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Muscle strengthening and prophylactic methods for lower limbs in soccer athletes to minimize muscle imbalance

Fortalecimento muscular e métodos profiláticos de membros inferiores em atletas de futebol para minimizar o desequilíbrio muscular

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ABSTRACT
In soccer, physical preparation and muscle strengthening are of paramount importance to maximize the performance of athletes, but physical trainers, when systematizing and planning training, end up overestimating the anterior thigh muscles and underestimating the posterior thigh muscles, which are important. to improve the overall performance of the athlete. Thus, this study aimed to present strengthening and prevention methods to avoid muscle imbalance in soccer players. For the composition of this research, scientific articles published between the years 1994 to the most current 2023 were consulted. Injuries resulting from soccer are related to inadequate training, alterations that overload some body structures, causing muscle weakness, which may affect tendons and joints. Muscle strengthening and prevention methods are important factors to maintain constant muscle balance during training and games, contributing to injury prevention and increasing the level of competitiveness in this sport.

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Keywords: Muscle imbalance, Strengthening, Soccer, Lesion.

1 INTRODUCTION

Soccer has about 400 million players, a number estimated by the International Federation of Football (FIFA). Researches point soccer as the greatest precursor of injuries in world sports (SILVA et al. 2005; API et al., 2023). These injuries can be affected by muscle imbalance, which is a dysfunction of the musculoskeletal system, i.e., one muscle is stronger than the other, which can cause postural changes and making the body need to adapt, in a compensatory way, to balance this dysfunction, with a frequency that makes this issue a concern during sports practice (DAHER and MORAIS, 2011). Problems can occur when two opposite muscles, agonist and antagonist, have different forces (ASSIS et al. 2005).

It is a consensus that the strength of the quadriceps femoris is significantly higher than the strength of the ischiotibials, which has a strength percentage of 45 to 65%, when related to the maximum strength of the quadriceps femoris (OATIS, 2014). Cruz-Ferreira et al. (2015), report that the strength program, concentrically and eccentrically, may be the most effective in preventing injury and other damage to the hamstrings.

Knowing that soccer is a sport that uses a lot of muscular strength of the lower limbs, injuries resulting from this sport may be related to inadequate training and periodization, thus causing changes that overload some body structures, which may cause muscle weakening due to poor training, and may affect tendons and joints (KURATA et al. 2007).

The primary factor that can trigger muscle imbalance is the training load applied. Professionals in the sports area play a key role in planning and in the responsibility of monitoring this training load, respecting the physical conditions of their athletes, controlling the internal and external variables of their prescription (GOMES, 2015).

Knowing the risks in soccer, prevention methods must be used frequently, to reduce the rates of injuries during the game and during the competition (RIBEIRO, 2003). Muscle strength is a very important physical capacity for the search of a high performance in sports practice in any modality, and also in the identification of athletes at risk of musculoskeletal injury (NETO et al. 2010).

According to Paiva (2014), proprioception is one of the main methods of prevention when it comes to high performance sports. Proprioception is used to reduce injuries and even in the recovery of athletes, containing an improvement in the articulation of lower limbs. Wyrick (2005),

reports in his study that muscle proprioceptors provide information about the movements of muscles and joints. They signal when muscles are contracting or relaxing or what position a joint is in. In view of the points portrayed here, this review aimed to present the aspects related to soccer and the methods of strengthening and prevention to avoid muscle imbalance and possible injuries in soccer athletes.

2 METHODOLOGICAL PROCEDURES

To compose this review, a bibliographic search was conducted in Scielo, Portal de Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Google Scholar databases for scientific articles published until 2023 using the following descriptors alone or in combination: Interval training; Muscle imbalance; Strengthening, Soccer; Injury.

For the selection of the material, three stages were carried out. The first was characterized by the search of the material that comprised the months of January to March 2023 with the selection of 67 works. The second step was reading the titles and abstracts of the papers, aiming at a greater approximation and knowledge, and excluding those that were not related and relevant to the theme. After this selection, the texts that were available in full were searched, totaling 47 works, which were included in the review.

As criteria for eligibility and inclusion of articles, we analyzed the origin of the journal and indexing, studies that presented data referring to muscle strengthening and possible prophylactic methods for lower limbs in soccer athletes aiming to minimize muscle imbalance and the occurrence of injuries published between the years 1994 and 2023. As exclusion criteria, incomplete references and currently discredited information were used, since this research aims to review updated knowledge on the subject.

3 RESULTS AND DISCUSSION

3.1 ASPECTS RELATED TO SOCCER AND THE PHYSICAL ABILITIES

Brazil is a country in which the predominant sport is soccer and this is in our daily lives through conversations, discussions and bonds of friendships (ZUFFO et al., 2023). It is usually not given much value in other important issues and events in our territory, citing as an example the elections in comparison to soccer (NASCIMENTO et al., 2020). With a high number of practitioners, Silva et al (2011), state that soccer is a worldwide passion, a passion that is left aside when the subject is result, people like coaches and managers are more concerned about the

immediate result, leaving aside the physical and motor development, thus generating future complications.

This sport demands a lot from the athletes, being valid to emphasize that soccer is a modality that uses 88% of the aerobic capacity and the other 12% of the anaerobic capacity of high intensity, using all the physical capacities, such as: strength, flexibility, agility and speed (BARROS and GUERRA 2004; ZUFFO et al., 2023). Silva et al. (2008), report that besides physical abilities, motor coordination is a very important ability for the increase of athlete's performance, and the more coordinated they become, the more efficient they become, improving their ability to increase their physical and technical performance.

Guimarães and Paoli (2011) reason that soccer presents as a priority the refined physical and technical forms, giving the coach the possibility to identify which position the athlete will be used within the team, for a better use of his or her abilities.

Guerra and Souza (2008) discuss about the evolution of the athlete within the team, that it is not enough to have all the physical, technical and tactical conditions. There are extra field factors such as psychological, family, and financial problems that totally interfere in this training process, and end up forgetting the importance of the same in polishing its talent, a primordial factor to achieve its goal in sport, high level respecting the training processes.

According to Platonov (2008), it is defined as being the individual's ability to overcome or support an overload. Strength can be isometric, with no alteration in the length of muscles, isotonic, with alteration in the muscles, concentric when shortening occurs, or eccentric characterized by the lengthening of muscles.

According to Araújo (2009), muscle strengthening is beneficial to the flexor and extensor muscles of the lower limbs, because with strengthened muscles, the risk of injury is lower, thus contributing to improve the athlete's performance. Neto et al. (2010) describe muscle strength as a very important physical capacity for the pursuit of high performance in sports in any modality.

Training of vertical jump power collected in basketball athletes shows that it can be used in various sports, including volleyball and soccer, based on the training of extensor and flexor thigh muscles, which contribute to injury prevention by being properly strengthened (MAFFIULETTI et al., 2000). Gomes (2011) conducted muscle strength training to verify possible gains in horizontal and vertical jumps in goalkeepers aged 15 and 16 years. Before and after the training period, vertical and horizontal jump tests were applied, so at the end of the study there were gains of about 9 centimeters in relation to the horizontal jump and 7 centimeters in relation to the vertical jump of these goalkeepers.

Another physical capacity would be flexibility, characterized by the amplitude of movements, that is, the mobility of the joints of the whole body (PLATONOV, 2008). According to Daher and Morais (2011), flexibility in these athletes is weakened, soccer, due to its characteristics, can lead the athlete to a chronic rigidity in the sport situation. A well-prepared prevention strategy is important to improve the athlete's performance, and well-stretched muscles tend to increase efficiency and decrease energy expenditure in movement. Lima and Silva (2006) report that flexibility is not directly related to an increase in strength and endurance, portraying that the athlete who has good flexibility achieves an improvement in strength and muscular hypertrophy.

Silva et al (2015), argue that both athletes who play on the sidelines and midfielders exert the same power and flexibility during the game, the greater emphasis is concentrated on the posterior chain and all present the same characteristic of mechanical and moving use in a match.

When it comes to speed, this is a motor action performed in a short space of time, being a response of rapid movements (PLATONOV, 2008).

A study with soccer players places speed as an element of power, listing coordination as the main one of all physical qualities, and the more efficient this ability is, the better the player's performance will be (SILVA et al, 2008).

Some evaluations made to analyze the athletes' performance show that the junior category has a better performance in speed (LARISSA et al, 2008). The speed is a requirement of the power, is one of the most important variables when applied to soccer, the athlete needs this variable to have a good movement and dynamics within a match, which is strenuous and requires much of the physical condition of this athlete (FERREIRA et al, 2015).

And finally, we list in this set the agility, being one of the most important abilities when it comes to soccer. Some studies show that in the dynamic warm-up we can enhance this ability, along with horizontal impulsion, and that in the shortened game it can also play a key role in increasing the athlete's physical disposition (COLEDAM and SANTOS, 2013).

Knowing that agility is a very important factor for soccer athletes, professionals involved in physical preparation should pay attention to agility tests, so that there is improvement in this capacity (EDUARDO et al. 2015).

3.2 MUSCLE IMBALANCE - CAUSES AND INJURIES

Muscle imbalance, basically would be the non-strengthening of an agonist and antagonist musculoskeletal segment, leaving one of them weaker than the other. It is also characterized as a

dysfunction of the musculoskeletal system, i.e., a musculature stronger than the other, with this can occur postural changes and the body will need to adapt in a compensatory way to balance such dysfunction and the frequency of these changes in athletes, makes this issue, a problem in sports practice (DAHER and MORAIS, 2011). The highest rates of injuries caused by muscle imbalance would be in the ischiotibial joints, and may lead to injuries in the knee joints, which are the most aggravating in the modality and the most common in sports practice (GONÇALVES, 2000).

The sport demands a lot of physical and motor issues such as coordination, agility, speed, and flexibility. During a soccer match, the lower limbs end up being the most used, so the muscle imbalance between agonist and antagonist (quadriceps and ischiotibials) can directly affect the athlete's condition (FRANCISCO et al, 2010).

Kurata et al. (2007) report that the most constant injuries in soccer are sprains and muscle strains and may be related because of muscle imbalance, being responsible for the number of players lost to injuries, and the lower limb is usually the most affected by these injuries, because they are the most requested in the sport (ZAVARIZE et al. 2013). According to Prati and Vieira (2008), the rate of injuries in team sports is very high, including sprains, traumas and knee ligaments.

According to Reilly (1994), other factors related to injury are linked to "muscle fatigue," which is presented during continuous and intense exercises and may cause loss of *performance* due to low production of power and maximum strength, causing injury. Rahnama et al. (2002), in a study involving muscle fatigue in athletes, reported that during a soccer game the fatigue produced is related to the decrease in muscle strength of the knee extensors and flexors, concentrically and eccentrically, and at the end of the game it may cause injuries due to physical exhaustion. The ischiotibial muscles, when weakened, are more exposed to these injuries. Carvalhais et al. (2013) reported that the rates of muscle fatigue are higher in the knee flexor muscles than in the extensor muscles, and injuries are affected regardless of the position in which the athlete acts on the field.

According to Prado et al. (2004), the athlete's postural analysis can trigger differences in the athlete's performance, which can lead to a possible injury because of the wrong posture. Ribeiro et al. (2003), agreed that the athlete's postural relationship is totally involved when referring to sports injuries; the athlete's posture indicates the variable injuries that occur in soccer and among other sports.

Knowing that training well applied brings benefits to the athlete, Braz et al (2011), reported the context of periodization of players, which has total importance as to the load time applied and

the organization of training in the competitive period, using the means and methods in the best way.

Neto et al. (2010) state that muscle strength is a very important physical capacity for the pursuit of high performance in sports in any modality. Aagaard et al. (2000), corroborate that this modality demands a lot from the extensor and flexor musculature of the knee (quadriceps and hamstrings). Soares et al (2011), ponder the importance of maintaining the strength of the lower limb muscles while maintaining the biomechanical functions and the transfer of force both dynamically and statically in the prevention of anterior cruciate ligament injury.

3.3 PREVENTION METHODS TO MUSCLE IMBALANCE

Among the methods of prevention we have proprioception, which according to Paiva (2014) is one of the main methods of prevention when it comes to high performance sports, proprioception is used to reduce injuries and even recovery of athletes, observing an improvement in the articulation of lower limbs. Anderson et al. (2012), reports that proprioception, when well worked, develops self-perception of the body when moving, through physical practices we can develop proprioception for the execution of more correct movements, making the individual able to correct and improve movements.

Wyrick (2005) describes that muscle and joint proprioceptors (tendonous golgi organs and muscle spindle) provide information about muscle and joint movements, they signal when muscles are contracting or relaxing or the position that a joint is in. Rossato et al. (2013) confirm that proprioceptive training programs are fundamental in balancing, strengthening and restoring from joint injury and in preventing them.

Another method would be stretching where Gama et al. (2007) describe that after the training session it is important to increase flexibility in the ischiotibials, considering an increase in amplitude in the biomechanical movement and muscle relaxation for the player's recovery. Elastic stretching (which stimulates the joint to start some activity without much effort) before training can be frequently used, but plastic stretching (stretching that forces the limbs and joints, increasing joint mobility) is not often used and can make the joint weak during exercise and cause injury.

Alencar and Karinna (2010), report that stretching is a method used to increase the capacity and mobility of muscles and tendons that are shortened, which favors the increase of joint range of motion.

Cunha (2004), affirms that the group that needs a greater emphasis on stretching and flexibility in soccer athletes is the musculature of the thigh, femoral quadriceps and posterior thigh. Injuries to the posterior thigh are frequent and occur due to the demand for mobility when kicking off and/or kicking at goal, thus the importance of stretching work in athletes to increase the amplitude of movements.

Another factor would be the strength training ; Marchetti et al. (2014), exalt the importance of the three types of strength in training: concentric strength, eccentric strength and isometric strength. And so each athlete can originate different forces during the execution of movements, in addition to maximal strength, endurance, and speed training.

Platonov (2008) defines: Maximal strength as being the maximum level of force applied during voluntary muscle contraction, using the maximum force production that the muscle can produce; Endurance strength, the ability to maintain a high strength index high, for a longer period of time, overcoming fatigue and reaching the very high number of repetitions and Speed strength that involves the neuromuscular system to activate high force indexes in less time, it is considered the ability to move objects or even the body itself in the shortest possible time.

According to Steven and William (2006), the speed of dynamic execution has a direct relationship with the adaptation of muscle strength training; the speed exerted in the movement can collaborate with the improvement of both the strength and power capacity of athletes.

4 FINAL CONSIDERATIONS

Studies on muscular imbalance of the lower limbs in soccer athletes is a theme that has been worked on in many points, demonstrating how important muscle strengthening is to combat injuries in athletes.

The low demands of exercises aimed at the posterior thigh muscle group have favored the occurrence of muscular imbalances and injuries, and as portrayed in this study, needs to be reviewed, being fundamental in the athlete's physical and motor increment.

The preventive methods such as strength training, stretching, and proprioception, which were mentioned above, are the most used procedures in soccer for the maintenance of the players' physical and muscular condition. Research on this subject is important to clarify some concepts used in training. It is worth pointing out that there are several evaluative and prescription protocols that must be taken into consideration when determining the protocol, respecting the individuality and possible limitations that the athlete may have.

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