ORIGINAL RESEARCH

Methods Of Physical Exercise As A Way To Optimize The Physical Condition Of Football Players: A Systematic Review

Pomo warih Adi[1], Singgih Hendarto[1], Sapta Kunta Purnama[1], Rumi Iqbal Doewes[1], Sugiyanto[1], Muchsin Doewes[1]

[1]Universitas Sebelas Maret, Jl. Ir. Sutami 36 A Surakarta 57126, Jawa Tengah Indonesia.

Corresponding author: Pomo warih Adi
Address: Jl. Ir. Sutami 36 A Surakarta 57126, Jawa Tengah Indonesia.
Email: pomowarih@staff.uns.ac.id

Abstract

Objective: Investigating the training methods used to optimize the physical condition of football players and describing the results of each study.
Methods: This is a systematic review of published research. Articles published between 2015 and 2021 describing training methods to improve the physical condition of football players were reviewed. Electronic searches were conducted via Google Scholar, Web of Science, Scopus, and PubMed. All articles presenting methods of physical exercise to improve physical condition performance were included.
Results: There were 41 articles that used training methods to improve the physical condition of football players. From these articles, they are grouped according to the physical condition that is assessed and which is improved. Some of the training methods that can be used include neuromuscular, unilateral and bilateral, ballistic, plyometric, combined weight & plyometric, mixed training with optimum load, complex COD & plyometric, strength, combined strength, eccentric, repeated-sprint, resisted/unresisted sprint, resistance, elastic band, core, combine core & small-sided games, aerobic interval training, blood flow restriction aerobic interval training, intermittent, anaerobic speed endurance, high-intensity interval training, high-intensity interval training & small-sided games, tabata sprint, very-heavy sled, pilates, and functional.
Conclusion: After a systematic review, several training programs were found to improve the physical condition of football players such as strength, aerobic and anaerobic endurance, muscle power, speed and acceleration, flexibility, agility, and balance.

Introduction

In a football game, the level of activity and physiological responses during the game reflect the physical demands inherent in playing it. Therefore, football players must have optimal physical conditions to respond the physical demands that are typical of playing at a competitive level. Training sessions are part of an effort to achieve physical demands, containing a systematic program in preparation for achieving long-term career or formal preparation when involved in competition. Physical conditioning training is the most important element in football training, aimed at increasing physiological potential and developing biomotor skills at the highest level. Since football has a complex technical and tactical content, physical training can also be achieved in its own way which is oriented from a structural and developmental point of view towards the training goals. The physical condition component is identified exclusively with off-ball activities. The football player is a functional unit that behaves as a whole, so its performance cannot be divided into separate parts, which determines the formation of training in accordance with the requirements of the sport. Therefore, this study aim of investigating the training methods used to optimize the physical condition of football players and describes the results of each study. So that it can be seen the method of physical condition training in accordance with the game of football.

Methods

Database and Search Profile

This systematic review was conducted using Google Scholar, Web of Science, Scopus, and PubMed electronic searches. The keyword combinations used for the electronic search were “training”, “soccer”, and “football”. The search strategy is divided into four stages. The first stage was an electronic search on the databases of Google Scholar, Web of Science, Scopus, and PubMed which identified 557 articles. The second stage was filtering titles and abstracts (165 articles), eliminating 392 articles. Furthermore, articles were excluded based on reasons (59 articles), leaving 106 articles. The third stage was reading and analysis of the entire article starting from the title, abstract, method, results and discussion, as well as conclusions. After reviewing the articles, 65 were eliminated because not meeting the inclusion criteria. Fourth stage was review the relevant articles. At this stage, there is not new studies were included. Thus, the total number of articles for the systematic review consisted of 41 articles (Figure 1).

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria described in table 1.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
1. Articles published in the last 7 years (January 2015 to December 2021) 2. Written in English. 3. Only experimental studies were included. 4. The samples used in the study were male and female football players aged between 15 and 30 years. 5. The training session is fully explained. 6. The research method is a comparative study, which produces a certain impact in physical exercise. 7. The exercise method used physical exercise. 8. The study results explain the changes in the assessed physical conditions.	1. Articles using samples of age < 15 years and > 30 years. 2. Articles using a sample of footbal players with cerebral palsy 3. Articles that use samples are not only football players, but players of other sports. 4. The article does not describe the training sessions.

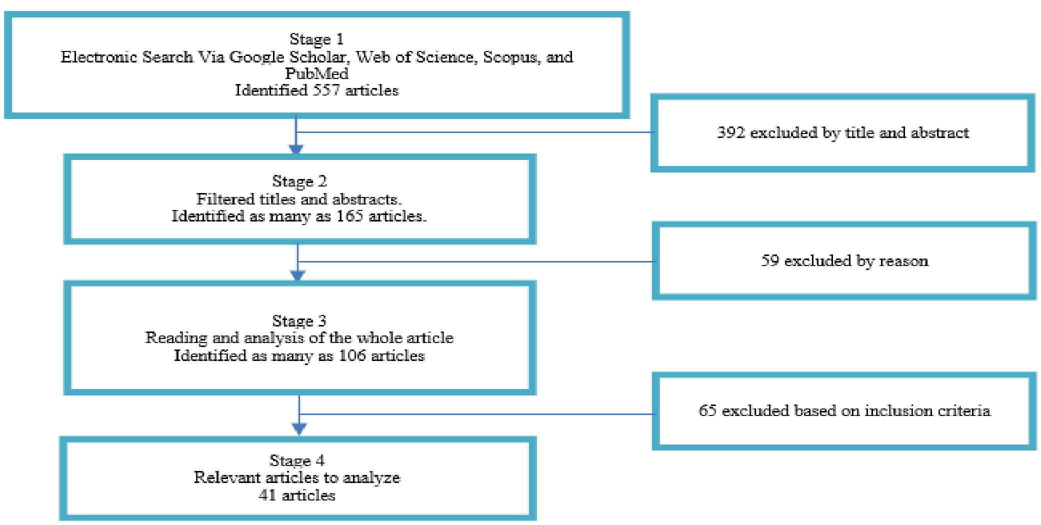

Figure 1. Flowchart of article identification in systematic review

Methodological quality assessment

11 PEDro (Physiotherapy Evidence Database) criteria were used to assess the quality of the articles reviewed. Assessment was done by giving an asterisk on each criterion. Articles with a score of eight to

eleven were considered to have high methodological quality, from four to seven moderate, and below four to low (Moseley et al., 2002).

Results and Discussion

Number of Results Reviewed

On an electronic search via Google Scholar, Web of Science, Scopus, and PubMed, 557 articles were identified and found no duplicate articles. Then the 557 articles were filtered by title and abstract, leaving 165 articles to be re-read. The results left 106 articles reviewed in total. Of the 106 articles, 65 were eliminated because they did not meet the inclusion criteria. Thus, the total number of studies for systematic review consists of 41 articles. This article is grouped by physical condition (table 2).

Exercise Significance Results

A total of 41 articles met the eligibility criteria based on the PEDro scale. Of the 41 articles selected and reviewed, regardless of gender, age, level of professionalism, beginner or elite players, or the type of training carried out, 39 articles revealed significant results on the physical condition of football players, namely [1-6]; [7-38] and only 2 articles, namely articles [39]&[40] which did not provide significant results on the physical condition of football.

Table 2. Characteristics and results of physical condition training methods for football players

Author, Year	Physical Condition Variable	Training Type	Performance
da Silva, et al., 2015 [1]	Aerobic endurance: VO2max	Aerobic Interval training	-
Mendiguchia, et al., 2015 [2]	Hamstring strength	Neuromuscular training	↑
Iaia, et al., 2015 [3]	Anaerobic endurance	Anaerobic speed endurance training: SEP (speed endurance production) SEM (speed endurance maintenance)	↑
Chinnavan, et al., 2015 [4]	Flexibility	Pilates training	↑
Loturco, et al., 2015 [5]	Acceleration, Strength	Ballistic exercise, (Jump squat (JS) and Half squat (HS))	↑
Los Arcos, et al., 2015 [6]	Aerobic fitness	Small-sided games (SSG) vs Aerobic Interval training (IT)	↑

de Hoyo, et al., 2016 [7]	Sprint, Muscle power, Agility (Change of direction)	Low/moderate load strength training: SQ (Full-back squat), RS (Resisted Sprint), PLYO (Plyometric training)	↑
Yanci, et al., 2016 [8]	Strength, Sprint, Agility	Plyometric training	-
Mohr & Krustrup, 2016 [9]	Anaerobic endurance	Anaerobic speed endurance training: SEP (speed endurance production) SEM (speed endurance maintenance)	↑
Tous-Fajardo, et al., 2016 [10]	Agility	Eccentric-overload and vibration training (EVT)	↑
Styles, et al., 2016 [11]	Strength	Strength training	↑
Rađo, et al., 2016 [12]	muscle power	Functional strength training	↑
Borges, et al., 2016 [13]	Speed	Resisted print training (RS), Plyometric training (PT)	↑
Ruivo, et al., 2016 [14]	Muscle endurance, Strength	Strength training	↑
Morin, et al., 2017 [15]	Acceleration	Very-Heavy Sled training	↑
Eniseler, et al., 2017 [16]	Anaerobic endurance	High-intensity Small-sided games (SSGT), Repeated-sprint training (RST)	↑
Rodríguez-Rosell, et al., 2017 [17]	Strength, Acceleration	Weight training (FSG), Combined weight training and plyometrics (COM)	↑
Hammami, et al., 2017 [18]	Speed, Agility, Strength	Strength training standard (ST), Contrast strength training (CST)	↑
Loturco, et al., 2017 [19]	Strength, Speed, Agility	Optimum power load (OPL) + resisted sprint (RS) OPL + vertical/horizontal plyometrics (PL)	↑
Rey, et al., 2017 [20]	Strength	Eccentric hamstring training: Nordic hamstring exercise (NHE), Russian belt (RB)	↑
Selmi, et al., 2017 [21]	Acceleration, Strength	Small-sided games (SSG), Repeated Sprint (RS)	↑
Otero-Esquina, et al., 2017 [22]	Strength, Speed, Agility	Combined strength training	↑
Ajayaghosh, 2017 [23]	Speed	Tabata sprint training	↑
Hammami, et al., 2018 [24]	Strength	Strength training	↑
Gill, et al., 2018 [25]	Speed, Agility, Strength	Resisted sprint training (RST), Unresisted sprint training (UR)	↑
Beato, et al., 2018 [26]	Speed, muscle power	Complex COD and plyometric training (CODJ), COD training (COD)	↑

Barbalho, et al., 2018 [27]	Strength, muscle power	Resistance training: nonlinear periodization model	↑
Amani, et al., 2018 [28]	Aerobic endurance	Blood flow restriction (BFR) aerobic interval training	↑
Ozcan, et al., 2018 [29]	Anaerobic endurance	Small-sided games training (SSGT), Conventional aerobic interval training (CAIT)	↑
Zouhal, et al., 2019 [30]	Agility	Neuromuscular training	↑
Paul, et al., 2019 [31]	Anaerobic endurance, muscle power Agility	Small-sided games & high intensity training (SSG & HIT)	↑
Tasevski, et al., 2020 [32]	Agility	Functional training	↑
Pardos-Mainer, et al., 2020 [33]	Speed, Agility	Combined strength and power training (CSPT)	↑
Stren, et al., 2020 [34]	Strength	Strength and power training: Unilateral (UG), Bilateral (BG)	↑
Januševičius, et al., 2020 [35]	Strength	Elastic band training	↑
de Oliveira, et al., 2020 [36]	Strength	Pragmatic nordic hamstring training (NHE)	↑
Calandro, et al., 2020 [37]	Aerobic endurance	Intermittent training	↑
Atli, 2021 [38]	Muscle power, Speed, Agility Flexibility	Core training	↑
Gökkurt & Kivrak, 2021 [39]	Speed, Agility, Acceleration	High intensity interval training	↑
Fischerova, et al., 2021 [40]	Strength	Strength training	↑
Arslan, et al., 2021 [41]	Speed, Strength, Balance	Combined core training + small-sided games (SSGcore), Small-sided games training (SSG)	↑

Discussion

Neuromuscular training

Most studies in adolescents examine neuromuscular training as a strategy that includes strength, balance, and agility [18]. As Menezes et al [36], showed after 12 weeks a significant improvement in flexibility, balance, countermovement vertical jump height in prepubertal football players (age 8 years) in the experimental group. The same thing is also shown by Chappell & Limpisvasti [8], that the neuromuscular training program improves performance in vertical jumps, one right foot hop and one left foot hop. This means that undergoing a 6-week neuromuscular training program improves certain measures of athletic performance and changes movement patterns during the jump task in female football players. Study of Mendiguchia et al [35], the experimental group showed an increase in hamstring strength so that they were able to maintain the sprint performance of male amateur football players aged 21-22 years after undergoing 7 weeks neuromuscular training program. On the other hand, Zouhal et al [41], with their agility variable, showed that neuromuscular training significantly increased agility after elite football players aged 16-17 years underwent a neuromuscular training program for 6 weeks.

Unilateral and Bilateral training

Due to the adaptation of the explosive action of the neuromuscular system, unilateral and bilateral training strategies have emerged. Both of these training are equally effective for inducing increased strength and leg power as well as strength development. In line with this, Stern et al [42] have proven in their experiments 1 group underwent unilateral and 1 group underwent bilateral. After 6 weeks of training, both of them showed an increase in some of the measured strength variables. Of the 13 strength variables measured, bilateral showed a significant increase in back squat, RFESS, broad jump, 10m and 30m sprint (5 strength variables). Unilateral showed a significant increase in RFESS, left foot SLCMJ, left foot SLBJ, 10m sprint, and right foot 505-change of direction (5 variables of strength). Stern et al [42] showed that both unilateral and bilateral only increased in 5 strength variables. Combined, the two exercises can provide significant results. Ramírez-Campillo et al [43], who both underwent unilateral and bilateral training and combining the two exercises gave different results in football players aged 11 years. After undergoing 6 weeks of training, the combination of unilateral and lateral showed a significantly higher change in 13 of the 21 performance measures, whereas if it was only unilateral it showed 6 and if it was only bilateral it showed 3. So that the combination of these two exercises would be more beneficial to boost performance.

significant changes during high-intensity, short-term explosive exercise.

Ballistic training

Football players need strength and speed for any explosive action like jumping and kicking. Ballistics training is one of the exercises to optimize muscle strength and power. Ballistic training consist of dynamic motor activities such as throwing, jumping, and running using external or self-resistance [30]. In this case, Loturco et al [34], used ballistic exercises in the form of jump squats (JS) and half squats (HS) on male elite football players aged 23-24 years. After 4 weeks of different exercises, both groups (JS and HS) increased their acceleration from 5 to 10m. JS is more effective at reducing acceleration drop more than 0-5m. HS increases the height of the squat jump. Meanwhile, to increase the potential for strength and speed at the same time using ballistic exercises, Krawczyk & Pociecha [30] in their experiments showed that by applying a combination of ballistic and plyometric training methods for 6 weeks helped increase the speed and strength of young soccer players, this was due to body adaptation. increased against effort based on explosive muscle work.

Plyometric training

Mengsh, et al [37], explained that plyometric training is an exercise program that increases strength and speed. This exercise is needed for football players, because football players must have the ability to respond quickly and strongly when attacking and defending. In line with this, de Villarreal, et al [16] have proven plyometric training in increasing explosive action by finding improvements in CMJ, Abalakov vertical jump, 10m sprint, and 10m agility. However, several studies have shown the opposite result. In the Yanci et al (2016) experiment, after 6 weeks of training in the form of horizontal plyometric training (countermovement jump) in two groups with different volumes (1:1 and 2:1), there was no significant increase in post-training ($p > 0.05$) in the sprint, change of direction ability (CODA) and horizontal arm swing countermovement jump were reported in both groups. Similar to Borges et al [40], in their experiment comparing resisted-sprint training with plyometric training, the results showed better RSA ability and sprint time in the training-resistant group. This can be explained perhaps because of the different forms of exercise that are carried out so that it affects the results of the exercise. However, when combined with other exercises, it gives different results, such as Rodríguez-Rosell et al [44] who combined weight training and plyometric training in a 3-group experiment. 1 group only underwent weight training, 1 group underwent weight training and plyometric training, and 1 group acted as control. After 6 weeks of training, the results show that the combination of weight training and plyometric training provides more efficient benefits in improving sprint, acceleration and deceleration abilities, as well as jumps, when compared to weight training alone. Similar is the case with Beato et al [6], with their combined experiment between complex change of direction (COD) and plyometric training. After 6 weeks of training, combined training (complex change of direction (COD) and plyometric training) gave a greater effect in sprints and jumps, in contrast to if only undergoing COD training alone. On the other hand, if the addition of a load to plyometric training gives different results as in the Loturco, et al [33] experiment. If Yanci et al (2016) apply 2-4 times each form of exercise, it is different from Loturco et al [33] which applies 3-8 times with 6 repetitions. The results showed an increase in COD velocity, SJ and CMJ heights. In line with this, a progressive increase in the volume of plyometric training shows more favorable results for encouraging the specific performance of football players aged 13.0 ± 2.3 years [45].

Strength training

The need for injury prevention to support health related to playing football, has led to various forms of training for injury prevention such as eccentric training, neuromuscular training and exercises that focus on strength, flexibility, balance and stability [46]. Strength training is strength training to improve muscle strength performance and reduce the incidence of injuries in football players aged 15-23 years [20, 23, 24, 47-49]. In line with this, Zouita et al [46] also proved strength training in improving performance and reducing injury rates in young football players aged 13-14 years. Despite the age difference, strength training still gives significant results. After undergoing 12 weeks of training, the experimental group showed better performance in sprinting both speed and time, increased number of jumps, and lower incidence of injuries. On the other hand, Otero-Esquina et al [50], in a combined experiment of strength training consisting of full-back squats, Yo-Yo leg curls, plyometric exercises, and resisted-sprints, where the implementation used 2 week different sessions (1 session per session) and 2 sessions per week). After 7 weeks of training, the results provided an increase in the variables of CMJ, COD, and linear velocity of U17 and U19 youth football players. However, it is necessary to do a minimum of two sessions per week to improve sprints and COD tasks, while one session per week is sufficient to improve jumping ability. In addition, the combination of strength training, combined with power training, also gave a higher increase in speed performance and COD of female football players aged 16 years [51].

Eccentric training

In football, muscle injuries often occur during eccentric contractions where muscle contractions are accompanied by lengthening or stretching of the muscles. This incident can occur due to a lack of muscle strength, so a muscle strengthening exercise program is proposed, one of which uses eccentric training. In this case, de Hoyo et al [13], have proven the use of eccentric training. After the subjects underwent eccentric training in the form of leg-curls and half-squats for 10 weeks, it resulted in a reduction in the incidence and severity of muscle injuries, showing improvement in soccer tasks such as jumping and running. On the other hand, Rey et al [52] in their experiments showed the same results although with different forms of exercise, namely Nordic Hamstring Exercise (NHE) and Russian Belt (RB). After 10 weeks, both forms of exercise were effective in developing eccentric hamstring strength in right and left SLHB. NHE is effective in reducing bilateral asymmetry in hamstring strength. de Oliveira et al [15], also gave significant results using the NHE exercise program. After 4 weeks, it significantly increased the players' eccentric knee flexor strength in both the right and left limbs. In addition to increasing the player's muscle strength, eccentric training also affects agility. de Hoyo et al [14], in their 10-week experiment using eccentric-overload training effectively increased kinetic variables during 2 COD maneuvers, namely crossover and explosive sidestep cutting. Similarly, Tous-Fajardo et al [53] with eccentric-overload training and combining other types of exercise, namely vibration training, gave more significant results on agility performance after 11 weeks of training, when compared to eccentric-overload training alone. Through combined training (eccentric-overload + vibration training), it not only improves agility in changing directions but also linear speed.

Repeated-sprint training

Repeated-sprint training (RST) is defined as a series of short sprints of 3-7 seconds duration, each separated by a short recovery period of <60 seconds. RST is an exercise strategy targeting complex neuromuscular development such as single sprint performance or metabolic function or both simultaneously [25]. Within 6 weeks consisting of 3 sets of 6 repetitions of a maximum 40 m sprint (straight sprints in the 1st set, alternating directions of 450 and 900 in the 2nd and 3rd sets) with passive recovery of 20 seconds between sets, the RST showed improvement in RSAdecrement and increased in Yo-Yo IR1 professional junior football players aged 16 years [19]. Within 7 weeks, RST can improve sprint time and leg strength in 18-year-old professional football players [54].

Resisted/Unresisted sprint training

To increase running capacity in the form of speed and acceleration, it can be done using resisted sprint training. This exercise involves the athlete running with added weights or uphill or dune training. In line with this, Borges et al [40] in their experiment using resisted sprint training (sprints with a sled load of 10-13% body mass) on football players aged 16 years for 7 weeks, resulting in a greater increase in sprint time. On the other hand, Gill et al (2018) in their experiments produced new findings that resisted sprint training not only increases speed and acceleration, but also as a means of increasing agility and strength. Through Gill et al's experiment for 6 weeks on 22-year-old elite football players using 2 groups (resisted and unresisted). Subjects underwent a squat jump exercise session and a resisted/unresisted running protocol. The resisted group underwent a running protocol with additional weights using elastic cords and sheaves, elastic cords were attached to the athlete's waist during training. The results showed a significant increase in running ability across all distances (5m, 10m, 15m, 20m, 25m), direction change, SJ, and CMJ.

Resistance training

It is important for football players to have strong muscles as they help in performing football playing actions such as running, kicking and jumping. Resistance training stimulates protein in muscle cells, which in turn increases the muscle's ability to generate strength [55]. The proof, Barbalho et al [5] in their 15-week experiment on football players aged 18-20 years using resistance training with a nonlinear periodization model showed significant results in increasing muscle strength and power without destroying speed and agility.

Elastic band training

To increase muscle capacity so that it has functional task ability, trainers can use elactic band exercises that are effective and safe if performed by athletes [56]. The proof can be seen in the study of Januševičius et al [27], in his experiment on 23-year-old professional football players who underwent elastic band training for 5 weeks. Subjects in this experiment underwent full ROM hamstring curls and maximal movement rate when lying on their stomach, 4-6 sets, duration 4 seconds, passive rest 3 minutes between sets. Participants in pairs, one holding a 1 m long elastic band tied with a special strap at the ankle while standing behind. The results show that maximum movement frequency of knee extension-flexion increase without significant effect on strength, jump, and sprint performance.

Core training

A strong body reduces the risk of injury and provides power to football players. Core training is one of the body parts that are responsible for developing power. Yakup [57], in a 12-week experiment, showed that core training applied to 16-year-old junior level players gave a significant increase in the parameters of balance, vertical jump, standing long jump, speed, and shuttle. The same thing was also shown by Atli [4], after 6 weeks of core training, the experimental group showed a significant difference in pre and post values in the 30m speed, vertical jump, flexibility and agility of soccer players aged 18-24 years, while the control group did not show the difference. Also in the study of Arslan et al [3], which combined core training with small-sided games on football players aged 16 years for 6 weeks, showed a significant increase in 20m sprint time, CMJ, SJ, three corner run test, and an increase in higher on the balance football of both feet.

Aerobic interval training

Aerobic interval training is known as exercise that induces a higher aerobic metabolic rate than anaerobic. Aerobic interval training for 5 weeks for soccer players aged 17 years which was applied based on PVP-CAR with 100% PV intensity, 4 sets of 4 minute bouts with 3 minute intervals were used in both groups. In group 1 (T12:12), for 4 minutes, the athletes performed repeated bouts of 10 x 12 seconds shuttle runs (with a change of direction every 6 seconds) separated by a 12 second recovery period. In group 2 (T6:6) consisted of 20 x 6 seconds separated by a recovery period of 6 seconds, and the athlete did not change direction. Both did not give significant results on the change in VO2max between the period before and after exercise. Thus, aerobic interval training with and without direction changes applied based on PV the results in increasing VO2max are the same [11]. Unlike the case with Los Arcos et al [32], in their experiment running aerobic interval training for 6 weeks (2-3 sessions per week), with an intervention of 3 bouts of 4 minutes each running at an exercise intensity of 90-95% HRmax for each player separated by 3 minutes of active jogging rest periods at 50-60% HRmax. The results show that it is effective in maintaining the aerobic fitness of 15-year-old football players. Even though in experiment comparing with small-sided games, the results were that both aerobic interval training and small-sided games training were equally effective in maintaining aerobic fitness, however, SSG increased significantly and increased the level of player play. On the other hand, by running conventional aerobic interval training for 6 weeks (2 sessions per week), 5 sets of 6 minutes duration of work at an intensity according to the anaerobic threshold and 3 minutes of rest between sets, can increase the anaerobic endurance parameters of amateur football players aged 21 years. [58].

Blood Flow Restriction Aerobic Interval training

This exercise has been proposed as an exercise that brings many benefits to improve adaptation in skeletal muscles and peripheral blood vessels, especially in the conduit arteries and capillary beds [59]. This exercise is performed with a blood pressure cuff combined with low weight resistance training. Amani et al [1], reported that exercise based on aerobic energy system intervals combined with blood flow restriction which was run for 2 weeks (4 sessions per week), exercise intensity was based on 60-70% maximum HR reserve where with a pressure of 140mmHG the first session and then increased to 180mmHG, can increase aerobic capacity and RPE simultaneously and prevent a decrease in VO2max due to exercise in young football players aged 23 years.

Intermittent training

Football matches are intermittent, so the ability to repeat high-intensity training is very important. Intermittent exercise training can be used to increase physical demands according to the actual needs of the competition [17]. Calandro et al [7] reported that a young football player aged 16 years, after undergoing intermittent training for 12 weeks (2-3 sessions per week) with sprints of 4-8 sets per session, work duration of 10-30 seconds and recovery of 10-30 seconds, showing a significant difference in aerobic performance. Therefore, intermittent training is an easy training method, even for young athletes, because it minimizes lactic acid production and the risk of injury. This study also shows the importance of paying attention to the recovery phase where the heart rate is feared to be low if recovery is >30 seconds.

Anaerobic speed endurance training

All football players are required to produce maximum effort in a short time interspersed with a short recovery period, thus triggering fatigue during play. Thus, high-intensity training is essential for competitive football players. Anaerobic speed endurance training is one of the exercises that can be done to overcome the endurance conditions of football players by optimizing RSA. There are two subcategories of this exercise, namely SEP and SEM. Iaia et al [26], in their experiment compared two sub-categories of anaerobic speed endurance training for 3 weeks (3 sessions per week). The results show that SEP with 6-8 repetitions of 20 seconds of all-out running bouts and 2 minutes of passive recovery can improve the performance of high-intensity repetitive and intermittent sprints, while SEM with 6-8 repetitions of 20 seconds of all-out efforts and 40 repetitions of exercise. Seconds of passive recovery can increase the muscle’s ability to maximize fatigue tolerance and maintain speed development during repetitive, short duration exercises. In line with previous research, Mohr & Krustrup [38] also gave similar results that after 19-year-old sub-elite football players underwent training for 4 weeks (2 sessions per week), SEP ratio of 1:5 (30 seconds: 150 seconds) increased capacity for intense intermittent exercise and repeated sprint ability to a higher level than 1:1 ratio SEM exercise (45 seconds: 45 seconds). This could be due to the higher exercise intensity during the SEP exercise intervention than the SEM. If the goal is to increase fatigue resistance, SEM can be a recommended alternative exercise.

High-intensity interval training

Laursen & Jenkins [31] explained that endurance will be increased if using HIT. This increase is partly due to the upregulation of aerobic and anaerobic metabolism for energy requirements. Several studies explain that high-intensity interval training programs are implemented to increase cardiorespiratory capacity. But on the other hand, the high-intensity interval training program that is run can also give different results. As Cvetković et al [10], in their experiment gave different results that a 12-week high-intensity interval training program could lead to positive changes in muscle fitness, flexibility, and biochemical parameters in overweight and obese children. In addition, Gökkurt & Kivrak [22], also gave different results. After undergoing a high-intensity interval training program for 8 weeks, the experimental group experienced significant improvements in speed, acceleration, and agility. When combined with other types of exercise also give different results. As in the experiment of Paul et al [60], which combined high-intensity training and small-sided games, for 4 weeks effectively increased anaerobic endurance, power, and agility in football players aged 16.2 ± 0.7 years. Different case if separated, will give different results. SSG training is an effective exercise to improve technical ability and agility, while HIIT is more suitable for speed and RSA-based conditioning in young football players [2].

Tabata sprint training

Tabata training helps improve athletic performance. The Tabata training protocol was carried out with constant exercise intensity (that is, 170% VO2max) from the first to the last exercise session [61]. The Tabata protocol is one of the HIIT models with a short time but high intensity followed by a relatively short recovery compared to execution time. Nithin et al [62] explained that the Tabata training method lasted for 4 minutes with 8 intervals. The exercise is carried out with a work duration of 20 seconds, 10 seconds of recovery and then repeat the pattern 8 times. In this case, Ajayaghosh [39], with a protocol of more than 4 minutes reported findings that during 12 weeks of tabata sprint training carried out with 3 exercise protocols (4.05 minutes short term, 8 minutes medium term, and 11 minutes long term), showed a significant improvement on the speed of football players aged 20-25 years. The short-term protocol was performed in 1 set with a duration of 20 seconds of work and 15 seconds of recovery per set, 7 repetitions. The medium-term protocol was performed with 2 sets with a duration of 20 seconds of work and 10 seconds of recovery per set, 6 reps. The long-term protocol was performed in 3 sets with a duration of 20 seconds of work and 10 seconds of recovery per set, 6 repetitions.

Very-heavy sled training

Very-heavy sled training is a weight training based on body mass. Kawamori et al [28] used an external load that reduced sprint velocity by about 30 and 10%, respectively, reporting that the heavy group significantly increased sprint time of 5 and 10m by 5.7 ± 5.7 and 5.0 ±, respectively. 3.5% ($P<0.05$). On the other hand, Morin et al [63] also in their experiment for 8 weeks (2 sessions per week) on 26-year-old soccer players showed that using a much larger load of 80% of body mass, clearly increased the maximum horizontal-force production. compared to standard unloaded sprint training. In addition, the increase in sprint performance of 5 m and 20 m was moderate and small for the very-heavy sled group and small and trivial for the control group.

Pilates training

Segal et al [64] explained that pilates training is designed to improve flexibility and overall health by emphasizing core strength, posture, breathing, and movement coordination. Pilates exercises are designed to place participants in positions that minimize unnecessary muscle recruitment and lead to decreased stability, premature fatigue, or impaired recovery. Chinnavan et al [9] reported that pilates training for 4 weeks (5 sessions per week) performed with leg circles, leg ups and downs, scissocrs, sidekicks, the saw, spine stretch, soulder bridge, neck pulls, pilates push ups, showed an increase in hamstring flexibility in football players aged 17-20 years. Increased flexibility involves biomechanical, neurological, and molecular mechanisms that determine long-term outcomes. After undergoing pilates training, the muscles become elastic gradually.

Functional training

Functional training is considered as an alternative to improve various measures of muscle fitness including strength, endurance, coordination and balance [65]. Functional training consists of characteristic physical movements to develop strength aimed at the entire human body. During functional training, the correct execution of exercises will lead to the development of the athlete's mobility and stability. This increased capability reduces the risk of accidents being suffered during the attempt. Tasevski et al [66] reported that functional training for 6 weeks with 4 sessions per week in the form of circuits had a positive effect in improving agility test results. In the first 2 weeks, 3 rounds were carried out at each station, 20 seconds duration per station, 90 seconds pause between stations. Week 3 and 4, 3 rounds at each station, duration 30 seconds per station, 90 seconds pause between stations. Week 5 and 6, 3 rounds at each station, duration 40 seconds per station, 90 seconds pause between stations.

Conclusion

After a systematic review, several training programs were found to improve the physical condition of football players such as strength, aerobic and anaerobic endurance, muscle power, speed and acceleration, flexibility, agility, and balance.

References

1. Amani, A.R., H. Sadeghi, and T. Afsharnezhad, *Interval training with blood flow restriction on aerobic performance among young soccer players at transition phase.* Montenegrin Journal of Sports Science and Medicine, 2018. **7**(2): p. 5.
2. Arslan, E., G. Orer, and F. Clemente, *Running-based high-intensity interval training vs. small-sided game training programs: effects on the physical performance, psychophysiological responses and technical skills in young soccer players.* Biology of Sport, 2020. **37**(2): p. 165-173.
3. Arslan, E., et al., *Short-term effects of on-field combined core strength and small-sided games training on physical performance in young*

soccer players. Biology of Sport, 2021. **38**(4): p. 609-616.

4. Atli, A., *The Effect of a Core Training Program Applied on Football Players on Some Performance Parameters.* Journal of Educational Issues, 2021. **7**(1): p. 337-350.
5. Barbalho, M., et al., *Non-linear resistance training program induced power and strength but not linear sprint velocity and agility gains in young soccer players.* Sports, 2018. **6**(2): p. 43.
6. Beato, M., et al., *Effects of plyometric and directional training on speed and jump performance in elite youth soccer players.* The Journal of Strength & Conditioning Research, 2018. **32**(2): p. 289-296.
7. Calandro, A., G. Esposito, and G. Altavilla, *Intermittent training and improvement of anthropometric parameters and aerobic capacity in youth football.* 2020.
8. Chappell, J.D. and O. Limpisvasti, *Effect of a neuromuscular training program on the kinetics and kinematics of jumping tasks.* The American journal of sports medicine, 2008. **36**(6): p. 1081-1086.
9. Chinnavan, E., S. Gopaladhas, and P. Kaikondan, *Effectiveness of pilates training in improving hamstring flexibility of football players.* Bangladesh Journal of Medical Science, 2015. **14**(3): p. 265-269.
10. Cvetković, N., et al., *Effects of a 12 week recreational football and high-intensity interval training on physical fitness in overweight children.* Facta Universitatis, Series: Physical Education and Sport, 2018: p. 435-450.
11. da Silva, J.F., et al., *The effect of two generic aerobic interval training methods on laboratory and field test performance in soccer players.* The Journal of Strength & Conditioning Research, 2015. **29**(6): p. 1666-1672.
12. de Hoyo, M., et al., *Comparative effects of in-season full-back squat, resisted sprint training, and plyometric training on explosive performance in U-19 elite soccer players.* The Journal of Strength & Conditioning Research, 2016. **30**(2): p. 368-377.
13. de Hoyo, M., et al., *Effects of a 10-week in-season eccentric-overload training program on muscle-injury prevention and performance in junior elite soccer players.* International journal of sports physiology and performance, 2015. **10**(1): p. 46-52.
14. de Hoyo, M., et al., *Effects of 10-week eccentric overload training on kinetic parameters during change of direction in football players.* Journal of sports sciences, 2016. **34**(14): p. 1380-1387.
15. de Oliveira, N.T., et al., *A four-week training program with the Nordic hamstring exercise during preseason increases eccentric strength of male soccer players.* International journal of sports physical therapy, 2020. **15**(4): p. 571.
16. de Villarreal, E.S., et al., *Effects of plyometric and sprint training on physical and technical skill performance in adolescent soccer players.* The Journal of Strength & Conditioning Research, 2015. **29**(7): p. 1894-1903.
17. Dellal, A., et al., *Physiologic effects of directional changes in intermittent*

exercise in soccer players. The Journal of Strength & Conditioning Research, 2010. **24**(12): p. 3219-3226.

18. Emery, C.A., et al., *Neuromuscular training injury prevention strategies in youth sport: a systematic review and meta-analysis.* British journal of sports medicine, 2015. **49**(13): p. 865-870.
19. Eniseler, N., et al., *High-intensity small-sided games versus repeated sprint training in junior soccer players.* Journal of human kinetics, 2017. **60**(1): p. 101-111.
20. Fischerova, P., et al., *The impact of strength training on the improvement of jumping ability and selected power parameters of the lower limbs in soccer players.* Baltic Journal of Health and Physical Activity, 2021. **13**(1): p. 9.
21. Gil, S., et al., *Effects of resisted sprint training on sprinting ability and change of direction speed in professional soccer players.* Journal of sports sciences, 2018. **36**(17): p. 1923-1929.
22. Gökkurt, K. and A. Kıvrak, *The effect of high intensity interval training during eight weeks on speed, agility, and acceleration in U19 soccer players.* Pakistan Journal of Medical and Health Sciences, 2021. **15**(8): p. 2390-2395.
23. Hammami, M., et al., *Effects of lower-limb strength training on agility, repeated sprinting with changes of direction, leg peak power, and neuromuscular adaptations of soccer players.* The Journal of Strength & Conditioning Research, 2018. **32**(1): p. 37-47.
24. Hammami, M., et al., *The effect of standard strength vs. contrast strength training on the development of sprint, agility, repeated change of direction, and jump in junior male soccer players.* Journal of strength and conditioning research, 2017. **31**(4): p. 901-912.
25. Iaia, F.M., et al., *Short-or long-rest intervals during repeated-sprint training in soccer?* PloS one, 2017. **12**(2): p. e0171462.
26. Iaia, F.M., et al., *The effect of two speed endurance training regimes on performance of soccer players.* PloS one, 2015. **10**(9): p. e0138096.
27. Januševičius, D., et al., *Integration of high velocity elastic band for hamstring training in pre-season routine of football players.* Baltic Journal of Sport and Health Sciences, 2020. **4**(119): p. 31-39.
28. Kawamori, N., et al., *Effects of weighted sled towing with heavy versus light load on sprint acceleration ability.* The Journal of Strength & Conditioning Research, 2014. **28**(10): p. 2738-2745.
29. Kim, J.-H. and Y.-H. Uhm, *Effect of ankle stabilization training using biofeedback on balance ability and lower limb muscle activity in football players with functional ankle instability.* The Journal of Korean Physical Therapy, 2016. **28**(3): p. 189-194.
30. Krawczyk, M. and M. Pociecha. *Influence of a 6-week mixed ballistic-plyometric training on the level of selected strength and speed indices of the lower limbs in young football players*. in *SOCIETY. INTEGRATION. EDUCATION.*

Proceedings of the International Scientific Conference. 2019.

31. Laursen, P.B. and D.G. Jenkins, *The scientific basis for high-intensity interval training.* Sports medicine, 2002. **32**(1): p. 53-73.
32. Los Arcos, A., et al., *Effects of small-sided games vs. interval training in aerobic fitness and physical enjoyment in young elite soccer players.* PloS one, 2015. **10**(9): p. e0137224.
33. Loturco, I., et al., *Mixed training methods: effects of combining resisted sprints or plyometrics with optimum power loads on sprint and agility performance in professional soccer players.* Frontiers in physiology, 2017. **8**: p. 1034.
34. Loturco, I., et al., *Half-squat or jump squat training under optimum power load conditions to counteract power and speed decrements in Brazilian elite soccer players during the preseason.* Journal of sports sciences, 2015. **33**(12): p. 1283-1292.
35. Mendiguchia, J., et al., *Effects of hamstring-emphasized neuromuscular training on strength and sprinting mechanics in football players.* Scandinavian journal of medicine & science in sports, 2015. **25**(6): p. e621-e629.
36. Menezes, G.B., et al., *Effects of integrative neuromuscular training on motor performance in prepubertal soccer players.* The Journal of Strength & Conditioning Research, 2022. **36**(6): p. 1667-1674.
37. Mengesh, M., R. Sangeeta, and M. Deyou, *Effects of plyometric training on soccer related physical fitness variables of intercollegiate female soccer players.* Turkish Journal of Kinesiology, 2015. **1**(1): p. 20-24.
38. Mohr, M. and P. Krustrup, *Comparison between two types of anaerobic speed endurance training in competitive soccer players.* Journal of Human Kinetics, 2016. **51**(1): p. 183-192.
39. Ajayaghosh, M., *Upshot of Tabata sprint training on selected speed parameters among men football players.* International Journal of Yoga, Physiotherapy and Physical Education, 2017. **2**(6): p. 33-36.
40. Borges, J., et al., *The effects of resisted sprint vs. plyometric training on sprint performance and repeated sprint ability during the final weeks of the youth soccer season.* Science & Sports, 2016. **31**(4): p. e101-e105.
41. Zouhal, H., et al., *Effects of neuromuscular training on agility performance in elite soccer players.* Frontiers in Physiology, 2019. **10**: p. 947.
42. Stern, D., et al., *A comparison of bilateral vs. unilateral-biased strength and power training interventions on measures of physical performance in elite youth soccer players.* The Journal of Strength & Conditioning Research, 2020. **34**(8): p. 2105-2111.
43. Ramírez-Campillo, R., et al., *Effect of unilateral, bilateral, and combined plyometric training on explosive and endurance performance of young soccer players.* The Journal of Strength & Conditioning Research, 2015. **29**(5): p. 1317-1328.
44. Rodríguez-Rosell, D., et al., *Effects of light-load maximal lifting velocity*

weight training vs. combined weight training and plyometrics on sprint, vertical jump and strength performance in adult soccer players. Journal of Science and Medicine in Sport, 2017. **20**(7): p. 695-699.

45. Ramírez-Campillo, R., et al., *Effect of progressive volume-based overload during plyometric training on explosive and endurance performance in young soccer players.* The Journal of Strength & Conditioning Research, 2015. **29**(7): p. 1884-1893.
46. Zouita, S., et al., *Strength training reduces injury rate in elite young soccer players during one season.* The Journal of Strength & Conditioning Research, 2016. **30**(5): p. 1295-1307.
47. Styles, W.J., M.J. Matthews, and P. Comfort, *Effects of strength training on squat and sprint performance in soccer players.* Journal of strength and conditioning research, 2016. **30**(6): p. 1534-1539.
48. Rađo, I., et al., *Functional strength training effects on knee flexors and extensors power output in football players.* Sport Mont, 2016. **14**(2): p. 13-16.
49. Ruivo, R., A. Carita, and P. Pezarat-Correia, *Effects of a 16-week strength-training program on soccer players.* Science & Sports, 2016. **31**(5): p. e107-e113.
50. Otero-Esquina, C., et al., *Is strength-training frequency a key factor to develop performance adaptations in young elite soccer players?* European journal of sport science, 2017. **17**(10): p. 1241-1251.
51. Pardos-Mainer, E., et al., *Effects of combined strength and power training on physical performance and interlimb asymmetries in adolescent female soccer players.* International Journal of Sports Physiology and Performance, 2020. **15**(8): p. 1147-1155.
52. Rey, E., et al., *Effects of a 10-week Nordic hamstring exercise and Russian belt training on posterior lower-limb muscle strength in elite junior soccer players.* The Journal of Strength & Conditioning Research, 2017. **31**(5): p. 1198-1205.
53. Tous-Fajardo, J., et al., *Enhancing change-of-direction speed in soccer players by functional inertial eccentric overload and vibration training.* International journal of sports physiology and performance, 2016. **11**(1): p. 66-73.
54. Selmi, O., et al., *Modeling in football training: the effect of two methods of training based on small sided games and repeated sprints on mood and physical performance among footballers.* Advances in Physical Education, 2017. **7**(03): p. 354.
55. Suresh, N. and P. Kavithashri, *Effects of SAQ with resistance training on physical and skill performance of Tribal football players.* 2021.
56. Oesen, S., et al., *Effects of elastic band resistance training and nutritional supplementation on physical performance of institutionalised elderly—A randomized controlled trial.* Experimental gerontology, 2015. **72**: p. 99-108.
57. Afyon, Y.A., *Effect of core training on 16 year-old soccer players.* Educational Research and Reviews, 2014. **9**(23): p. 1275-1279.

58. Özcan, İ., N. Eniseler, and Ç. Şahan, *Effects of small-sided games and conventional aerobic interval training on various physiological characteristics and defensive and offensive skills used in soccer.* Kinesiology, 2018. **50**(1.): p. 104-111.

59. Taylor, C.W., S.A. Ingham, and R.A. Ferguson, *Acute and chronic effect of sprint interval training combined with postexercise blood-flow restriction in trained individuals.* Experimental physiology, 2016. **101**(1): p. 143-154.

60. Paul, D.J., J.B. Marques, and G.P. Nassis, *The effect of a concentrated period of soccer-specific fitness training with small-sided games on physical fitness in youth players.* J Sports Med Phys Fitness, 2019. **59**(6): p. 962-968.

61. Tabata, I., *Tabata training: one of the most energetically effective high-intensity intermittent training methods.* The Journal of Physiological Sciences, 2019. **69**(4): p. 559-572.

62. Nithin, M., et al., *Effect of Tabata training on agility and speed among hockey players.* Mukt Shabd Journal, 2020. **9**(7): p. 1209-13.

63. Morin, J.-B., et al., *Very-heavy sled training for improving horizontal-force output in soccer players.* International journal of sports physiology and performance, 2017. **12**(6): p. 840-844.

64. Segal, N.A., J. Hein, and J.R. Basford, *The effects of Pilates training on flexibility and body composition: an observational study.* Archives of physical medicine and rehabilitation, 2004. **85**(12): p. 1977-1981.

65. Ramesh, K. and S. Arumugam, *EFFECT OF FUNCTIONAL STRENGTH TRAINING ON EXPLOSIVE STRENGTH AMONG COLLEGE FOOTBALL PLAYER.*

66. Tasevski, Z., et al., *Influence of an adapted functional football training in improving the specific-motor performances of football players.* Research in Physical Education, Sport and Health, Skopje, 2020.