compact wall stadiometer (E210, WISO, SC, Brazil) according to the International Society of Advanced of Kinenanthropy. Body composition was assessed by Air Displacement Plethysmography technology (BOD POD, Life Measurement Instruments, CA, USA). The variable considered for this study was BF% and it was calculated from the body density. All operational procedures were conducted according to the equipment manufacturer.

The VO_2 max of the subjects was measured by a progressive treadmill (Movement® RT350) test adapted from Bruce, Kusumi, Hosmer (1973). The gases were collected through the spirometer VO2000 (MedGraphics®, MN, USA) and this was calibrated before each test. The test consisted of 5 minutes of initial warm up at 5 km/hr followed by an increment of 1km/hr per minute until the maximum voluntary effort. Exhaustion was confirmed by the following criteria: (1) respiratory ratio exchange ratio greater than 1.15 or (2) the presence of a plateau in oxygen consumption [maintenance of VO_2 values (oscillations of ±2 ml/min/kg) despite the increase in exercise intensity]. Data were collected breath by breath.

The maximal velocity (Vmax) was considered the higher velocity achieved at the last completed stage. Throughout the test, the heart rate (HR) was recorded via a strapped Polar Wearlink coded (Polar® T31) and the maximal HR (HRmáx) was determined at the end of the test. The AnT was determined by the V-Slope method as suggested elsewhere (Beaver; Wasserman; Whipp, 1986). Further, the parameters of velocity (v∆25, v∆50, v∆75) were determined and the VO_2 was estimated for each velocity variable. The subjects were verbally encouraged during all tests.

Statistical Analysis

The normality of the data distribution was verified using the Shapiro-Wilk test. An independent t-test was applied to compare all variables between groups with a 95% of confidence interval.

The Cohen's d was calculated as an effect size indicator and was classified according to the criteria suggested by Batterham, Hopkins (2006). Statistical analyses were performed using SPSS version 24 (Chicago, IL, USA) and the level of significance was set at 5% ($p<0.05$).

Revista Brasileira de Prescrição e Fisiologia do Exercício
ISSN 1981-9900 *versão eletrônica*

Periódico do Instituto Brasileiro de Pesquisa e Ensino em Fisiologia do Exercício

w w w . i b p e f e x . c o m . b r / w w w . r b p f e x . c o m . b r

RESULTS

Table 1 presents descriptive statistics to characterize the sample in the age, anthropometric variables and body composition by groups. Participants were young adults (20.5 ± 1.5 years) with a higher BF% for Group 2 when compared to Group 1 ($p<0.001$; d = 3.3; very large).

Table 1 - General and body composition characteristics by group of the study sample.

	Group 1	Group 2
Age (years)	20.8 ± 2	20.2 ± 1
Height (cm)	168.7 ± 5.7	175.1 ± 5.6
Body Fat (%)	7.3 ± 4.0*	25.6 ± 6.7
Body Mass (kg)	65.6 ± 7.9	82.7 ± 13.0

Note: values are mean ± standard deviation; * = $p < 0.001$

Table 2 presents the mean values, standard deviation, p-value and confidence intervals of the incremental test. All subjects attained at least one of the VO_2 max test endpoints. No significant differences were Observed between the groups for the variables VT, vVT, VO_2 Δ25, VO_2 Δ50, VO_2 Δ75 and HRmax ($p > 0.05$ for all comparisons). On the other hand, group 1 presented higher values in VO_2 max (d=1.1; moderate), vVO_2 max (d= 2.0; large); vΔ25(d = 1.4; large); vΔ50(d = 1.8; large) vΔ75(d = 2.0; large) and Vmax (d = 2.0; large).

Table 2 - Physiological and velocity parameters during maximal exercise test by groups.

	Group 1	Group 2	p Value	$CI_{95\%}$
VT ($ml.kg.min^{-1}$)	35.41 ± 7.80	30.58 ± 6.37	0.210	-3.0 – 12.7
vVT (km/h)	11.86 ± 1.06	10.63 ± 1.30	0.069	-0.1 – 2.5
VO_2max ($ml.kg.min^{-1}$)	45.75 ± 5.64*	37.99 ± 7.58	0.045	0.2 – 15.3
vVO_2max (km/h)	14.71 ± 0.75*	12.75 ± 1.16	0.002	0.8 – 3.0
$VO_2Δ25$ ($ml.kg.min^{-1}$)	34.42 ± 7.69	31.24 ± 6.64	0.406	-4.8 – 11.1
vΔ25 (km/h)	12.57 ± 0.85*	11.16 ± 1.10	0.016	0.3 – 2.5
$VO_2Δ50$ ($ml.kg.min^{-1}$)	36.48 ± 5.63	32.87 ±6.71	0.284	-3.3 – 10.5
vΔ50 (km/h)	13.29 ± 0.69*	11.69 ± 0.99	0.004	0.6 – 2.5
$VO_2Δ75$ ($ml.kg.min^{-1}$)	37.41 ± 3.83	33.44 ± 6.86	0.200	-2.3 – 10.3
vΔ75 (km/h)	14 ± 0.66*	12.22 ± 1.02	0.002	0.8 – 2.7
HRmax (bpm)	193 ± 9.36	189.12 ± 1.59	0.502	-8.2 – 16.0
Vmax (km/h)	14.71 ± 0.75*	12.75 ± 1.16	0.002	0.8 – 3.0

Legend: VT: Ventilatory Threshold; vVT: Velocity at ventilatory threshold; VO_2max: maximal oxygen consumption; vVO_2max: velocity at VO_2max; $VO_2Δ25$: Oxygen Consumption Between Δ50 and LAn; vΔ25: Velocity between vLAn and vΔ50; $VO_2Δ50$: Oxygen consumption between LAn and VO_2 max; vΔ50: Velocity between vLAn: and vVO2max; $VO_2Δ75$: Oxygen consumption between Δ50 and VO2max; vΔ75: Velocity between vΔ50 and vVO2max; HRmáx: Maximal Heart Rate; Vmax: Maximal Velocity; CI = confidence interval; * = statistically significant at $p<0.05$.

Revista Brasileira de Prescrição e Fisiologia do Exercício
ISSN 1981-9900 *versão eletrônica*
Periódico do Instituto Brasileiro de Pesquisa e Ensino em Fisiologia do Exercício
w w w . i b p e f e x . c o m . b r / w w w . r b p f e x . c o m . b r

DISCUSSION

The impact of physical exercise on BF% has been extensively studied. However, in the opposite direction, there is an absence of evidence regarding the effects of BF% on exercise performance, namely velocity intensity parameters.

Thus, the aim of this study was to evaluate the influence of BF% on the intensity parameters for physical exercise prescription in young adults. The main finds of this study were that VO_2 max and the velocity values in the proposed parameters (vΔ25, vΔ50, vΔ75) were significantly lower for subjects with BF% > 12, with higher effects on vΔ75, vVO_2 max, Vmáx.

Among the velocity parameters utilized to exercise prescription, the velocity obtained at Δ25, Δ50 e Δ75 has received increasing attention from the scientific community, probably because they are supramaximal intensity parameters obtained between VT and VO_2 max (Beaver, Wasserman, Whipp, 1986; Billat, Hamard, Koralsztein, 2002).

Further, the specific literature describes positive correlations between effort time in this intensity range and delay in recuperation post-exercise (Hughson et al., 2000), which can be explained for the increase of oxygen deficit during efforts in this intensity range (Schaun et al., 2018).

Thus, considering that this delay in post effort recuperation can promote an increase in post-exercise oxygen consumption, unleashing higher utilization of lipid metabolism to return to homeostasis and ATP resynthesis (Schaun et al., 2018; Schleppenbach et al., 2017; Tucker, Angadi, Gaesser, 2016), the utilization of this training strategy becomes interesting to exercise prescription to subjects with high levels body composition index.

In a study, Nikbakht (2011) applied an exercise test battery (60 m sprints, medicine ball put, vertical jump, standing board jump, and Harvard step test) with the objective to assess the physical conditioning of active university students with different somatotypes. The authors reported a negative correlation between body composition and physical performance in all proposed tests. These results corroborate the finds of an earlier study (Sadhan, Koley, Sandhu, 2007), when investigating the influence of body composition on physical conditioning in 99 male students, found a negative correlation between VO_2 max and BF%.

Concerning to O_2 consumption, the results reported in specific literature seem consistent, with authors reporting negative effects of BF% on this parameter (Browning et al., 2017; Nikbakht, 2011; Sadhan, Koley, Sandhu, 2007).

The results in the present go, partially, in the opposite direction, indicating no significant differences in the rates at which O_2 consumption values were obtained at Δ25, Δ50 and Δ75 which are the intensity parameters used in exercise prescription proposed by Billat Hamard, Koralsztein, (2002) with only VO_2 max presenting significant differences.

It is important to highlight that the differences between this study and the studies cited above might be explained by some factors as the sample analyzed and methods applied to determine the BF%. The subjects involved in the study of Browning et al., (2017) were females after gastric surgery.

On Nikbakht (2011) study, the individuals were males stratified by somatotypes. The study conducted by Sadhan, Koley, Sandhu (2007) involved both sexes in the analysis. Lastly, none of these studies determine the BF% by plethysmography, which is recognized as a method of high accuracy when compared to other methods (Fields, Goran, Mccrory, 2002).

Specifically, with similar subjects, we found only two studies (Amani et al., 2010; Sharma, Kamal, Chawla, 2016) with health adults' subjects. The study conducted by Amani et al., (2010) had physically active young adults which were submitted to an incremental maximal test. In this study, the authors reported negative correlations between BF% and oxygen consumption. Afterward, these results were corroborated by Sharma, Kamal and Chawla (2016) which evaluated 30 university subjects and found negative correlations for the same reported above parameters.

BF% effect is not limited only to physical fitness, but it might be a determinant factor for others physical performances. Dawes et al., (2016) submitted 76 policemen to different physical tasks and observed that those with higher values of BF% reached inferior results, thus presenting lower physical performance. In this sense, others studies reported that BF% caused impairment in firemen physical performance (Williford et al., 1996) and BF% negatively affect aerobic performance and strength in military force men

Revista Brasileira de Prescrição e Fisiologia do Exercício
ISSN 1981-9900 *versão eletrônica*
Periódico do Instituto Brasileiro de Pesquisa e Ensino em Fisiologia do Exercício
www.ibpefex.com.br / www.rbpfex.com.br

with military equipment (Ricciardi, Deuster, Talbot, 2007).

Our study presented some limitations that are important to highlight. Analyse only young and healthy men subjects probably limit the inferences and the external validity of the conclusions. Appropriated caution is needed to generalize the study results to groups of different sex and health status. Our small sample size could be also addressed as a limitation.

Thus, we suggest the applicability of velocity parameters to physical exercise prescription can be an interesting parameter to subjects with different body composition index. Further, utilize velocity parameters to dosage the exercise intensity prescription presents advantages as easy application, efficient training load prediction and can provide immediate results, what can be important to subjects motivation exercise practice (Mann, Ivey, Sayers, 2015).

Furthermore, probably these advantages can be responsible for the increased utilization of velocity parameters in exercise prescription to develop the sportive performance (González-Badillo et al., 2015; González-Badillo, Sánchez-Medina, 2010; Mann, Ivey, Sayers, 2015; Ramirez et al., 2015).

CONCLUSIONS

Considering that subjects with higher BF% reached lowers velocity indicators, we conclude that the BF% directly impairs the intensity indicators to exercise prescription.

As a practical application for exercise prescription based on velocity indicators used in this study, those values allow us to infer that BF% must be considered when professionals are analyzing the indicators to planning exercise prescription.

Moreover, determine the BF% is important to interpret treadmill exercise and avoid underestimate results.

A suggestion for future studies, analyze the effects of exercise practice at the proposed intensity parameters (vΔ25, vΔ50, vΔ75) in the reduction of BF% could add new finds to the body of knowledge concerning about health promotion.

REFERENCES

1-Amani, A.R.; Somchit, M.N.; Konting, M.M.B.; Kok, L.Y. Relationship between body fat percent and maximal oxygen uptake among young adults. Journal of American Science. Vol. 6. Num. 4. p. 1-4. 2010.

2-Batterham, A. M.; Hopkins, W. G. Making meaningful inferences about magnitudes. International Journal of Sports Physiology and Performance. Vol. 1. Num. 1. p. 50-57. 2006.

3-Beaver, W.L.; Wasserman, K.; Whipp, B.J. A new method for detecting anaerobic threshold by gas exchange. Journal of Applied Physiology. Vol. 60. Num. 6. p. 2020-27. 1986.

4-Billat, V.L.; Hamard, L.; Koralsztein, J.P. The influence of exercise duration at VO2 max on the offtransient pulmonary oxygen uptake phase during high intensity running activity. Archives of Physiology and Biochemistry. Vol. 110. Num. 5. p. 383-92. 2002.

5-Browning, M.G.; Francoi, R.L.; Herrick, J.E.; Arrowood, J.A.; Evans, R.K. Assessment of cardiopulmonary responses to treadmill walking following gastric bypass surgery. Obesity Surgery. Vol. 27. Num. 1. p. 96-101. 2017.

6-Bruce, R.; Kusumi, F.; Hosmer, D. Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. American Heart Journal. Vol. 85. Num. 4. p. 546-62. 1973.

7-Coen, P.M.; Hames, K.C.; Leachman, E.M.; DeLany, J.P.; Ritov, V.B.; Mentshikova, E.V.; Dube, J.J.; Stefanovic-Racic, M.; Toledo, F.G.; Goodpaster, B.H. Reduced skeletal muscle oxidative capacity and elevated ceramide but not diacylglycerol content in severe obesity. Obesity. Vol. 21. Num. 11. p. 2362-71. 2013.

8-Dawes, J.J.; Orr, R.M.; Siekaniec, C.L.; Vanderwoude, A.A.; Pope, R. Associations between anthropometric characteristics and physical performance in male law enforcement officers: a retrospective cohort study. Annals of Occupational and Environmental Medicine. Vol. 28. Num. 1. p. 26. 2016.

9-Denadai, B.S. Limiar anaeróbio: considerações fisiológicas e metodológicas. Revista Brasileira de Atividade Física & Saúde. Vol. 1. Num. 2. p. 74-88. 1995.

10-Esmat, T. Measuring and evaluating body composition. American College of Sports

Revista Brasileira de Prescrição e Fisiologia do Exercício
ISSN 1981-9900 *versão eletrônica*
Periódico do Instituto Brasileiro de Pesquisa e Ensino em Fisiologia do Exercício
www.ibpefex.com.br / www.rbpfex.com.br

Medicine Fit Society Page. Vol. 1. p. 3-10. 2010.

11-Fields, D.A.; Goran, M.I.; Mccrory, M.A. Body-composition assessment via air-displacement plethysmography in adults and children: a review. The American Journal of Clinical Nutrition. Vol. 75. Num. 3. p. 453-67. 2002.

12-González-Badillo, J.J.; Pareja-Blaco, F.; Rodriguez-Rosell, D.; Abad-Herencia, J.L.; del Ojo-Lopez, J.J.; Sanchez-Medina, L. Effects of velocity-based resistance training on young soccer players of different ages. The Journal of Strength & Conditioning Research. Vol. 29. Num. 5. p. 1329-38. 2015.

13-González-Badillo, J.J.; Sánchez-Medina, L. Movement velocity as a measure of loading intensity in resistance training. International Journal of Sports Medicine. Vol. 31. Num. 05. p. 347-52. 2010.

14-Hall, C.; Figueroa, A.; Fernhall, B.; Kanaley, J.A. Energy expenditure of walking and running: comparison with prediction equations. Medicine & Science in Sports & Exercise. Vol. 36. Num. 12. p. 2128-34. 2004.

15-Hughson, R.L.; O'Learly, D.D.; Betik, A.C.; Hebestreit, H. Kinetics of oxygen uptake at the onset of exercise near or above peak oxygen uptake. Journal of Applied Physiology. Vol. 88. Num. 5. p. 1812-19. 2000.

16-Hunter, G.R.; Plaisance, E.P.; Carter, S.J.; Fisher, G. Why intensity is not a bad word: optimizing health status at any age. Clinical Nutrition. Vol. 37. Num. 1. p. 56-60. 2018.

17-Keating, S.E.; Johnson, N.A.; Mielke, G.I.; Coombes, J.S. A systematic review and meta-analysis of interval training versus moderate-intensity continuous training on body adiposity. Obesity Reviews. Vol. 18. Num. 8. p. 943-64. 2017.

18-Laffite, L.P.; Mille-Hamard, L.; Koralsztein, J.P.; Billat, V.L. The effects of interval training on oxygen pulse and performance in supra-threshold runs. Archives of Physiology and Biochemistry. Vol. 111. Num. 3. p. 202-10. 2003.

19-Laxmi, C.; Udaya, I.; Shankar, V. Effect of body mass index on cardiorespiratory fitness in young healthy males. International Journal of Scientific and Research Publications. Vol. 4. Vol. 2. p. 1-4. 2014.

20-Mann, J.B.; Ivey, P.A.; Sayers, S.P. Velocity-based training in football. Strength & Conditioning Journal. Vol. 37. Num. 6. p. 52-57. 2015.

21-Mendes, R.; Silva, P.M.; Reis, V.M. Exercise prescription for health: characterization of energy expenditure of walking and running/Prescricao de exercicio para a saude: caracterizacao do dispendio energetico da marcha e da corrida. Motricidade. Vol. 8. Num. S1. p. 51-6. 2012.

22-Mondal, H.; Mishra, S.P. Effect of BMI, body fat percentage and fat free mass on maximal oxygen consumption in healthy young adults. Journal of Clinical and Diagnostic Research. Vol. 11. Num. 6. p. 17-20. 2017.

23-Nikbakht, M. Relationships between somatotype, anthropometry and physical fitness variables in untrained university students. Journal of Physical Education and Sport. Vol. 11. Num. 2. p. 211. 2011.

24-Oliveira, A.; Monteiro, A.; Jacome, C.; Afreixo, V.; Marques, A. Effects of group sports on health-related physical fitness of overweight youth: A systematic review and meta-analysis. Scandinavian Journal of Medicine & Science in Sports. Vol. 27. Num. 6. p. 604-11. 2017.

25-Prabhu, S.; Padmanabha, B.V.; Doddamani, B.R. Correlation between obesity and cardiorespiratory fitness. International Journal of Medical Science and Public Health. Vol. 2. Num. 2. p. 300-04. 2013.

26-Ramirez, J.M.; Nunez, V.M.; Lancho, C.; Poblador, M.S.; Lancho, J.L. Velocity-based training of lower limb to improve absolute and relative power outputs in concentric phase of half-squat in soccer players. The Journal of Strength & Conditioning Research. Vol. 29. Num. 11. p. 3084-88. 2015.

27-Ricciardi, R.; Deuster, P.A.; Talbot, L.A. Effects of gender and body adiposity on physiological responses to physical work while wearing body armor. Military Medicine. Vol. 172. Num. 7. p. 743-48. 2007.

Revista Brasileira de Prescrição e Fisiologia do Exercício
ISSN 1981-9900 ***versão eletrônica***
Periódico do Instituto Brasileiro de Pesquisa e Ensino em Fisiologia do Exercício
w w w . i b p e f e x . c o m . b r / w w w . r b p f e x . c o m . b r

28-Richard, R.; Lonsdorfer-Wolf, E.; Dufour, S.; Doutreleau, S.; Oswald-Mammosser, M.; Billat, V.L.; Lonsdorfer, J. Cardiac output and oxygen release during very high-intensity exercise performed until exhaustion. European Journal of Applied Physiology. Vol. 93. Num. 2. p. 9-18. 2004.

29-Sadhan, B.; Koley, S.; Sandhu, J.S. Relationship between cardiorespiratory fitness, body composition and blood pressure in Punjabi collegiate population. Journal of Human Ecology. Vol. 22. Num. 3. p. 215-19. 2007.

30-Schaun, G.Z.; Pinto, S.S.; Praia, A.B.C.; Alberton, C.L. Energy expenditure and EPOC between water-based high-intensity interval training and moderate-intensity continuous training sessions in healthy women. Journal of Sports Sciences. Vol. 36. Num. 18. p. 2053-60. 2018.

31-Schleppenbach, L.N.; Ezer, A.B.; Gronemus, S.A.; Widenski, K.R.; Braun, S.I.; Janot, J.M. Speed-and circuit-based high-intensity interval training on recovery oxygen consumption. International Journal of Exercise Science. Vol. 10. Num. 7. p. 942. 2017.

32-Sharma, M.; Kamal, R.; Chawla, K. Correlation of body composition to aerobic capacity; A cross sectional study. International Journal of Applied Research. Vol. 2. Num. 1. p. 38-42. 2016.

33-Tucker, W.J.; Angadi, S.S.; Gaesser, G.A. Excess postexercise oxygen consumption after high-intensity and sprint interval exercise, and continuous steady-state exercise. The Journal of Strength & Conditioning Research. Vol. 30. Num. 11. p. 3090-97. 2016.

34-Wasserman, K.; Mcilroy, M.B. Detecting the threshold of anaerobic metabolism in cardiac patients during exercise. The American Journal of Cardiology. Vol. 14. Num. 6. p. 844-52. 1964.

35-Williford, H.N.; Duey, W.J.; Olson, M.S.; Blessing, D.L. The Relationship Between Fire Fighter Physical Fitness And Performance. Medicine & Science in Sports & Exercise. Vol. 28. Num. 5. p. 198. 1996.

36-World Health Organization. Obesity and Overweight Fact Sheet. Geneva. 2016.

Recebido para publicação em 29/10/2020
Aceito em 21/04/2021