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Original article

Effects of the training of the inspiratory respiratory musculature of anaerobic power, in rugby

Efectos del entrenamiento de la musculatura respiratoria inspiratoria de la potencia anaeróbica, en el rugby

Efeitos do treinamento muscular respiratório inspiratório na potência anaeróbica em jogadores de rugby

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ABSTRACT

Respiratory muscle training has emerged as a relevant field of study in the ambit of health and sports performance. The aim of this study was to describe a methodology for training the inspiratory muscles to improve anaerobic capacity in rugby players. The research was a quantitative, quasi-experimental, longitudinal study, where results were compared between an experimental and control group in a total of twenty-two amateur rugby players. Maximum inspiratory pressure and anaerobic power (Shuttle Test) were evaluated before the start of training. For training of the inspiratory muscles, the Powerbreathe ® device was used, with a protocol of 60 inspirations at 50% of the maximum inspiratory pressure once a day, three times a week, for six weeks. The results obtained showed a significant increase in maximum inspiratory pressure in the experimental group and performance in the Shuttle test Run showed an improvement, both with a statistically significant difference. These findings suggested that the program had a positive impact on both indicators and revealed the importance of interventions focused on improving respiratory capacity and physical performance.

Keywords: training, respiratory muscles, anaerobic power, rugby

RESUMEN

El entrenamiento de la musculatura respiratoria ha surgido como un campo de estudio relevante en el ámbito de la salud y el rendimiento deportivo, el objetivo de este estudio fue describir una metodología de entrenamiento de la musculatura inspiratoria sobre la mejora de la capacidad anaeróbica, en jugadores de rugby. La investigación fue cuantitativa cuasi experimental de tipo longitudinal, donde se compararon resultados entre un grupo experimental y de control, en un total de veintidós jugadores de rugby amateur. Se evaluó la presión inspiratoria y potencia anaeróbica máximas (Test Shuttle Run) antes del inicio del entrenamiento. Para el entrenamiento de la musculatura inspiratoria, se utilizó el dispositivo Powerbreathe®, con un protocolo de 60 inspiraciones al 50 % de la presión inspiratoria máxima una vez al día, tres veces a la semana, durante seis semanas. Los resultados obtenidos mostraron un aumento significativo de la presión inspiratoria máxima en el grupo experimental y el rendimiento en la prueba de Shuttle Run mostró una mejora, ambos con una diferencia estadísticamente significativa. Estos hallazgos sugirieron que el programa tuvo un impacto positivo en ambos indicadores y reveló la importancia de intervenciones enfocadas en la mejora de la capacidad respiratoria y el rendimiento físico.

Palabras Clave: entrenamiento, musculatura respiratoria, potencia anaeróbica, rugby

RESUMO

O treinamento muscular respiratório emergiu como um campo de estudo relevante na área da saúde e do desempenho esportivo. O objetivo deste estudo foi descrever uma metodologia de treinamento da musculatura inspiratória para melhorar a capacidade anaeróbica em jogadores de rugby. A pesquisa é quantitativa, quase-experimental, do tipo longitudinal, onde foram comparados resultados entre um grupo experimental e controle, totalizando vinte e dois jogadores amadores de rugby. A pressão inspiratória máxima e a potência anaeróbia máxima foram avaliadas (Shuttle Run Test) antes do início do treinamento. Para o treinamento muscular inspiratório foi utilizado o aparelho Powerbreathe®, com protocolo de 60 inspirações a 50% da pressão inspiratória máxima uma vez ao dia, três vezes por semana durante seis semanas. Os resultados obtidos mostraram aumento significativo da pressão inspiratória máxima no grupo experimental; Da mesma forma, o desempenho no teste Shuttle Run apresentou melhora no grupo experimental, ambos com diferença estatisticamente significativa. Estes resultados sugerem que o programa teve um impacto positivo em ambos os indicadores, destacando a importância de intervenções focadas na melhoria da capacidade respiratória e do desempenho físico.

Palavras-chaves: treinamento, músculos respiratórios, potência anaeróbica, rugby

INTRODUCTION

Rugby is a sport characterized by short duration and high intensity movements, which alternate periods of longer duration and lower motor intensity (Nunes , et al, 2018). In the context of high performance sports training, there are numerous variables that influence the physical performance, among these "(…) Maximum oxygen consumption is an indicator directly related to aerobic resistance, which makes it a determining factor in the performance of athletes" (Ochog & Calero, 2023, p.2).

Likewise, physical training is essential to optimize performance, either to improve a specific physical quality or to prevent injuries; among the variables in this type of training is the work on the inspiratory respiratory muscles. The benefits of adequate training are associated with a greater supply of oxygen to the tissues, which improves physical performance (Gómez, et al, 2016). On the other hand, fatigue of the inspiratory muscles can inhibit maximum physical performance, which negatively affects blood flow and perfusion of skeletal muscles, in addition to reducing maximum inspiratory pressure (Vasconcelos, et al., 2017).

Scientific advances reveal that the maximum inspiratory pressure is greater in the residual volume than in the functional residual capacity, because, in most cases, the inspiratory muscles are at their maximum length, which allows for greater tension to be generated; in addition, the fatigue endurance time of the expiratory muscles is greater than the fatigue endurance time of the inspiratory muscles.

This phenomenon can be explained by the fact that patients with chronic obstructive pulmonary disease are often hyperinflated and experience expiratory collapse, which requires active contraction of the expiratory muscles to facilitate air expulsion (Jiménez, et al., 2017). These subjects are able to increase respiratory endurance by around 300% and cycle endurance by 50% after isolated respiratory training.

For this type of training, devices are developed that offer endurance on inspiration and expiration, which causes an increase in the tension on the respiratory muscles. On the other hand, one of the characteristics of rugby is the variety of efforts required in both offensive and defensive actions, as well as the development of aerobic capacity (Frias & Ramos, 2021). It is important to know the viability of a training method, as this can provide valuable information to ensure the expected results (Way , et al., 2020).

In the sports field, inspiratory muscle training is presented as a therapeutic modality that overcomes the endurance against the muscles responsible for the expansion of the rib cage. This effort must be controlled, specific, and repeated at regular intervals. Its application has proven to be a viable strategy to optimize respiratory capacity, allowing the athlete to increase their physical tolerance in adverse situations during sports practice (Gómez, et al., 2016).

Lower limb power is one of the most relevant physical abilities in rugby players, given that the game involves high-intensity situations and rapid changes of direction (Martins , et al., 2018). The results show that inspiratory muscle training significantly improves the ability to generate greater maximum inspiratory pressure, these findings support the inclusion of this type of training, but in high-performance swimmers (Troncoso, et al., 2021).

In the context of rugby, technological advancement has increased competitiveness, and players of different training levels have managed to increase their maximum inspiratory pressure (Nunes , et al., 2018). Players are required to have a high level of aerobic endurance development, in addition to maintaining high performance under lactacidemia conditions (Frias & Ramos, 2021).

Many athletes who practice aerobic sports develop well-trained respiratory muscles due to the demands of training; a study conducted on rugby sevens players found no significant relationship between explosive strength and physical performance parameters (García, et al., 2023). However, it is still unknown whether additional respiratory muscle training can induce positive adaptations in aerobically trained athletes and improve the efficiency of their ventilatory processes.

The endurance to fatigue of these processes is related to the training status of the muscle. In rugby, it is essential to maintain high performance, in order to respond to prolonged demands of intensities, where anaerobic capacity is fundamental (Frias & Ramos, 2021).

Rugby players must have a wide variety of physiological responses due to the number of sprints, high-intensity runs and frequent physical contacts. A study, carried out with a representative sample of rugby players from different positions, has shown that calculating oxygen consumption based on body weight, using a linear scale, is underestimated in heavier players (Moreno et al, 2023).

Based on the questions raised, it is posed how to implement a training protocol for the inspiratory respiratory muscles to improve anaerobic power in rugby players, and what would be the difference in the results between an experimental group and a control group. It is important to highlight that the maximum inspiratory and expiratory pressure increase significantly after training of the inspiratory muscles, influenced by the cardiovascular system responsible for transporting blood to the tissues (Nunes , et al., 2018).

Therefore, the objective of this study was to describe a methodology for training the inspiratory muscles to improve anaerobic capacity in rugby players.

MATERIALS AND METHODS

The research was quantitative with a quasi-experimental design, longitudinal type, the population was made up of players belonging to the first rugby team of the city of La Serena, in Chile, aged between 18 and 34 years. The sample used was intentional, based on the accessibility to obtain the data.

The subjects were classified as active, with an average training frequency of between three and five times per week, and an individual frequency of between two and three training sessions, with an average session duration of 120 minutes. All players had a minimum of five years of competition in the first division championship of the Santiago Rugby Association (ARUSA).

The variables selected for this study were inspiratory pressure maximum and anaerobic power. Subjects with a history of musculoskeletal injuries that prevented them from performing the test were excluded. A Micro RPM brand pymometer was used to evaluate the inspiratory and expiratory pressure generated by the respiratory muscles, and noninvasively measured the strength of the respiratory muscles (in cmH2O), maximum inspiratory and expiratory pressure (MIP/MEP) in the mouth.

For inspiratory muscle training, the Powerbreathe ® device was used, patented by IMT Technologies LTD, consisting of a mouthpiece, a main body and a regulator that, through a valve, controlled the resistance of the air passage, with 10 levels of training load, for the inspiratory muscles.

The protocol used was to perform 60 breaths at 50% of maximum inspiratory pressure (PIMAX) once a day, three times a week, for six weeks (two days were before rugby training and one day before the match), this protocol was based on a systematic review of the literature to analyze the effects of Powerbreathe ® on muscle training inspiration, by athletes in the disciplines of swimming, cycling and rowing.

To assess maximum anaerobic power, an indirect Shuttle Run test was used, the purpose of this test was to measure the ability to repeat sprints in each subject; the local muscular endurance of the lower limbs; as well as agility. The materials used were six cones, a measuring tape, a grass surface, two stopwatches and a whistle.

Two athletes were required for this test, the exact distance covered by each was measured (0 m 5 m 10 m 15 m 20 m 25 m), they started the test at point (0), and at an audible signal (whistle), they ran to cone 1, touched the base of the cone with their foot and, returned to point 0, touched the base, and then ran to point 2; it continued in this way, at the remaining cones (3, 4 and 5) and made sure to return to the start (0) between each start.

At the sound of the whistle after 30 seconds, the athletes rest for 35 seconds, while the player's distance is recorded. The measured distance was taken from the position of the front foot at the moment the whistle blew. During the recovery period, they made their way back to the starting point (0) and at the end of the 35 seconds, they started the next series of shuttles. They needed to complete six 30-second runs, with the distance of each series recorded. The aim of the test was to cover the greatest possible distance in the six runs which had to be completed at around 90% of their maximum heart rate.

Statistics v20 Software for Windows was used; to evaluate the results and check the assumption of normality, the Kolmogorov-Smirnov test was used; for the second step, the

LEVENE test was applied, as part of the T- student and to check the assumption of equality of variances and statistical significance, in the pre- and posttest.

RESULTS

A meeting was held with the staff of the La Serena rugby club, with the aim of carrying out a diagnosis of the players' physical performance during the matches; and an unstructured interview was conducted with the players, to obtain information about their experience on the field. During the conversations, the players stated that, from the 50th minute of the match, they experienced a decrease in their ability to execute sprints and cover longer distances, which revealed a lack of ability to maintain intensity during the second half of the match.

This finding indicated a possible deficiency in aerobic capacity or low anaerobic power towards the end of the match, which contributed to a decrease in physical performance. To address this issue, the Powerbreathe, the Shuttle Indirect Test, and the Indirect Shuttle Run Test and the Bronco Test were applied. A training protocol was designed, with respiratory valves once a day, three times a week, for six weeks and on Saturdays before each match. These tests allowed the players to improve their cardiorespiratory capacity and anaerobic power.

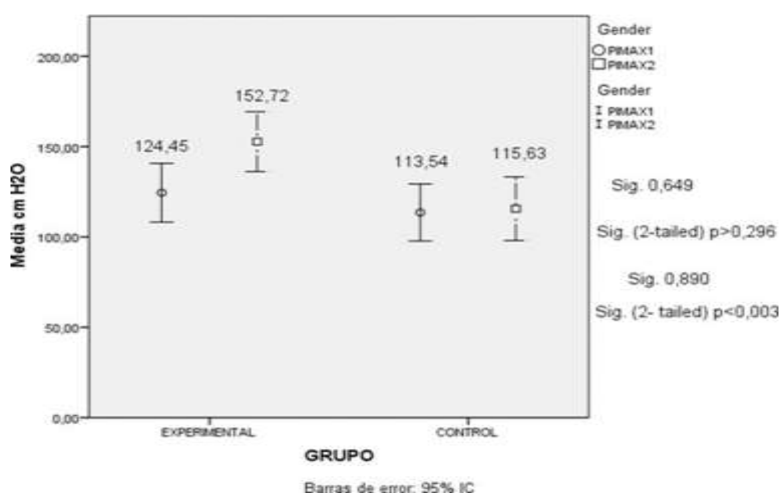

Figure 1. *Comparison of means in the PIMAX pre- and posttest, in the control and experimental groups*

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The effects of inspired respiratory muscle training performed using the PIMAX test are presented in the figure. In the experimental group, the average pretest pressure was 124.45 cmH2O; while in the posttest, it was 152.72 cmH2O, which represented an improvement of 23.84%. On the other hand, in the control group, the average pressure in the pretest was 113.54 cmH2O; and in the posttest, 115.63 cmH2O, which reflected an improvement of 1.84%.

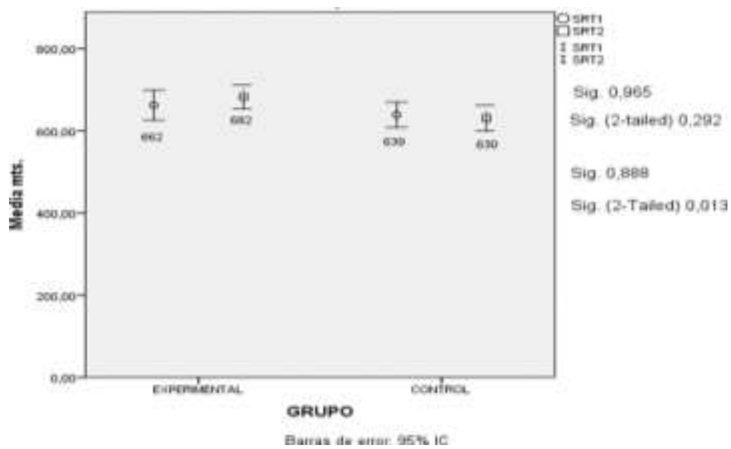

Figure 2. *Comparison of means in the pre- and posttest STR, in the control and experimental groups*

Figure 2 shows the effects of inspiratory respiratory muscle training in the Shuttle test, with a significant increase in the experimental group with a p value < 0.013. In the experimental group, the average in the pretest was 662 m; and in the posttest, 682 m, which represented an improvement of 3.09%. In the control group, the average in the pretest was 639 m; and in the posttest, 630 m, with a decrease of 1.40%.

		PIMAX1	SRT1
N		11	11
Normal Parameters[b,c]	Mean	124,4545	662,4091
	Std. Deviation	24,15932	54,67898
Most Extreme Differences	Absolute	,181	,216
	Positive	,117	,216
	Negative	-,181	-,210
Kolmogorov-Smirnov Z		,600	,716
Asymp. Sig. (2-tailed)		,864	,684

a. GRUPO = EXPERIMENTAL
b. Test distribution is Normal.
c. Calculated from data.

Table 1*. One- Sample Kolmogorov - Simrvov Test* [a]

In table 1, the samples came from a normal distribution for the PIMAX and Shuttle (SRT1) tests, the control group PIMAX1 had an average of 113.54 cmH2O, with a standard deviation of 23.27 cmH2O; and the experimental group, an average of 124.45 cmH2O, with a standard deviation of 24.15 cmH2O.

	GRUPO	N	Mean	Std. Deviation	Std. Error Mean
PIMAX2	CONTROL	11	115,6364	26,23842	7,91118
	EXPERIMENTAL	11	152,7273	24,67829	7,44079

Table 2*. Measurement in the PIMAX2 posttest in the control and experimental groups*

In table 2, the mean of the PIMAX2 posttest, the average of the control group was 115.63 cmH2O, with a standard deviation of 26.23 cmH2O; and the experimental group, 152.72 cmH2O, with a standard deviation of 24.67 cmH2O .

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	GRUPO	N	Mean	Std. Deviation	Std. Error Mean
SRT2	CONTROL	11	630,6818	46,42320	13,99712
	EXPERIMENTAL	11	682,8182	43,22978	13,03427

Table 3. *Measurement in the STR2 posttest, in the control and experimental groups*

In table 3, the mean of the SRT2 posttest of the control group was 630.68 m, with a standard deviation of 46.42 m; and the experimental group, 682.81 m, with a standard deviation of 43.22 m.

DISCUSSION

The results of the present study confirmed that inspiratory respiratory muscle training had positive effects on both improving respiratory capacity and physical performance; these findings were consistent with the results reported by Arnold & Bausek (2020) who observed improvements in respiratory function after similar training. In particular, in the PIMAX test, the control group experienced a notable improvement, showing that specific respiratory muscle training was effective in increasing respiratory strength.

The studies by Arnold & Bausek (2020) and the presented work agreed in revealing that combined training of the inspiratory and expiratory muscles had applications in improving airway protection, an important aspect in a population with conditions such as dysphasia.

The study by Way et al. (2020) suggested that longer and more frequent training periods were necessary to improve maximal pulmonary ventilation and aerobic endurance in soccer players, and noted that although the observed effects were encouraging, it is important to consider the duration and frequency of respiratory training in future studies.

In the Shuttle test, the results showed that the experimental group significantly improved in the distance covered, which suggested an improvement in the ability to maintain prolonged efforts, which coincided with the research of Mackala et al. (2019), who reported that respiratory training was able to improve both inspiratory muscle strength and aerobic endurance.

The improvement in performance during the Shuttle test reflected that respiratory training not only favored respiratory strength, but also endurance and physical performance in high-intensity exercises; similar results to those obtained by Wang et al. (2024), who found that applying techniques such as warm-up breathing and the diving reflex, caused by holding the breath, improved cardiopulmonary capacity and increased oxygen consumption during physical tests, which demonstrated that respiratory training had a positive impact on physical efficiency, especially in intense and prolonged activities.

Analysis of the PIMAX and Shuttle test distributions confirmed that the results were reliable, as no bias or random factors were observed in the samples, which confirmed their validity; the experimental group presented a higher respiratory capacity in the pretest and substantial improvements in respiratory strength were evident after training. The result highlighted the effectiveness of this type of intervention even in individuals with a high respiratory capacity.

As mentioned in Owen et al. (2023), the results suggested that in addition to respiratory training, other factors such as age and maturation should be considered in the design of training programs to maximize the physical performance of rugby players.

CONCLUSIONS

The findings of the study demonstrated a significant improvement in the tests applied to the experimental group, so respiratory muscle training had a positive impact on physical performance and players who implemented this type of training optimized aerobic and anaerobic capacity.

In terms of practical applications, the findings of this study highlighted the benefits of respiratory training in high-intensity and endurance sports such as rugby, as these athletes required a high capacity for anaerobic effort, and respiratory training was an effective intervention strategy. Another test that served to make an initial diagnosis was the Wingate

Test, due to rugby´s demand places on various physical qualities such as speed, maximum strength, power and flexibility, among others.

Finally, a major challenge identified was amateurism in rugby, where many players had to balance their training with study and work, which limited the time available for physical training.

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The author declares that there are no conflicts of interest.

Author's contribution:

The author is responsible for writing the work and analyzing the documents.