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Concepts and principles of sports training: A narrative review based on the classic literature of reference

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Abstract

The training periodization is not something trivial and simplistic, on the contrary, in addition to the technical and practical knowledge about the sport in question, it is essential for the coach to have a solid knowledge of the general principles that govern training. In this case, we can point out the principle of biological individuality, adaptation, overload, continuity, volume-intensity interdependence and specificity. Such principles should not be seen in isolation, instead, the coach should see the close relationship established in each of them throughout training. This requires a careful and intentional manipulation of these principles throughout the micro and mesocycles in the most varied phases and periods of the periodization macrocycle. This intervention, when assertive, will not only allow the evolution and maintenance of the athlete's performance, as well as help in the preservation of their physical well-being, which will have repercussions on their general state of health. Thus, this article aims, through a narrative review based on the classic literature of reference, to discuss the main concepts and principles of sports training.

Keywords: sports training, training periodization, sports training principles

1. Introduction

Far beyond competition, recreational aspects, improved health and physical conditioning, the practice of sports over the years has also become an object of scientific investigation. From the ancient Olympic Games to the practice of contemporary sports, the trajectory followed in favor of the scientificization of sport is notorious ^[1].

Sports training, regardless of the modality in question, is an extremely complex physical activity. The progress in the athlete's sports performance, whether professional or not, requires the improvement of several attributes, such as cardiovascular fitness, muscle strength and endurance, body composition, flexibility, agility, balance, motor coordination, speed, agility, time reaction, among others ^[2]. Additionally, it is essential the constant tactical, technical and cognitive refinement of the athlete, making him able to perform, with excellence, his sports performance ^[3]. Thus, it is up to the coach and the technical team the difficult mission of promoting this overall improvement in the athlete.

Thus, given the complex task of periodizing the athlete's sports training, it is up to the coach to master the conceptual bases and principles of sports training. Such knowledge is essential and directly contributes to the athlete's good performance. That said, this article aims, through a narrative review, to discuss the main concepts and principles of sports training.

2. Concepts and principles of sports training

2.1 Biological individuality principle

The principle of biological individuality addresses the fact that even for individuals of the same biological sex, age, ethnicity and with some similar phenotypic attributes (weight, height, body composition, among others), the physiological responses to a training program will have an impact distinct.

This is due to the complex interaction and interdependence between the genotypic and phenotypic characteristics of each individual's metabolism ^[4].

Such knowledge becomes crucial since, for best results, whenever possible, the training prescription must be individualized. Thus, the variables intensity, volume, duration, frequency and density, as well as physical exercise modalities and their specificities may be prescribed differently. Such adjustments will depend, for example, on the tactical position that the player plays, the physical abilities that one intends to improve, the technical-tactical gestures and actions performed, as well as the level of physical conditioning of the athlete in question.

2.2 Adaptation principle

The human body is extremely efficient at adapting to stress. This characteristic, among others, allowed the evolution and perpetuation of the species over the years. This principle applies perfectly in sports training. According to Weineck ^[5], physiological adaptation is the most important characteristic for life, especially for human beings. It has as its central characteristic morphological and functional changes in several physiological systems.

To understand the principle of adaptation in training, it is necessary to recall the concept of homeostasis. According to Dantas ^[6], homeostasis represents harmony/balance in the functioning of physiological systems, which is influenced by intrinsic and extrinsic aspects of the individual. Among the extrinsic aspects, we can mention the sports training

According to Tubino ^[4], the stress provided by sports training, when in sufficiently intense volume and intensity, generates a physiological phenomenon called General Adaptation Syndrome (GAS), which acutely interrupts the basal homeostasis of the organism. The GAS is divided into 3 phases (alarm, adaptation and exhaustion).

The alarm phase represents the body's initial response to the stressor mechanism, in this case sports training. This fact requires from the different physiological systems acute responses that meet the demands imposed by the generated stress ^[4]. Among these responses, we can mention the increase in heart rate, as well as in the systolic volume and, consequently, in cardiac output and blood pressure, changes that aim to guarantee a greater supply of blood and oxygen to the tissues involved in this activity, especially the muscle tissue. On the other hand, we have the reduction of activities modulated by the parasympathetic autonomic nervous system, such as digestion.

Then we have the resistance phase, also known as the adaptation phase ^[4]. This phase in question is characterized by changes at the morphological, physiological and metabolic levels that allow the body to respond with less effort (hence the name adaptation principle) to the stressor mechanism, in this case sports training. Thus, changes such as strength gain, muscular endurance, and cardiorespiratory conditioning are observed in athletes who train at intensities that promote this need for adaptation. That is, they have a sufficiently relevant intensity to stimulate the SGA process. It is worth mentioning that the positive repercussion of these alterations in the athlete's performance requires practice time, that is, they are chronic.

Finally, we have the exhaustion phase. This phase is related to a phenomenon called "Overtraining" ^[7]. This process is the result of a high training overload without proper periods of recovery and recomposition of the athlete's physiological systems and structures. This condition leads to decreased

performance, increased predisposition to injuries and even immunosuppression ^[8].

Fortunately, a proper periodization of training can benefit from improving performance and avoiding the phenomenon of overtraining. For this, far beyond the training stimuli in moderate/high intensity, it is necessary to consider the periods of rest, recovery and regeneration of the athlete, within the sporting calendar of competitions and training.

2.3 Overload principle

Undoubtedly, the overload used in sports training, especially in athletes, is an essential variable for improving performance. Therefore, it will be up to the coach to use it intentionally and coherently in the planning of sports periodization. Its correct use during training sessions will break homeostasis, which in turn will require adaptive responses to the effort from the athlete's body. Furthermore, controlling this variable will help the athlete not to present a state of overtraining ^[9].

The control of training overload during periodization should not be seen in a simplistic and isolated way, that is, in just one session or in isolated exercises. The coach needs to understand that this variable must be understood as the interaction of the volume, duration, frequency and intensity of the load used at the time of periodization and the competitive and preparation calendar in which the athlete is.

It is worth mentioning that a very frequent error regarding the overload principle, regardless of the physical capacity to be improved, the athlete's biological characteristics and even the sports modality, is the idea that throughout the training periodization the athlete must use increasing overloads. Such conduct, constantly linked to short rest periods, will not only place the athlete on a performance plateau, but will also contribute to a state of overtraining ^[6]. Hence the need for stabilizing and regenerative microcycles during periodization, at strategic moments, which will cause physiological, metabolic and morphological supercompensation in the athlete. That is, they will be able to progress in training intensity ^[10].

2.4 Principle of continuity

It is widely known that sports training is capable of promoting physiological, metabolic and morphological changes that result in improvement of physical capacities and, consequently, improvement in sports performance ^[4]. This fact occurs not only in professional athletes with extensive experience, but also in amateur and beginner athletes.

In beginner athletes, in a short period of time (few months), it is possible to observe significant and expressive improvements in their performance. In professional athletes with a very high level of experience and physical conditioning, such changes are more time consuming, in addition to requiring greater dedication. This is because their physical capabilities are close to the physiological maximum limit. In other words, the less trained the individual, the more trainable he is, and the opposite is also true ^[4].

That said, it is worth mentioning that, in general, isolated training stimuli will not promote physiological, metabolic or morphological adaptations that result in a consistent improvement in performance. This process depends on the chronicity of the stimuli. This applies not only to improving physical capabilities, but also to maintaining it ^[4]. That is, if there is a significant discontinuity in the training process (around 3 to 4 weeks), even if minimal, there will already be a reduction in the performance of physical capacities. In this case, individuals with less training time (beginners) are the

most affected by the magnitude of the losses. This characteristic gives this training principle also the name of “reversibility principle”.

Fortunately, it has been shown that to maintain performance it is not necessary to continuously maintain training at the highest intensity and volume achieved by the athlete. In this case, smaller training volumes and moderate intensity are enough to maintain performance. This strategy is widely used by coaches in regenerative microcycles and can also be applied during the athlete's vacation periods. For example, a professional soccer athlete could easily maintain his cardiorespiratory fitness during the vacation period if he did moderate-intensity jogging on a treadmill at home for a few minutes (about 30 minutes 5 days a week). Such knowledge and conduct will allow a better return of the athlete to the pre-season period.

2.5 Principle of volume-intensity interdependence

This principle of sports training is directly related to another principle already discussed, that of overload. Before understanding it, it is necessary to remember separately the concepts of intensity and training volume.

The training intensity can be understood as the degree of effort or the level of fatigue reached by the individual during the practice of the physical activity in question. This in turn is a variable that is directly related to the level of physical fitness or physical conditioning of the athlete. That is, a given overload can represent different levels of intensity for the most varied subjects ^[11].

Its increase can be given through the total load used in the exercise, by the speed and range of movements, the combination of exercises, management of the rest time between the training series, among others. Its measurement can be done in a more precise, but expensive, way, such as through the assessment of oxygen consumption during activity (VO₂) (in a laboratory environment), or even by simpler methods such as lactate levels, heart rate monitoring or subjective perception of effort ^[11].

Regarding the volume, some aspects deserve to be commented. Initially, it is common for some coaches, the less experienced ones, to have an erroneous view of the athlete's real training volume, so that in many cases it ends up being underestimated. Such an error occurs due to the fact that often only the volume of a training session is counted, or even worse, a specific exercise. A good coach needs to monitor the training volume (total overload or distance covered) of the athlete throughout the micro and mesocycles in the most varied phases and periods of the periodization macrocycle ^[12]. That said, we can now comment on the interdependence between the volume and intensity variables. In sports training, increases in the intensity of the exercises performed will have a negative impact on the volume variable and, in the opposite way, exercises of lower intensity will allow a greater volume of training.

The explanation for the principle of volume-intensity interdependence is based on the physiological and metabolic events that affect the energy bioavailability of the muscle cell. Higher intensity exercise depletes the cell's energy stores more quickly, in this case, Adenosine Triphosphate (ATP). This requires other energy substrates such as glucose, fatty acids and amino acids to be metabolized to produce more ATP for muscle contraction ^[13].

Despite this variety of energy substrates for ATP production (glucose, fatty acids and amino acids), the greatest efficiency for ATP production occurs through metabolic pathways that

have good oxygen (O₂) availability (aerobic glycolysis and oxidative metabolism of fats). When the exercise intensity is increased, the greater the need for ATP production and, consequently, the greater the need for O₂ by the cell, which to a certain point (before the first ventilatory threshold - L₁, or anaerobic threshold) is maintained. After passing through the L₁, it becomes increasingly difficult to supply the O₂ demand of the cells that are performing muscle contraction, which leads to the accumulation of hydrogen ions (H⁺) that, if not properly buffered, will generate muscle fatigue and the consequent exercise interruption ^[13].

The knowledge of these physiological events is essential for the coach, who, from then on, should ask himself which variable he wants to prioritize for a given moment of the athlete's periodization, the volume or the intensity.

2.6 Specificity principle

Finally, the last principle that we will address here is the specificity of training. Nowadays it is very common to see some athletes performing exercises that, in essence, escape the physical and motor demands of the sport they practice. At an example level, it is as if a long-distance runner was in order to improve his maximum capacity to capture, transport and use oxygen as a source of energy (VO₂max) by swimming. This activity would not harm him and would probably be able to provide him with an improvement in VO₂, however the motor experiences of running, his main requirement activity in the modality would not be being performed. Such motor deprivation would deprive him of several biomechanical adjustments possible to be performed by the coach.

Another crucial point that deserves to be pointed out about training, which also usually makes mistakes, refers to the intensities used throughout the periodization. According to Barbanti ^[14], the effects of the intensity of the exercises used are specific to the body parts and systems performed. Thus, with the performance of strength training, musculoskeletal and neuro-motor changes will benefit athletes in a different way from muscular endurance workout. This requires that, except in the general preparation phase where the use of the most different intensities of exercise are necessary, throughout the micro and mesocycles in the most varied phases and periods of the periodization macrocycle, the most intensities are prioritized. required on the athlete during competition ^[14].

3. Conclusion

As we have seen throughout this article, the training periodization is not something trivial and simplistic, on the contrary, in addition to the technical and practical knowledge about the sport in question, it is essential for the coach to have a solid knowledge of the general principles that govern training. In this case, we can point out the principle of biological individuality, adaptation, overload, continuity, volume-intensity interdependence and specificity.

Such principles should not be seen in isolation, on the contrary, the coach should see the close relationship established in each of them throughout training. This requires a careful and intentional manipulation of these principles throughout the micro and mesocycles in the most varied phases and periods of the periodization macrocycle. This intervention, when assertive, will not only allow the evolution and maintenance of the athlete's performance, as well as help in the preservation of their physical well-being, which will have repercussions on their general state of health.

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