ORIGINAL RESEARCH PAPER

Education

SPORTS SPECIFIC INFLUENCE ON PEAK INSPIRATORY FLOW IN UNIVERSITY PLAYERS

KEY WORDS: Peak Inspiratory Flow; Athletes; Sports; Respiratory function tests.

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ABSTRACT

Objective: The objective of this research was to analysis the **Peak Inspiratory Flow** (PIF) in different types of sports and compare them with controls in order to find out which sports improve lung function the most.

Methods: This was a cross-sectional study involving 240 sportsmen of eight different games (30 of each): Basketball, Volleyball, Athletics (long & short distance Runners), Boxing (Fly to Middle weight boxers), Wrestling (57 to 86 kg), Swimming and Control group (Non-sportsmen). The Peak Inspiratory Flow (PIF) was measured with Minispir ® New, Computer based Spirometer.

Results: The t – value of Force Vital Capacity (FVC) (L/S) for Non-Sportsmen (M - 7.80±0.95) v/s Basketball players (M - 10.57±1.43) was 11.52 ($p<0.001$) and that of Non-Sports (M - 7.80±0.95) and Volley Ball (M - 10.69±1.02) was 11.42 ($p<0.001$). Similarly, the swimmers, boxers and wrestlers were found with significant better PIF in comparison to control group.

Conclusions: Our results suggest that the different sport activities performed ≥16 h per week have a significant impact on the physiological adaptation of the respiratory system.

Introduction

Athletes can be illustrious from members of the general population in that, in general, the former show better cardiovascular function, larger stroke volume, and greater maxi mal cardiac output Gay O et al. (2014). Bearing all of this in mind, we can assume that athletes would present with higher spirometric values in comparison with the general population. It is possible that highly trained athletes develop maladaptive changes in the respiratory system—such as intrathoracic and extrathoracic obstruction; expiratory flow limitation; respiratory muscle fatigue; and exercise-induced hypoxemia—that can influence their performance Hackett DA et al. (2013). Interval training and aerobic exercises significantly improve spirometric parameters of non-athletes, while weight training (resistance training) has no significant effect on respiratory parameters Vahan M et al. (2016). Mazic S et al. (2006) found that in Serbian elite Basketball, water polo players and rowers had statistically higher vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in one second (FEV1) than the healthy sedentary control individuals. Shin YS et al. (2016) reported that the respiratory function of Korean wrestling athletes is better than that of non-athletes as analysis of the FVC graph revealed that the Korean wrestlers, athletes and the non-athletes were significantly different. The respiratory muscles of the athletes were anticipated to be better than those of the non-athletes.

Most aerobic athletes have very well trained respiratory muscles from their sport alone. However, it is not known if additional respiratory muscle training could elicit positive adaptations within the aerobically trained athlete that would make the ventilatory process more efficient. During competition athletes will take thousands of breaths. Like all other skeletal muscles, the pulmonary muscles when engaging in aerobic metabolism require oxygen. The fatigue resistance of this process is related to the training status of the muscle. If the muscle is more endurance trained, then it will be less likely to constrain ventilation and exercise performance.

The purpose of this study was to examine and compare pulmonary function through Peak Inspiratory Flow (PIF) in different types of sports that are of a similar nature, according to the type and intensity of exercise performed i.e. Basketball, Volleyball, Boxing, Wrestling, Athletics, Swimming and compare them with controls in order to find out which sports improve lung function the most.

Methodology:

The present study was conducted on 240 subjects of eight different games (30 of each): Basketball (Age – 22.12± 2.67 & BMI – 21.32±1.62), Volleyball (Age – 23.01± 2.31 & BMI – 21.01±1.54), Athletics (Long Distance Runners) (Age – 23.62± 2.17 & BMI – 20.12±1.44), Athletics (Short Distance Runners) (Age – 21.32± 2.06 & BMI – 22.02±1.91), Boxing (Fly to Middle weight boxers) (Age – 22.62± 2.06 & BMI – 21.32±1.51), Wrestling (57 to 86 kg) (Age – 23.62± 2.17 & BMI – 20.12±1.44) Swimming (Age – 22.22± 2.37 & BMI – 22.02±1.37) and Control (Non-sportsmen) (Age – 22.19± 2.11 & BMI – 23.82±1.98). Only those players are selected in the sports category that represented their Universities/State (Haryana, India) in the All India Interuniversity/National in their respective sports discipline in 2016 and were engaging in that sport for ≥16 h per week. In non sportsmen category only those students were selected, who were pursuing their master's degree from Kurukshetra University and had never participated in any competitive sports. The Peak Inspiratory Flow (PIF) was measured with Minispir ® New, Computer–based Spirometer, Medical International Research S.r.l. - via del Maggiolino 125, 00155 Roma, Italy - P.IVA IT04564101006, USA - MIR Medical International Research USA.

Results:

Table - 1 Analysis of variance (ANOVA) for Peak Inspiratory Flow (PIF) Liters/Seconds in the subjects of various categories.

Sources of Variation	Sum of squares	df	Mean Square Variance	F. Value	P
Between Groups	337.82	7	48.26	27.58**	<0.01
With in Groups	479.48	274	1.74		
Total	817.31	281			

** - significant at 1% level ($P<0.01$)

For the Peak Inspiratory Flow (PIF) L/S in the Subjects of various categories the F value is 27.58, which is more than the table value at 0.01 levels of significance. As F value is significant, it indicates that there exists significant difference within and between the in the eight categories of subjects for Peak Inspiratory Flow (PIF) L/S.

Table - 2
Significance of difference between Mean of Non-Sports persons and players of various Sports Categories for Peak Inspiratory Flow (PIF).

S. No.	Categories	Mean of First Group	Mean of Second Group	S.E.D.	T-Value
1	Non-Sports v/s Basket Ball	7.80 ± 0.95	10.57 ± 1.43	0.32	11.52**

2	Non-Sports v/s Athletic (SDR)	7.80 ± 0.95	8.35 ± 1.40	0.37	1.63
3	Non-Sports v/s Athletic (LDR)	7.80 ± 0.95	8.59 ± 1.48	0.46	1.43
4	Non-Sports v/s Swimming	7.80 ± 0.95	9.65 ± 1.29	0.36	6.19**
5	Non-Sports v/s Volley Ball	7.80 ± 0.95	10.69 ± 1.02	0.33	11.42**
6	Non-Sports v/s Boxing	7.80 ± 0.95	9.70 ± 1.44	0.26	7.76**
7	Non-Sports v/s Wrestling	7.80 ± 0.95	9.75 ± 1. 31	0.32	8.24**

** = significant at 0.01% level

According to above table the significant difference in the means of Peak Inspiratory Flow (PIF) between the non-sportsmen and sportsmen of various categories, it is indicated that mean Peak Inspiratory Flow (PIF) of non-sportsmen and basketball is 7.80 and 10.57 respectively and the t-value is 11.52 (p< 0.001, one tail test). Whereas, when PIF (L/S) of non-sportsmen (M - 7.80 ± 0.95) and Athletes (Short Distance Race) (M - 8.35 ± 1.40) were compared, the t-value 1.63, was not significant. Similarly, the mean Peak Inspiratory Flow (PIF) of non-sportsmen (M - 7.80 ± 0.95 L/S) and Athletes (Long Distance Race) (M - 8.59 ± 1.48 L/S) with t – value 1.43, was again not significant.

The t – value of Peak Inspiratory Flow (PIF) (L/S) for Non-Sports (M - 7.80 ± 0.95) v/s Swimming (M - 9.65 ± 1.29) was 6.19 (p<0.001, one tail test) and that of Non-Sports (M - 7.80 ± 0.95) and Volley Ball (10.69 ± 1.02) was 11.42 (p<0.001, one tail test). Whereas, when the mean Peak Inspiratory Flow (PIF) (L/S) of Boxers (M - 9.70 ± 1.44 L/S) and Wrestlers (M - 9.75 ± 1. 31) were compared with non sportsmen the t – value (one tail test) were 7.76 (p< 0.002, one tail test) and 8.24 (p< 0.002, one tail test) respectively.
Discussion of results:

According to results t - value for one tail test is found to be significant, when different categories were compared for Peak Inspiratory Flow (PIF) (L/S) with the non sportsmen i. e. Basketball - 11.52 (p< 0.001), Swimming - 6.19 (p<0.001), Volley Ball - 11.42 (p<0.001), Boxers - 7.76 (p< 0.002) and Wrestlers - 8.24 (p< 0.002).

The above results indicate that players of basketball, Volleyball, Boxers and Swimmers who have at least represented university and state (Haryana) had higher values of PIF compared to the controls. It contrasts with previous reports which found that all athletes, regardless of the sport, had higher lung volumes than physically inactive persons Armour J et al.(1993), Mehrotra PK et al. (1998), Jakes RW et al.(2002), Janssen I (2009), Sable M et al.(2012), Shin YS et al. (2016).

Resistance training when performed with the correct repetition scheme and load can produce skeletal muscle hypertrophy, strength, or local muscle endurance. Skeletal muscle also controls many crucial elements of aerobic conditioning including lung ventilation. The diaphragm, external and internal intercostals, scalene, and abdominal muscles (i.e. respiratory muscles) help to facilitate the increased ventilation needed to sustain blood oxygenation during exercise Boutellier U et al. (1992).

Prolonged and forced inhalation and exhalation due to exercise causes an increased strain on the respiratory muscles. This additional resistance has been shown positive pulmonary function changes in people with chronic obstructed pulmonary disease (COPD). Villafranca et al. (1998) showed increases in maximal inspiratory pressure (PImax) after ten weeks of inspiratory muscle training using a threshold inspiratory trainer allowing 30% resistance. Likewise, Larson and Kim (1984) observed increases in PImax after one month of inspiratory muscle training in people with COPD.

Pulmonary resistance training has also been shown to change enzymatic profiles in sheep. Akabas et al.(1989) assigned nine adult sheep to a training for twenty minutes using inspiratory flow resistance (50-100 cmH2O) five to six times per week for three weeks and found that in compared to the control group, the experimental group diaphragm muscle had a 26% increase in citrate synthase (CS), a 29% increase in b-hydroxyacl-CoA dehydrogenase (bHAD), and a 36% increase in cytochrome oxidase (COX). It can be concluded from this study that the aerobic enzymatic profiles increased significantly in sheep when put under inspiratory stress. An increase in aerobic enzymes during exercise in humans would equate to more efficient energy utilization of the respiratory muscles and lower fatigueability. Data involving healthy humans using respiratory muscle training with exercise is limited. In two separate studies, Suzuki et al. (1993 & 1995) observed changes in the rate of perceived exertion (RPE) after inspiratory and expiratory muscle training in healthy adults. Suzuki concluded that expiratory muscle training did not decrease RPE at a given work load while inspiratory muscle training did decrease RPE.

In a cross-sectional study conducted by Myrianthefs et al. (2014), which included 276 athletes engaged in various sports, the results were similar to those obtained in our study. One possible explanation is that every sport differs in terms of the type and intensity of the exercise involved, which varies by season, as well as that there are sport-specific adaptations of body composition, a phenomenon known as "sport-specific morphological optimization" Berglund L. et al. (2011). Sabe M et al. (2012) swimming exercise affects lung volume measurements as respiratory muscles including diaphragm of swimmers are required to develop greater pressure as a consequence of immersion in water during respiratory cycle, thus may lead to functional improvement in these muscles and also alterations in elasticity of lung and chest wall or of ventilatory muscles, leading to an improvement in forced vital capacity and other lung functions of swimmers than runners.

It is recognized that the respiratory muscles will adapt to aerobic training Losnegard T et al (2014). Most aerobic athletes have very well trained respiratory muscles from their sport alone. However, it is not known if additional respiratory muscle training could elicit positive adaptations within the aerobically trained athlete that would make the ventilatory process more efficient. During competition athletes will take thousands of breaths. Like all other skeletal muscles, the pulmonary muscles when engaging in aerobic metabolism require oxygen. The fatigue resistance of this process is related to the training status of the muscle. If the muscle is more endurance trained, then it will be less likely to constrain ventilation and exercise performance.

Boutellier U et al. (1992) suggest resistance training offers some benefit to fatigue resistance in untrained students. The research also suggests that inspiratory muscles, like all other skeletal muscles, adapt according to the stress placed on them. William E et al.(2002) because the subjects had trained their pulmonary muscles, they were able to increase ventilation. The increase in Ventilation in L/min and decrease in Respiratory rate in the training group indicated that the Powerlung device increased the strength of the respiratory muscles. The increased strength of the respiratory muscles allowed the subjects to perform more work (i.e. move more air) while breathing fewer times.

Enright et al. (2006) showed that eight weeks of high-intensity inspiratory muscle training significantly increased VC. Wells et al. (2005) demonstrated the effect of 11 weeks of concurrent respiratory muscle training on lung function. Hallstrand et al. (2000) showed that aerobic training increases ventilation capacity. During physical activity, the number of lung volume receptors and other receptors in respiratory control center increase, which result in higher ventilation rate. Therefore during an exercise initially tidal volume and subsequently breathing rate increase.

As the lung volumes depend on height, higher values are expected in all tall athletes Laszlo (2006). We found higher value of Peak Inspiratory Flow in basketball and Volleyball players, who were significantly taller than other sportsmen and controls. There was no difference in height among Wrestlers, Boxers, Athletes and swimmers , it would suggest that although height and age are the most commonly used predictive factors for lung volumes, other factors, thoracic diameter and trunk length, may predict lung volume in athletes. It is therefore likely that both anatomical and mechanical factors may account for differences in lung volume Cotes JE et al. (2001) & Lazovic B et al. (2015).

Our results suggest that the type of sport has a significant impact on respiratory adaptation. Because of these sport-specific differences, there is a need for further investigations examining sports specific and exercise specific; the influence of the duration, severity, and intensity of exercise; the early years of training; respiratory muscle strength; and specific genetic influences.

Conclusion:

This study agrees with previous reports and supports that regular exercise improves lungs functions. The study revealed that the sedentary subject's performance on PIF was poorer when compared with sportsmen who have been engaged in sports for ≥16 h per week and represented their Universities/State (Haryana, India) in the All India Interuniversity/National in Basketball, Volleyball, Boxing, Wrestling and Swimming. Volleyball and Basketball players were having highest value of PIF. However, although the unique anthropometric characteristics of successful players of Volleyball and basketball have, as previously mentioned, been shown to be mostly attributable to genetic endowment, it remains unclear whether the superior lung function found in such athletes is due to genetic influences or to the specific pattern of exercise.

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