

Influence of Anti-group and Endurance Training on the Running Economy of Long-distance Runners and the Design and Application of Anti-group Training Scheme

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Abstract: This paper reviews the current research literature and explains how impedance training on improving maximum power and power output affects running economy, which is a key indicator of long-distance running. Studies have shown that maximum, explosive and mixed strength training during endurance training can have a positive role in improving running economy, but this improvement is easier to improve the performance of high-level long-distance runners. Among them, the resistance training lasted 10 -13 weeks, training frequency 3-4 times / week, and high weight training replaced low strength and multiple strength endurance training, which is more conducive to the promotion benefits of running economy. To avoid the incompatibility between endurance and strength training during the same period, maximum strength training and intense continuous running training are required to be at least 24 hours apart.

Keywords: Simultaneous Training; Group Resistance Training; Running Economy; Long-distance Runner; Training Scheme Design

Past studies have been suggesting that the maximal oxygen intake (VO₂max) is a key factor affecting the performance of middle and long-distance running, but recent scholars have proved that the improvement of running economy promotes the middle and long-distance running performance. Studies show that resistance resistance training and endurance training have multiple benefits for long-distance runners. However, because of the lack of relevant knowledge or some misunderstanding, many runners do not adopt the same period of training method in their training. This paper is mainly designed for athletes from a marathon distance of 1000 meters, amateur distance runners and competitive sprinters not within the scope of this article.

1. The impact of endurance and strength training on the running economy of long-distance runners in the same period

Through a review of the current research literature, the authors found that the researchers have not formed a relatively unified view on the effect of anti-group training on aerobic function, but most scholars believe that anti-group

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training has a positive role in promoting the improvement of running economy. Therefore, the more efficient and scientific training program to improve the performance of long-distance running has naturally become the entry point of deepening research. A recent literature review proposed that after medium-distance running, long-distance running, triathletes underwent concurrent high-load impedance training ($> 80\%1RM$ or $60-90\%1RM$), running economy improved 2-8% and effect sizes 0.14-3.22, the authors noted that typical measurement error range 1.6 to 2% with minimum meaningful change of about 2%, arguing that 2% improvement represents real improvement rather than due to measurement errors. A 2-8% improvement in running economy over the same period means such improvement is a meaningful change.

Storen et al found that running economy, peak speed and subjective fatigue were significantly improved in both the high load and low load training groups compared to the extremely low load resistance training group, with no weight change in each group.

Strength training, traditionally defined as impedance training, training load is greater than or equal to $85\%1RM$, Each group was 2-6 times, Group interval for at least 2 min, with the goal of developing the maximum strength, such training improves the hair force rate and muscle bond rigidity. This can reduce energy expenditure (shortening-induced energy cost) during muscle contraction and in turn improve running economy. Explosive training improves running economy. A range of metrics such as maximum power and peak power have been well established in the studies. The explosive force training in this study was described in a high-speed enhanced training with medium to maximum intensity ($75 - 95\%1RM$). In addition, it is also shown that reaction strength training (such as enhanced training with low load and high speed) can increase the hair force rate by improving the utilization of tension shortening circulation and leg muscle tendon rigidity. In conclusion, short periods of traditional strength training can improve the RE, of well-trained runners, but this improvement depends on the characteristics of strength training.

2. Design of the strength training scheme during the same training period

2.1 Type of training

The size of the cross section area of motor muscle and the strength of motor neurons recruitment are two important indicators of strength quality in terms of training effect, large weight training and explosive force training, both can strengthen the activation of motor units and improve the recruitment of motor nerves). Instead, large weight training mainly by raising more high threshold motor units increases the frequency of motor neurons recruitment, which in turn increases the ability to store and release elastic energy during running. Maximum strength training, which can change the proportion of different types of motor muscle fibers, which improves type A in type muscle fibers and decreased type X muscle fibers. According to the current findings, large-weight training has less risk of damage compared to other types of strength training (Lauersen et al. 2014), and are more likely to receive better training benefits in the short term; High-speed enhanced training described by explosive force training as medium to maximum intensity ($75-95\%1RM$) can also improve running economy, and mixed strength training combining the above two training advantages may be more promising.

2.2 Training cycle

The body's adaptation to strength training varies with the duration of the training. In the first 4-8 weeks of maximum strength training, the increase of strength quality was mainly related to the number, frequency and synchronization of motor units, while the increased cross-section of muscle fiber physiology showed that even with continuous adjustment for training load, strength quality was difficult to grow significantly again after 4-8 weeks. Strength training, usually below 8 weeks, is mainly characterized by increased neural activation function, reduced proportion of type X myofiber recruitment, and enhanced cooperativity, all of which contribute to improved RE, after 8 weeks, increased muscle hypertrophy and muscle-tendon consortium hardness became the main expression of fitness.

2.3 Training volume and intensity

The most common intensity or training load of concurrent impedance training targeting maximum force development is with a load greater than $70\%1RM$. Each training group was 2 – 6, with 3 – 10 replicates. According to

the training principle, it is recommended that the coaches regularly evaluate the athletes, 1RM to prevent overtraining. And determine the load progress to achieve the best yield, and for long distance runners, 4~5 times / week, 3 and 1 ~ 2 times / week; some professional weightlifters have the highest training frequency or even 18 times / week, the higher the training frequency, the better the training effect.

2.4 Recovery between the two classes

Doma et al (2013) believed that in order to maximize training, the order of training is also an important factor. This study found that strength training during endurance training, which, even after 6 hours of endurance training, will affect RE performance; Recovery time of less than 24 hours will affect the duration of exercise to exhaustion. Therefore, during endurance training, if frequent strength training, will have a negative impact on long-distance runners, combined with the results of Doma et al, the maximum strength training is at least 24h. Apart from the high-intensity continuous running training.

3. Conclusion and outlook

Maximum, explosive and mixed strength training during endurance training has a positive effect in improving running economy, but this improvement more easily improves the performance of high-distance runners. Among them, the resistance training lasted 10-13 weeks, training frequency 3-4 times / week, and high weight training replaced low strength and multiple strength endurance training, which is more conducive to the promotion benefits of running economy. Due to the positive effect on running economy (RunE), body composition change is recommended after equivalent training is negligible. High-load resistance training, explosive power, and reactive strength training can maximize running economy (RunE) improvements. The implementation of simultaneous training in competitive long distance runners should be scientific and taking into account the training cycle, exercise action selection, fatigue, current training status and other training variables recorded in this paper.

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