83 - EFFECTS OF CONCURRENT TRAINING ON PERFORMANCE DURING ENDURANCE EXERCISE

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The effects of strength and endurance training (concurrent training), the neuromuscular, metabolic and increased performance adaptation has been extensively studied by a lot of studies groups and showed different results. There is a lot of scientific evidence that strength training can increase aerobic performance and concurrent training could decrease strength gain compared with strength training alone.

Because this training models diversity showed in studies is very difficult to see consistent results. Despite it, the studies have showed increased aerobic performance and even strength performance for those who trained concurrent.

In a research with elite cross country runners, it was evidenced that concurrent training could increase running economy when it was compared with endurance training alone, this data is confirmed by Millet that has found similar results. Other studies have shown increased endurance performance, but also have shown decrease in strength performance when compared with strength training alone.

Concordant with this information Hakkinen et al find a decrease on strength performance when concurrent training was occurred, in part because there is a residual fatigue provoked by previous endurance exercise. MacCarthy et al did not find significant changes in levels of strength between concurrent and strength training groups. It is notice that there is a variety of results in models of studies with seems objectives.

Thus being, the present study of revision it has as objective to identify the chronic effect of the competing training on the performance during the aerobic exercise, and on the basis of the studies, to compare different models of training for the determination of the limitations between the types of the carried through research.

Kinds of training and physiological adaptations

Studies on the competing training have been carried through using different modalities of aerobic exercise, however, the majority use the race in the mat treadmill (2, 3, 7) as type of training; other studies use cicloergometro(8) as the trainings aerobic, still that in lesser scale of that the trainings of race.

The chronic adaptations to the carried through aerobic training in an isolated section of training. They represent such adaptations: the increase of the hair density, the increase of sanguine volume, the reduction of cardiac frequency, the increase of the deposit of muscular glycogen, and the increases of size and number of mitochondria, and enzymatic function, as well as change in the type of muscular fiber, seems not to happen in the same intensity during the competing training; the hypothesis is raised of that the esqueletic muscle does not have the capacity of if adapting simultaneously to the two types of train(9).

Kinds of strength training and physiological adaptations

The training of force carried through in isolated way promotes some physiological changes in the human body as chronic reply to the stimulations, the main ones are: increase of the size of the muscle (hypertrophy) and in the levels of force, among others. The force training possess innumerable 0 variable (number of repetitions, serial, of exercise, time of interval between the series and exercises and order of exercise), this makes it difficult the definition of which still more is the ideal training for the improvement of the force, that can or not benefit the aerobic capacity.

According to Campos et al(10), the muscular adaptation generated in reply the three different types of resistance training (group 1 of low 4 repetitions x 3-5 RM with 3 minutes of interval, group 2 of 3 repetitions intermediate x 9 -11RM with 2 minutes of interval and group 3 of 2 high repetitions x 20 - 28 RM with 1min of interval) and the specificity of the maximum repetition for one determined training zone, concluding that the adaptation reply of the training this related directly with the specificity for combinations of series and repetitions. This study it demonstrates that the variable of the force training influence directly in the physiological reply, justifying the limitation of if comparing the studies with different protocols.

Sequence of Training

Sequence of training is an excellent factor in function of the specific objective of the training, a time that intervenes of important form with the observed results. The study carried through for Chtara et al(2) evidenced significant improvement of the performance (ventilatory threshold and in the time test has limited and time in 4km), when the trainings of force (trainings in circuit) were carried through after the trainings of endurance. Already when the force training (trainings in circuit) was carried through immediately before the training of endurance, it did not have a significant improvement in the performance of the studied group. This study it seems to have design ideal to analyze the effect of the competing training, a time that adopts the two possible orders of trainings competing, two groups serving of comparison, being one only with trainings of force, another one endurance and still a group has only controlled, or either, all the controlled methodological possibilities.

It seems that for the comment of the influence of the adopted sequence of competing training, in the chronic effect of competing training, this he is "design" more appropriate, a time that the experimental groups had always carried through the two sequences of training (followed aerobic force and followed aerobic of force) in the same order during the study, thus being able to be compared between itself.

Effect of the trainings competing on the performance of endurance

The anaerobic power is determinative a basic one for the success in a race of aerobic character in athlete who has similar values of maximum VO2, is known the importance of the maximum consumption of oxygen in the performance of athlete of modality of endurance as, increase of the capilarização, enzymatic activity and mitocondrial density also indicates the importance of the oxidativa capacity of the esqueletic muscle in the performance of aerobic character. Already the trainings of force can favor the race economy, mainly, through neural adaptations, that include, alterations in the conscription and synchronization of motor units, contractions of sinergistas muscles in determined movements, minor activity of antagonistic muscles, increase of the reserve and production of elastic energy (improves of the function of stretch-shortening cycle) and still, the trainings of force take the hormones and enzymatic changes, especially in contractive enzymes as well as changes in the types of staple fibers muscular also in the training concurrent(5, 11).

As previous information the force training very generates a small effect on the aerobic capacity in itself, but still thus this type of trainings can intervene with the result of a race, for example; depending on the methodology adopted during the training of a race athlete and on the type of trainings of used force, some results can be waited, as for example the studies on the improvement of the performance during the accomplishment of the exercise of endurance for the neural adaptation and economy of running(2, 4, 7) or not the alteration of the way performance significant(3, 5).

A classic study of the Paavolainen et al(7) found resulted similar in that it says respect to the performance during the aerobic exercise, the trainings of carried through specific force in explosive way and with emphasis in the concentrically phase km without significant increase of VO2máx improved the time of athlete in the test of 5 time has limited of. The combination of the training of explosive force with the training of endurance km in all improves the time for 5 the well trained athletes in endurance, but, without changes in the VO2máx. This improvement is related the improvement in the standard of activation of the motor units (characteristic neuromuscular) and not aerobic, that is transferred to the Vmart (maximum speed reached during the metabolism anaerobic) (7) and economy of race. These results demonstrate that on factors the neural adaptation to the force exercise, such as coordination and conscription of motor units, greater movement efficiency, that are the main factor for which the trainings of force exert influence on the performance during the exercise aerobic(7).

To guarantee an excellent neural adaptation in a program of force training it is important to impose one stress of high value (great percentage of load of work during the force training) reaching thus all the motor units, mainly, of bigger threshold of excitabilities. It is known mainly that these neural adaptations happen, in the first weeks of training of strength (12, 13). Studies with duration above of 8 weeks (2), (2, 7) had shown that still adaptation occurs to neuromuscular responsible for mechanisms that can improve the performance during the exercise aerobic (2, 4). One another source of force training is the pliometric training that it shows to have benefits related to the improvement of the performance of the corridors. (14) (15).

On factors to the competing training that can influence the performance during the aerobic exercise

When the force training is carried through moments before to the training of endurance, seems to have a inhibition in the performance, what it does not happen when the opposite is carried through, or either, the trainings of endurance happening before the trainings of force (2), based in the acute hypothesis, exist a located residual fatigue in the trained muscle, being able to be explained by the accumulation of metabólitos and depletion of substrates (16).

Influence of the competing training in the race economy

The race economy (RE) typically is defined as a demand of energy consumed for one determined race speed submáxima, and is determined by the measure of the consumption of oxygen in "steady state" and the relation in the respiratory changes.

The RE is a steady test capable to identify to relatively small changes related to the training or other interventions. Some physiological factors and biochemists influence the RE in athlete of the trained elite or good. They include the adaptations intramuscular, as the increase of mitochondria and oxidativas enzymes, the capacity of muscular supply, release of elastic energy for the increase of tonus of the musculature, greater efficiency in the mechanism to save energy and improve in the vertical oscillation.

Studies have demonstrated the benefits of the competing training on the race economy. Johnston et al(17) had verified that I implement it of a program of training of force for running women of distance results positively in the race economy, and this improvement was of 4% after 10 weeks of training, these values seems small, but when if they relate the athlete, this small improvement can be the difference in the determination of a champion and a vice one. The author relates the improvement in the RE with the increase of force of the inferior members leading to a change in the standard of conscription of the motor units. In this in case that, the force training can, mainly, cause hypertrophy in staple fibers of fast contraction and the hypertrophy still occurs for staple fibers of slow contraction, thus requiring a lesser activation of the motor units to produce more force.

One another possible explanation for the improvement in the EC being able to involve the conversion of the type of fiber (13). Staron et al(18) had found a reduction in glicolítica staple fibers, of fast contraction and the type IIb, with a concomitant increase in the percentage of fast staple fibers of the type IIa, oxidativa and glicolítica. The staple fibers of the type IIa are oxidativas than staple fibers of the type IIb and possess more similar functional characteristics of the one than the staple fibers of type I. As consequence an increase in staple fibers of the type IIa shows an increase in the oxidativa capacity of the muscle, that can possibly contribute for the improvement of the performance of the capacity of endurance (38) improving the RE.

Mechanisms for the improvement of the performance

As given gotten in the study carried through for Hickson et al the submitted individuals to the competing training are citizens to the "phenomenon of the interference", that is, the muscular adaptations and metabolic they enter in a species of conflict, therefore they are inverse in the two types of training, thus causing, a reduction in the performance, as much in relation to the trainings of force, how much in relation to the trainings of endurance, when compared with these carried through trains of isolated form.

While the force training exerts an increase of production of muscular force, bigger enzymatic glicolitic activity and bigger supplies of ATP and fosfocreatina in the muscle and increase of the size and the section transversal of the muscular fiber, the trainings of endurance promote an increase in the mitocondrial and hair density, the content of mioglobina to intramuscular and the aerobic capacity maximal(7, 16). MacCarthy et al(5) had not found significant changes in the levels of force not even for changes of type of muscular fiber between the group that only trained force (high intensity) and the group of competing training (it trained force in high intensity and endurance in cicloergometro), but had presented significant difference for the group that only trained endurance what in part it can explain the improvement in the performance during the aerobic exercise

Conclusion

The carried through competing training of chronic form is considered an important factor in the influence of the performance during the aerobic exercise of citizens athlete or not athlete. In sight of the limitations of the studies how much a diversity of models presented in literature until the present moment, becomes difficult the visualization of an only reply. It can be affirmed that the improvement of the performance for neural adaptations exists, the improvement of the race economy, the improvement of the stretching cycle - shortening, the increase of the effort threshold, the improvement of the time has limited, the improvement of the efficiency mechanics and consequence the increase of the performance without VO2 increase max. These are the main benefits for which the force training can favor the performance during the aerobic exercise.

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Abstract

The concurrent training (strength and endurance) is associated to mechanisms that could increase performance during exercise, despite involved mechanisms are unclear, there is a hypothesis that the muscle submitted to a conflict situation can't adapt to both training models. There are controversial points at present literature about it, principally about the kind of strength training, sequence and training volume. Because the variety of designs of studies is very difficult to visualize and compare it, there are a lot of studies and different protocols of training. When we can compare similar trainings in studies, we can see that explosive and concentric strength training increase neural adaptation in muscle and can increase aerobic training performance. Running economy appears like an important factor related to an increase in aerobic training performance; many factors that increase aerobic performance are related to strength training. According papers used in the research, we can say that neural adaptation as result as strength training can increase performance during aerobic training through running economy.

Key words: Concurrent training; neural adaptation; running economy.

EFEITOS DO TREINAMENTO CONCORRENTE SOBRE A PERFORMANCE DURANTE O EXERCÍCIO AERÓBIO

Resumo

O treinamento concorrente (força e endurance) está associado com mecanismos que podem levar a um aumento no desempenho durante o exercício, embora estes mecanismos envolvidos não estejam totalmente esclarecidos, existe a hipótese de que o músculo esquelético é colocado em uma situação de conflito e não pode se adaptar aos dois tipos de treinamento. A presente literatura sobre o assunto apresenta pontos controversos, principalmente quanto ao tipo de treino utilizado, ordem de treinamento e volume de trabalho realizado. Devido à diversidade de desenhos de pesquisa torna-se muito difícil à visualização de resultados e comparações entre eles. Muitos destes estudos utilizam protocolos de treinamento diferente. Comparando-se estudos com tipos de treinamentos similares quando realizaram treinamento de força de caráter explosivo com ênfase na fase concêntrica onde a adaptação neural acontece, isso proporcionou melhora do desempenho durante o exercício aeróbio. A economia de corrida aparece como um dos fatores relacionados a melhora do desempenho; vários fatores que levam a economia de corrida estão relacionados ao treinamento de força. Os artigos científicos utilizados nesta pesquisa de revisão são artigos de estudo originais, indexados pela base de dados Pubmed e de categoria C internacional ou maior, a partir da década de oitenta e foram utilizadas as seguintes palavras chaves: treinamento concorrente, performance e economia de corrida. Nesta

pesquisa, pode-se dizer que a adaptação neural resultante do treinamento de força pode aumentar a performance durante o exercício aeróbio através da economia de corrida.

Palavras Chave: treinamento concorrente; economia de corrida; adaptação neural.

LOS EFECTOS DEL ENTRENAMIENTO CONCURRENTE EM FUNCIONAMIENTO DURANTE RESISTENCIA EJERCITAN

RESUMEN

El entrenamiento concurrente (fuerza y resistencia) se asocia a los mecanismos que podrían aumentar funcionamiento durante ejercicio, a pesar de mecanismos implicados es confuso, allí ordena y volumen del entrenamiento. Porque la variedad de diseños de estudios es muy difícil de visualizarlo y de comparar, hay muchos de estudios y diversos protocolos del entrenamiento. Cuando podemos comparar entrenamientos similares en estudios, podemos ver que explosivo y adaptación de los nervios de la fuerza del aumento concéntrico del entrenamiento en músculo y podemos aumentar funcionamiento aerobio del entrenamiento. La economía corriente aparece como un factor importante relacionado con un aumento en funcionamiento aerobio del entrenamiento; muchos factores que aumentan funcionamiento aerobio se relacionan con el entrenamiento de la fuerza. Acordando los papeles usados en la investigación, podemos decir que la adaptación de los nervios como resultado como entrenamiento de la fuerza puede aumentar funcionamiento durante el entrenamiento aerobio con economía corriente.

Palabra llave: entrenamiento concurrente; economia de funcionamento; adaptación de los nervios.

LES EFFETS DE LA FORMATION CONCOURANTE SUR L'EXÉCUTION PENDANT LA RÉSISTANCE S'EXERCENT

RÉSUMÉ

La formation concourante (force et résistance) est associée aux mécanismes qui pourraient augmenter l'exécution pendant l'exercice, en dépit des mécanismes impliqués sont peu claire, il y a une hypothèse que le muscle a soumise à un can't de situation de conflit s'adapte aux deux modèles de formation. Il y a de littérature de points controversés actuellement à son sujet, principalement au sujet du genre de formation de force, d'ordre et de volume de formation. Puisque la variété de conceptions des études est très difficile de la visualiser et comparer, il y a beaucoup d'études et différents protocoles de la formation. Quand nous pouvons comparer les formations semblables dans les études, nous pouvons voir qu'explosif et adaptation neurale de force d'augmentation concentrique de formation dans le muscle et pouvons augmenter l'exécution aérobie de formation. L'économie courante apparaît comme un facteur important lié à une augmentation d'exécution aérobie de formation; beaucoup de facteurs qui augmentent l'exécution aérobie sont liés à la formation de force. Accordant des papiers utilisés dans la recherche, nous pouvons dire que l'adaptation neurale comme résultat comme formation de force peut augmenter l'exécution pendant la formation aérobie par l'économie courante.

Clef Mot: concourante formation; adaptation neurale; économie courir;

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Palavras Chave: treinamento concorrente; economia de corrida; adaptação neural.