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Research on the analysis of training methods in the sport of swimming

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Abstract. Strength qualities are fundamental to the development of various physical qualities. Targeted land-based training based on the specific needs of the sport of swimming can contribute well to an athlete's underwater performance. Strength training combined with land and water can effectively improve athletes' core stability and short-distance swimming performance. This article aims to discuss in depth the comprehensive optimization of physical fitness in swimming training, focusing on the dialectical relationship between fast and slow movements and the integration of functional movements. The article adopts the methods of literature review and comparative analysis to systematically sort out and theoretically analyze the existing researches, and proposes the optimization strategies of fast movement, slow movement, and functional movement in swimming training. Although the existing methods are effective in improving physical fitness, they lack in-depth consideration of individual differences. The paper suggests that the limited training effect of fast and slow movements may be related to the over-generalization of training, and therefore suggests the introduction of more specialized functional movements, and emphasizes the focus on diet.

Keywords: physical training, swimmer, Strength training, Sports performance

1. Introduction

Swimming is a sport that is carried out in a special environment of water [1], which belongs to the category of physical fitness. The methods of improving physical fitness mainly include strength, speed, endurance, agility, and flexibility. As a comprehensive sport, swimming training has a profound impact on the overall improvement of athletes' comprehensive quality. It is not only to cultivate athletes' technical level, but also to exercise and strengthen their cardiopulmonary function, muscle strength, explosive power, and other aspects of physical fitness. This comprehensive training is not only beneficial to the swimming events themselves, but also plays a positive role in enabling athletes to have stronger physical reserves in other fields. However, the research on swimming training is not smooth sailing, and its difficulty mainly lies in the effective balance of fast and slow sports training, the development of individualized training programs suitable for different athletes, as well as improving the technical level.

How to effectively balance fast and slow movements in training and ensure coordination between them is a major difficulty in current swimming training research. Fast exercise emphasizes explosive power and speed, while slow exercise emphasizes endurance. How to make them complement each other has become an urgent problem to be solved in research. In addition, there are huge individual

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differences among different athletes, including technical level and physical condition. Therefore, how to make a comprehensive and personalized training plan to meet the needs of different athletes has become a challenge for researchers. And since swimming is a sport with high technical content, and its training research needs to solve how to better improve the technical level of athletes and make them better in competition. This requires in-depth excavation of training methods in order to better cultivate athletes' technical details and water quality. However, at present, due to the fact that the swimming teams of sports schools pay too much attention to the special exercises in water, and pay insufficient attention to the physical fitness exercises of teenagers, especially ignoring the importance of land strength quality to comprehensively improve physical fitness. Zheng believes that the land training methods are diversified and flexible, and the development of limb explosive power is more comprehensive, and the effect is better than that in water [2]. Therefore, the training methods and means related to strength quality in the training process lack of richness, physical exercise content is limited in a single way, which leads to unsatisfactory training results. Therefore, the purpose of this paper is to study the importance of swimming training in depth, to explore the reasons why swimming training is very important for athletes, and to analyze and study the complex difficulties faced in this field.

2. The physical qualities required for swimming training

The meaning of physical fitness includes physical ability, human function, physical quality, and physical adaptability. In a broad sense, physical fitness includes three aspects: form, function, and quality. The level of physical development of athletes is determined by their body shape, physiological function, and sports quality. Among them, motor diathesis refers to the basic motor abilities of the organism through muscle activities under the control of the central nervous system in the process of movement. In a narrow sense, the athlete's physical fitness level is mainly manifested through sports quality. In the study of exercise physiology and physique, physical ability refers to the body function, physiological function and exercise ability, aerobic, and anaerobic capacity belong to the scope of physical ability. In the study of physical fitness, physical fitness refers to physical fitness and physical adaptability [3]. Moreover, physical fitness can be divided according to different criteria. The main purpose of the division of physical fitness is to have a general understanding of the extension of the concept of physical fitness. However, the intensity of these attributes is not the same for different types of physical fitness.

Firstly, in terms of the way of acquisition, physical fitness can be divided into congenital physical fitness (congenital genetic possession, a part of trainability) and post-natural physical fitness (trainability). Innate physical fitness mainly depends on heredity, and acquired physical fitness is closely related to the athletes' living effects, training effects, and environmental effects. Therefore, the formation and development of athletes' physical fitness not only depend on congenital heredity, but also have a great relationship with the influence of acquired life, environment, and training. Secondly, from the nature of the work, it can be divided into structural physical ability and functional physical ability. Structural physical ability refers to a potential ability contained in the human body shape structure, the perfection of these structures of the human body determines the level of its functional activities. Function is the external expression of the system structure, and different structures inevitably embody different specific functions. For example, studies show that the reason why blacks can dominate many sports, such as sprinting, for a long time lies in the superiority of some structural physical abilities [4]. In addition, in terms of the energy supply system, physical fitness can be divided into anaerobic physical fitness (mainly anaerobic metabolism, including anaerobic non-lactic acid and anaerobic lactic acid) and aerobic physical fitness (mainly aerobic metabolism). The 100-meter run in track and field belongs to the anaerobic metabolism (anaerobic non-lactic acid) based physical speed items. It requires the athletes to keep high speed displacement movement under conditions of extreme strength without oxygen [5-6].

Moreover, physical ability can be divided into training physical ability and competition physical ability in terms of athletes' physical ability in training and competition. And according to the relationship between physical fitness and sports, physical fitness can be divided into two types of special physical fitness.

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3. Aerobic endurance and energy supply of swimming

3.1. Swimming

The competition distance of the swimming event is 50 meters, 100 meters, 200 meters, 400 meters, 800 meters, and 1500 meters. Because of the different sports intensity of the athletes at different sports distances, the energy supply system of the athletes is also different. From the three major energy supply systems, the characteristics of the phosphate system are fast energy supply speed, high output power but short energy supply time. The energy supply speed and output power of the glycolysis energy supply system are lower than those of the prophosphate system, but the energy supply time is slightly longer than that of the prophosphate system, which is 30 seconds to 1 minute 30 seconds. The energy supply speed of the aerobic oxidation system is the slowest, the participation of oxygen gas is required, the energy supply process does not produce other substances, and the energy supply time is long. From the perspective of competition time and distance, excellent swimmers only need 30 seconds and 60 seconds to finish 50 meters and 100 meters, respectively. According to the characteristics of the three major energy supply systems, the main energy supply system is the mixed energy supply based on anaerobic metabolism, such as the phosphogenic system and the glycolysis system. When the exercise distance and exercise time exceed the energy supply of anaerobic metabolism, the aerobic oxidation system will continuously improve the energy supply rate with the continuous increase in exercise time, so as to meet the needs of long-distance aerobic projects (Table 1). In 200-meter swimming events, the anaerobic metabolic system is the main energy supply, supplemented by aerobic metabolic system, and the proportion of aerobic metabolic energy supply gradually increases with the continuous improvement of exercise distance. Aerobic oxidation energy supply system is required when swimming exercise distance exceeds 200 meters, and the ratio of anaerobic metabolism to aerobic oxidation energy supply system also changes with the increase of exercise distance [7]. The energy supply system of swimming events changes with the change in exercise distance and exercise time. When the swimming distance exceeds 200 meters, the energy supply ratio of the aerobic oxidation system keeps rising, while the energy supply ratio of the anaerobic metabolic system gradually decreases.

Table 1. Main energy systems of swimming races at different distances [7]

Time	Normal race distance	Phosphogen system (%)	Glycolytic system (%)	Aerobic oxidation system (%)
10-20s	25-50m	78	20	2
40-60s	100m	25	65	10
1.5-2mins	200m	10	65	25
3-5mins	400-500m	7	40	53
5-6mins	400-500m	7	38	55
7-10mins	800-1000m	5	30	65
10-12mins	1000m	4	26	70
14-18mins	1500-1650m	3	20	77
18-22min	1500-1650m	2	18	80

3.2. Common training methods

When selecting the training method and mastering the amount of exercise, it must formulate the training plan scientifically according to the distribution characteristics of the energy supply system of the training method. At present, there are four common training methods for aerobic endurance, interval training, lactate threshold training, lactate threshold intensity training, maximum lactate steady-state training, and plateau (or low oxygen) training. Through the training of aerobic metabolism, the ability of oxygen transport and utilization in the body can be improved, the body can adapt, and the athlete's

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aerobic endurance can be improved. The adaptive changes of the body are mainly manifested in the functional adaptation of respiratory and circulatory systems, skeletal muscle adaptation, enzyme adaptation, energy material adaptation, and so on. After a period of training, athletes will lead to adaptive changes in the body, thereby improving the physical function of various parts of the body, and then showing a higher level of exercise.

4. Land physical training

4.1. Significance of Land physical training

Nowadays, most scholars agree that a certain proportion of land training for swimmers has a certain role and significance. In the training of swimming events, training on land cannot replace training on water, but resistance training on land is more effective than in water to increase the muscle load of athletes, and it is easier to quantify [8]. It can be said that land training is a supplement to water training. As the training time of amateur sports schools is relatively short, the content of land training is relatively monotonous, more attention is paid to strength training, and the correlation between different skills is not well taken into account, improvement of sports quality may be slow [9]. Reasonable and scientific land training can comprehensively improve the physical quality and special abilities of swimmers, not only laying a good foundation for water training, but also reduce the occurrence of sports injuries. Therefore, when arranging the training plan for swimmers, land training should occupy a certain proportion.

4.2. Training method

Land special strength training includes commonly used rubber band tension, equal dynamic tension, pulley tension, spring lever tension, and other land tension strength training. With the action and swimming posture of the four strokes closely combined, the body potential can be adopted in upright, sitting, or lying positions. It is very important to pay attention to the alternation and combination of dynamic and static strength exercises in land strength training [10]. Land training is based on the special characteristics of swimming, improving the athletes' muscle strength, endurance level, speed quality, sensitivity, flexibility, and other physical qualities, laying the foundation for improving athletic ability, and finally obtaining a higher level of competitive swimming ability. Land rally strength training mainly develops special maximum power, fast strength, and strength endurance.

4.2.1. Power training. Improve muscle contraction intensity, increase muscle fiber recruitment rate, mobilize more muscle fibers for work, strengthen correct movements. Pay attention to body position and posture. Max strength tension training is beneficial for the body to lie on the skateboard and perform other exercises in different postures. The max pulling load should be 15%-20% of body weight, 18 kg for men, 13 kg for women. The maximum power pull can effectively improve muscle strength and endurance, improving athletic performance. However, children should not participate. Fast strength emphasis on speed with a pull load of about 10% of own body weight (10 kg for excellent athletes). The action speed (frequency) should match or exceed game action frequency (4-6 seconds for 10 crawls/backstrokes and 4-6 seconds for 5 swim/breaststrokes). The number of pulls equals the number of movements for the special distance (20-25 times for 50 meters, 45-50 times for 100 meters). Control actions with number or time, with a time range of 30 seconds to 2 minutes. Each interval time group is longer, typically 3-4 repetitions. Rapid stretching compound training (Plyometrics) improves explosive power and coordination by rapidly stretching muscles and then contracting them [3]. It originated in track and field sports and is also known as plyometrics training or super-length training. This training emphasizes the conversion time of muscle contraction from centrifugal to centripetal contraction [4]. This training method extends from lower extremity "jump deep" exercises to upper limbs and core exercises and includes the development of sensitive coordination ability. Rapid expansion compound training is effective in improving explosive power and sensitive coordination abilities for athletes in different sports [4]. This training can improve the

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speed of athletes by shortening the response time of muscle elongation and contraction [4]. The application field of rapid expansion compound training has expanded from track and field fast strength events to ball games, and its scope will eventually extend to various events' special physical training [14]. Few studies have been conducted on the impact of rapid stretching compound training on swimmers' athletic ability, with most experiments using single group before and after control. Future research should consider the swimming specific situation, arrange relevant load, and target training movements when designing the rapid expansion compound training plan.

4.2.2. Strength endurance. Strength endurance rally training, with the number of movements or long duration as an evaluation indicator, the load of 4-8 kg, generally requires 100-300 times each pull or continuous pull for 5-20 minutes. For a long time, repeated tension training should emphasize correct and standardized movements, maintain the range of movements, and relax the movements. In order to make land tensile training as close as possible to the energy supply characteristics of special sports, tensile training can also use some methods of water training, such as variable speed, repetition, interval, games, competitions, etc., so that land strength training is more in line with the requirements of water training and improves the effect of land special strength training. Compared with traditional strength training, land resistance training has a more significant effect on improving athletes' skills, special sports performance, and muscle strength [13]. Under the premise of dynamic tensile strength training, static strength training can also be appropriately used. Static strength training can effectively strengthen the movement and increase tnerve impulses to movement controlling muscle group, thereby improving stimulus intensity. The effect of static strength training depends on the static motion and time. The choice of movement posture of swimming static training should be considered from two aspects: first, choose the typical movements and key movements of swimming propulsion force, such as holding water, bending arms, and high elbows. Second, the development of kinetic or weak muscles, using a variety of angles of static exercises. The duration of static exercise is generally limited to 30 seconds, and the load is adjusted according to the static time. When the static training weight is large, the time should be short, and when the weight is light, it is about 3 to 15 seconds, which can be extended appropriately after adaptation. It needs to repeat 3-6 sets. Static exercises should be combined with muscle-pulling dynamic relaxation activities, which is conducive to maintaining (improving) muscle elasticity.

5. Training Principles

5.1. Principle of gradual and orderly progress

The improvement of athletic ability needs to increase the training load step by step. Training with excessive load may not bring great improvement, but it will easily deform the training movements and increase the risk of injury and early entry into the peak of athletic career [15]. The subjects of this experiment are 12-14 year old female swimmers in early adolescence who are sensitive to strength development. During this period, we should pay more attention to the monitoring of load to avoid injuries caused by overtraining and to reach the peak of competitive ability prematurely.

5.2. Principle of periodic training

The adaptation of the human body to training is not only long-term, but also phased. In the long period of training process, the physical changes of athletes go through different stages, that is, the improvement of competitive ability, maintenance, and decline of three stages. This means that athletes cannot be in the best state of competition at any time, so in order to enable athletes to use the ability gained in training as much as possible in the game, training arrangements for different periods are particularly important [14]. Therefore, training should be planned and periodic, in order to arrange the appropriate training stimulus while ensuring timely recovery, which will be conducive to the long-term development of athletes.

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5.3. The principle of combining land and water training

Swimming is a whole-body sport. The disadvantage of land training is that it cannot use all the muscle fibers in water training at the same time, so land training is a supplement to water training, but can not replace water training. But training on land has some advantages over training on water. In other words, water training is the most direct and effective form of training to improve swimmers' specific performance, but strength training on land can better exert load on relevant muscles than water training [8]. At the same time, the influence of resistance during water training will slow down the movement speed of the athletes and may not be able to form a rapid force adaptation.

Through visiting experts and reviewing literature, it is understood that swimmers should conduct 2-3 land training sessions a week. Therefore, swimmers can improve their specific abilities through water training, while using land training as a supplement can effectively improve their muscle strength. However, water training and land training are often regarded as independent training. How to transfer the training effect obtained by land training to the water is more to be considered. The power generated by a swimmer during a fast stroke comes not only from the efficiency with which muscles produce power, but also from the ability of the central nervous system to properly innervate the muscle fibers needed to swim, which means that the muscle strength gained during training on land can be translated into the specialized abilities needed in the water. One method is to perform sprints in the water after land training to collect the required muscle fibers [8].

5.4. Diversity principle

A variety of training methods and means should be adopted in training to improve the coordination of athletes' muscle work, improve their training enthusiasm, and improve training efficiency. At the same time, in order to prevent injury caused by over-training of young swimmers, it is suggested that athletes should not only conduct water training or single-land training, but should encourage them to engage in other physical activities and increase strength training against load at the same time [16]. For example, when developing an athlete's upper body strength, in addition to traditional pull training, you can also add some fast stretching exercises with your bare hands and balls.

The selection of training methods for high-level swimmers needs to be reasonably adjusted according to individual differences, goals, and time. Different training methods have their advantages and disadvantages. A reasonable, comprehensive training program is an effective way to improve the level and keep healthy. In practice, scientific risk management, regular assessment, and adjustment will help to achieve better training results.

6. Conclusion

In swimming, both fast movement and slow movement training are of great significance. Theoretically, these two training methods can effectively promote the improvement of swimmers' absolute strength and explosive power. Although fast exercise and slow exercise training theoretically promote the improvement of absolute strength and explosive power, current research has found that they have limited improvement in swimming performance. Reasons for this may include limitations in training methods, lack of specialized functional movement training, and a lack of attention to diet.

Swimming is a systemic sport that involves multiple muscle groups working together, and traditional training methods may not be able to fully cover these aspects. Fast and slow movement training may not be able to combine the actual muscle groups used in swimming for specialized functional training, resulting in training that is less effective than expected in practice. Moreover, if the diet is not reasonable, the body cannot get enough energy and nutrition, and even with the quality of training, it is difficult to achieve the best performance state. In order to improve the swimming performance more effectively, it is necessary to develop towards more refined fast movement and slow movement training. First of all, it is necessary to develop specialized functional training movements or methods, especially targeted training for muscle groups actually used in swimming. Through the simulation of the competition scene, the training is closer to the actual needs. Secondly, it is necessary to enhance personalized training programs for each swimmer's physique, skill level, and needs, which are different, with the use of sports

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biomechanical analysis, genetic testing, and other modern technology, tailored for training programs to athletes that better suit their individual differences. Meanwhile, there is a need to delve deeper into more refined training methods while exploring the underlying mechanisms of physiology, the nervous system, and psychology to improve the training effect.

Therefore, the future training direction will be more personalized, scientific, and comprehensive. Combined with the application of modern technology, such as virtual reality technology, intelligent monitoring equipment, etc., to achieve more detailed training and more comprehensive data analysis. At the same time, focus on the overall training concept, including the comprehensive improvement of muscle strength, flexibility, technical excellence. and psychological quality, in order to better meet the comprehensive needs of swimmers in the arena. In this process, diet should also be a non-negligible part to ensure that athletes can obtain sufficient energy and nutritional support. Through these comprehensive developments, it is expected to provide more scientific and personalized training programs for high-level swimmers and promote the improvement of their performance.

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