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Comparison of the strength and resistance of inspirational muscles between assets and sedentary

Comparação da força e resistência dos músculos inspiratórios entre ativos e sedentários

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RESUMO | INTRODUÇÃO: A prática regular de atividade física está associada com melhora do estado de saúde, aumento da capacidade funcional, aumento da força muscular e redução da mortalidade por doenças cardíacas. Apesar dos benefícios de a prática regular de exercício físico estarem consolidados na literatura, as adaptações na força e resistência dos músculos inspiratórios são controversas. **OBJETIVO:** Testar a hipótese que não há diferença da força e resistência dos músculos inspiratórios entre indivíduos ativos e sedentários. **MÉTODOS:** Estudo observacional de corte transversal. Avaliou-se indivíduos entre 18 e 30 anos, ambos os sexos e saudáveis. Os voluntários foram divididos em ativos e sedentários de acordo a classificação da American College of Sports Medicine (ACMS). Os indivíduos tiveram a força máxima dos músculos inspiratórios (FMI) determinada através do dispositivo POWERbreathe® K5 inspiratory muscle trainer, que intula esta variável como Sindex. A resistência dos músculos inspiratórios foi avaliada través de um teste incremental. Para comparação das médias foi aplicada o teste t de student para distribuição simétrica, p< 0,05. O estudo foi aprovado pelo comitê de ética em pesquisa com CAAE : 37781014.4.0000.5544. **RESULTADOS:** Foram avaliados 92 indivíduos, destes 55 (60%) foram classificados como ativos e 57 (62%) do sexo masculino. Ao realizar a comparação do Sindex entre ativos e sedentários (128±26; 119±24 cmH2O; p=0,85) e da exaustão no teste incremental (65±16% e 60±16%;p=0,095), respctivamente. **CONCLUSÃO:** Os indivíduos ativos não apresentam músculos inspiratórios mais fortes e resistentes quando comparados com sedentários.

PALAVRAS-CHAVE: Músculos inspiratórios. Força muscular inspiratória. Teste incremental.

ABSTRACT | INTRODUCTION: The regular practice of physical activity is associated with improved health status, increased functional capacity, increased muscle strength and reduced mortality from heart disease. Although the benefits of regular exercise are well established in the literature, adaptations in inspiratory muscle strength and endurance are controversial. **OBJECTIVE:** To test the hypothesis that there is no difference in the strength and resistance of the inspiratory muscles between active and sedentary individuals. **METHODS:** Cross-sectional observational study. It was evaluated individuals between 18 and 30 years old, both sexes and healthy. The volunteers were divided into active and sedentary according to the classification of the American College of Sports Medicine (ACMS). Individuals had maximal inspiratory muscle strength (IMS) determined through the POWERbreathe® K5 inspiratory muscle trainer, which injects this variable as Sindex. The inspiratory muscle strength was evaluated through an incremental test. For the comparison of the means the student's t-test was applied for symmetrical distribution, p <0.05. The study was approved by the research ethics committee with CAAE: 37781014.4.0000.5544. **RESULTS:** A total of 92 individuals were evaluated. Of these, 55 (60%) were classified as active and 57 (62%) were male. When comparing Sindex between active and sedentary (128 ± 26/119 ± 24 cmH2O, p = 0.85) and exhaustion in the incremental test (63.2 ± 16.1%. p = 0.095), respectively. **CONCLUSION:** Active individuals do not present stronger and stronger inspiratory muscles when compared to sedentary ones.

KEYWORDS: Inspiratory muscles. Inspiratory muscle strength. Incremental test.

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Introduction

Physical activity is classified as any body movement performed by muscles in which there is a higher energy consumption than at rest. When practiced in a planned, orderly and repeated way it is classified as physical exercise (EF)[1]. Although of the regular practice of PE to improve overall the health of the practitioner, according to the principle of specificity, adaptations will occur according to the characteristics of the exercise and muscle groups stimulated during exercise[2]. For this reason, there are controversies as to the efficiency of practices such as running, neuromuscular exercises and some sports in improving the strength and endurance of inspiratory muscles.

In common sense, it is considered that swimming is able to specifically condition the inspiratory muscles. However, it was observed that junior Olympic athletes after a swimming training session did not cause acute reduction of inspiratory muscle strength (IMS). This remit to the idea that the training session was not able to overwhelm this muscle group acutely, thus reducing the magnitude of the chronic adaptations[3].

Eastwood et al[4] in 2001, studied elite marathoners and did not identify differences in respiratory muscle strength when compared to sedentary volunteers. However, they observed that these athletes obtained greater endurance capacity in the voluntary hyperpnea test.

Contrasting the above articles, researchers identified that weight-lifting athletes obtained increased strength and hypertrophy of inspiratory muscles when compared to the control group[5]. A similar result was found by Giacomini et al. which identified an IMF increase after 8 weeks of training with the Pilates6 method.

Given the divergences, the present study aims to test the hypothesis that there is no difference in the strength and endurance of the inspiratory muscles between active individuals and physical exercise practitioners.

Methods

This is a cross-sectional, observational study carried out in the Exercise Physiology laboratory of the Bahia Social Faculty from February 2015 to October 2016. For the research, university students, healthy, adults of both sexes. Excluded were those who reported tobacco use, respiratory infection in the last month, history of asthma, any known cardiorespiratory system affection or use of anabolic drugs in the last year.

Participants were divided into two groups, Active and Sedentary. Physically active volunteers were classified based on the ACSM guidelines criteria, who considered active those who did 30 to 60 minutes daily of moderate intensity exercise or 150 minutes weekly; 20 to 60 minutes daily of vigorous intensity exercises or 75 minutes weekly. The absence of physical exercise was considered as sedentary lifestyle[1].

The POWERbreathe® K5 inspiratory muscle trainer (POWER-breathe International Ltd, Warwickshire, UK)[7,8,9] digital device was used for IMS determination. This equipment measures the peak inspiratory flow, generated in a fast and strong contraction of the diaphragm and its accessories. This equipment names the strength of inspiratory muscles as Index Stress or Sindex. The tests were performed by physiotherapists specialized in respiratory physiotherapy evaluation and with experience in the manipulation of the research instrument.

To obtain Sindex, the individual was positioned in a comfortable chair, with feet supported. The volunteer was instructed to perform a slow expiratory maneuver followed by a quick and forced inspiration with a nasal clip occluded by a nasal clip. The maneuver was repeated until the highest value was found, and the last maneuver could not present the highest value of Sindex, when this occurred a new maneuver was requested, avoiding the learning effect of the test.

Resistance of the inhaling muscles was assessed by a maximal progressive test performed on POWERbreathe® K5. This inspiratory muscle test, with an incremental non-continuous characteristic, consists of up to 10 stages of 19 repetitions with increasing load increase. After the end of each

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stages an interval of 2 minutes was performed. Through the same evaluation equipment, it starts with 10% of the maximum value and increments 10% at each stages of the test. As the equipment only imposes the load determined in the fourth inspiration, 19 raids were carried out in each level, with a 5-second breathing cycle guided by a beep of the apparatus. The test was discontinued when the individual was no longer able to overcome the burden imposed by the device or expressed that he was unable to continue the test. Figure 1 shows the procedures performed in the incremental test.

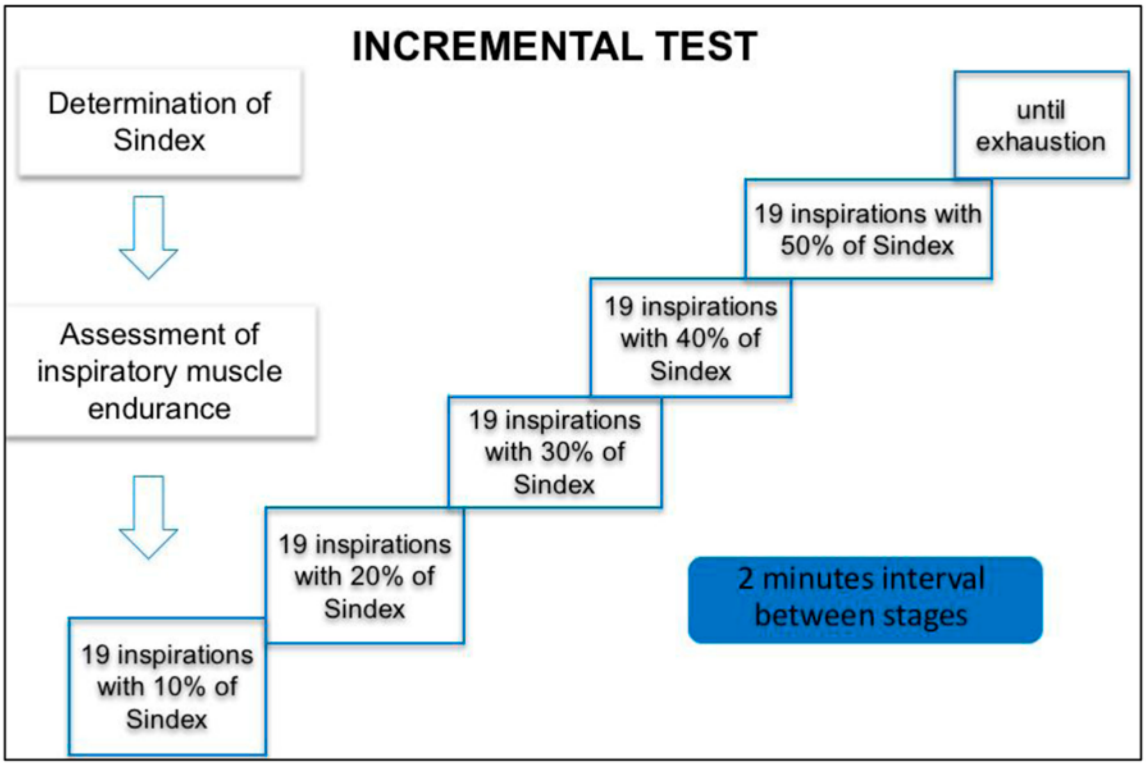

Figure 1. Procedures performed in the incremental test to obtain inspiratory muscle endurance.

For the sample calculation, a pilot study was carried out with 10 study participants. The determination of the sample calculation was in the WINPEPI program (publichealth.jbpub.com/book/gerstman/winpepi). For the elaboration of the calculation, the significance level of 0.5% was adopted, acceptable difference of 4.0, standard deviation 19.3, totaling 92 participants.

Statistical Package for Social Sciences (SPSS) software version 14.0 for windows was used to elaborate the bank and data analysis. The distribution of the variables was defined by the descriptive analysis and in case of doubt the Kolmogorov-Smirnov test was applied. The variables Sindex, height, mass, body mass index (BMI) and the percentage of Sindex that occurred in the test were considered with symmetrical distribution, therefore they were presented by mean and standard deviation (±). Exhaustion of the incremental test was presented in percent (%) of inspiratory muscle strength (Sindex).

This study was approved by the Research Ethics Committee of the Bahia School of Medicine and Public Health, CAAE 37781014.4.0000.5544. All volunteers signed the informed consent form.

Results

In this study, 92 individuals were evaluated, with a mean age of 25.2±6.3 years, of which 62% were male. In the sample studied 60% of the volunteers declared to be regular exercise practitioners. The mean BMI of the study population was 24.8±4,8 kg/m2, with no statistical difference between the physically active and sedentary groups, p= 0.59, revealing the homogeneity of the groups. The general characterization of the sample is described in Table 1.

Table 1. Comparison of groups in relation to age, anthropometric measures and variables analyzed in the incremental test. Salvador-Ba, N = 92

Variables	Physically active	Sedentary	*p**
Age (years)	25.9±6.4	25.3±6.2	*0.901*
Height (m)	1.7±0.1	1.7±0.1	*1.000*
Weight (Kg)	71.5±16.1	73.2±14.2	*0.601*
BMI (Kg/cm^2)	23.6±5.4	24.8±3.9	*0.247*
Sindex (cmH_2O)	128.4±26.4	119.2±23.6	*0.091*
% exhaustion**	65.4±15.8	59.7±16.07	*0.095*

Student's t test for independent groups; ** Percentage relative to Sindex; BMI: body mass index; Sindex: Stress index of inspiratory muscles; % exhaustion: percentage of Sindex that there was exhaustion in the incremental test.

When the inspiratory muscle strength was analyzed, the population obtained an average of 124.7 ± 25.6 cmH2O. Males had higher mean values than females (139.8 ± 17.9 and 100 ± 14.6, p <0.001). When analyzing the IMS difference in physical activity and sedentary practitioners, no difference was observed between the groups studied (128.4 ± 26.4 and 119.2 ± 23.7, p = 0.091).

Regarding the percentage of inspiratory muscle strength that was identified exhaustion during the incremental test, the volunteers presented an average of 63.2 ± 16.1%. In the comparison between the sexes, the men had higher mean values than the women (69.8 ± 15.9% and 55.14 ± 13.1%, p <0.001, respectively), however, when analyzing the influence of the practice of (65.5 ± 15.9% and 59.73 ± 16.8%, p = 0.095), as shown in Figure 2.

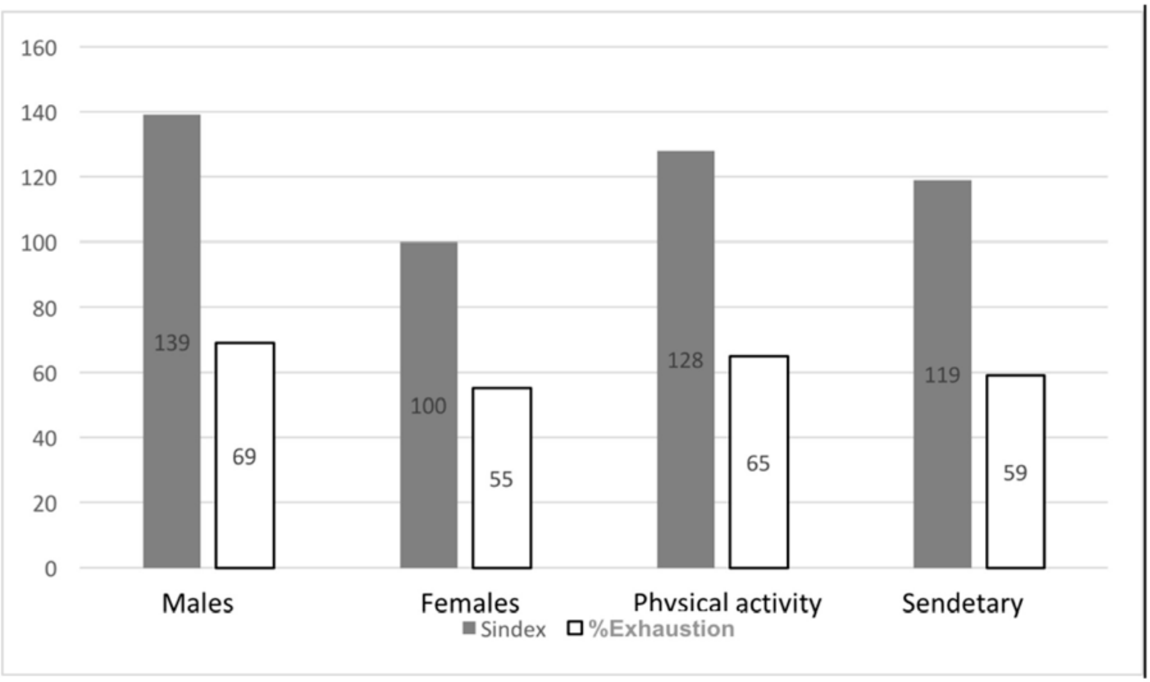

Figure 2. Comparison between the means of Sindex and exhaustion between the sexes and between the active and sedentary participants. Sindex: Stress index of inspiratory muscles. % exhaustion: percentage of Sindex that there was exhaustion in the incremental test.

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Discussion

The study, observed that participants who practice regular exercise do not have a difference in strength and endurance of inspiratory muscles when compared to their sedentary pairs. This research was a pioneer in comparing the inspiratory muscle resistance in an incremental test with linear pressure load using as a tool an accessible device in clinical practice.

Despite the availability of equipment and test protocols to evaluate the resistance of respiratory muscles, in clinical practice this valuable evaluation is little accomplished[10]. The gold standard is the isocapnic voluntary hyperpnea test. However, high-cost equipment, which offers low resistance to inspiratory flow and stable carbon dioxide (CO2) levels, is necessary. In addition, the subject needs to be motivated enough to remain ventilated at high volumes for about 25 to 30 minutes[11-13].

In the literature review we did not find articles that used a linear load resistance protocol in healthy individuals. However, Basso-Vanelli et al. evaluated patients with Chronic Obstructive Pulmonary Disease and high reproducibility was identified in an incremental test using a device of the same brand as the present study. Using the same reasoning, Hill et al.[12] highlighted the importance of this type of evaluation in the response to an inspiratory muscle training program in patients with COPD.

The reasons why the practice of global physical exercise does not promote adaptations in the strength and endurance of inspiratory muscles may be related to the respiratory pattern during physical activity. At the beginning of the exercise, the increase minute volume (MV) suffers more influence in tidal volume (CV) than by the respiratory rate (RR). This initial rise in CV does not occur only because of the greater activation of the inspiratory muscles. During exertion, the expiratory muscles are essential for proper ventilation. After the transition from moderate to high intensity, there is a disproportionate increase in ventilation, that is, non-linear with exercise load. At this stage of the exercise, there is stabilization of the CV and concomitant increase of the RR[13-15]. The relevant contribution of the expiratory muscles to the increase in MV during exercise, coupled with the non-expressive increase of the RR in moderate intensity activities, reduces the likelihood of adequate stimulation of the inspiratory muscles in healthy subjects.

The importance of expiratory muscles during exercise was demonstrated by Sugiura et al.[16]. In this study, it was observed that when the exercise was realized in existence expiratory muscle fatigue, there was a significant reduction of CV, MV and increase in RR at peak exercise. These results confirm the importance of the expiratory muscles in generating the minute volume during exercise.

It is known that after a vigorous exercise session, there is a reduction of the peak force of the exercised muscles associated with factors bioenergetic and neuromuscular[3]. This reduction of strength after training is a marker of muscle stress, which will trigger the process of contractile protein reconstruction and the specific adaptations induced by each exercise modality. Therefore, if after the physical training session there is maintenance of the strength of a muscular group, possibly, this group was underestimated for gain of strength and power. In a study conducted with cycling[17] and swimming[6] athletes, this decrease in inspiratory muscle power was not found even after a high intensity training session in these modalities, demonstrating little efficiency of overall physical training in promoting adequate stimuli for IMS gain.

In the study by Brown et al.[5], which assessed ventilatory muscle strength and lung function in elite weightlifting athletes (Powerlifting), they identified that these athletes had higher IMS values than sedentary individuals with the same physical characteristics. The divergence of the results of this study with our results can be explained by the study population. We evaluated physically active individuals while Brown et al.[5] evaluated professional athletes with more than 10 years of physical training.

Eastwood et al.[4] compared the resistance of the ventilatory muscles of six high level marathon runners with healthy sedentary ones. In this study, it was observed that the athletes obtained better endurance of the ventilatory muscles when compared to their sedentary pairs.

The limitation of this study was the fact that the physical activity level of the evaluated population was declared and the volume and intensity of the exercise practiced was not controlled by the researchers. Therefore, it is not possible to establish a cause and effect relationship. Therefore, it is necessary to carry out new studies on the impact of the different types of training on the performance of the inspiratory musculature.

Conclusion

The results of this study suggest that there is no difference in either strength or inspiratory muscle resistance in physical activity practitioners when compared to sedentary individuals.

Author contributions

Oliveira FTO participated in the final writing of the article, bibliographic review, data collection and data analysis. Petto J participated in the bibliographic review, data collection and analysis, intellectual contribution. Esquivel MS and Santos PHS participated in data collection and literature review. Oliveira ACS participated in the writing of the article. Aras R supervised the study and wrote the final draft of the paper

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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