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REVIEW ARTICLE **OPEN ACCESS**

Effects of Exercise Frequency with Circuit Training (CT)on Measures of Physical Fitness Among Athletes: A Systematic Review

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ABSTRACT
The primary aim of this systematic review was to evaluate and compare the published studies that have investigated the impact of high, moderate, and low intensity circuit training protocols influence key aspects of physical fitness. The searches were carried out on the electronic database PubMed and Google Scholar platforms. Study was selected based on specific inclusion and exclusion criteria, such as, studies from October 2013 to October 2023 related to varied intensity Circuit training and its effect on physical fitness in active male athletes aged between 10 and 25 were included, the research employed a randomized and non-randomized controlled trial design involving athletes from diverse sporting backgrounds. Ten of 1432 studies were included in this review. The studies were of a high standard of quality. Analysis of the study data revealed notable differences in the impact of high, moderate, and low intensity circuit training on various aspects of physical fitness. HICT demonstrated significant improvements in speed, coordination, balance muscle strength, power, muscle endurance, cardiovascular endurance with a moderate impact on body composition. MICT resulted in balanced enhancements across all measured parameters, Whereas the HICT group and MICT group didn't show significant difference on their agility, flexibility. while LICT, yet there is no evidence regarding the effect of LICT on cardiovascular endurance but limited improvements in other fitness dimensions. Our study reveals that training with high intensity demonstrates greater effectiveness in physical fitness improvements among athletes when compared to moderate-intensity training., From our new finding we conclude that different intensity of training brings different changes in different Physical parameters and similar changes in some variables as well. Thus, the CT intensity should be considered in the coaching plan for players. Our conclusion emphasizes the necessity of considering CT intensity as a crucial factor.
Keywords: *Frequency, Circuit Training, Physical Fitness, Active Adult*

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INTRODUCTION

Intensity is often considered as the essential component of any exercise intervention (1). If our hearts are not beating fast enough while we exercise, then we may not be getting all the benefits. It is a zone to which the heart rate is to be enhanced from the normal value so, as to ensure that the exercise under taken produces maximum training effect on the sportsperson. Training load in terms of stimulus intensity would be either too high or too low for the athlete, resulting in no benefit in terms of effort put in by the athlete. Each athlete's target-training zone is located between the two target heart rates (2). Furthermore, several studies have found that prepubertal children's exercise frequency must be higher than that of young adults, with heart rates of 170-180 beats per minute, or approximately 80-85% of the maximal heart rate, required for training adaptations to be realized (3). His or her target heart rate should be at least 60% (or ⅗) of his or her maximum heart rate (4). Experienced coaches have opined that for the best development of endurance, the intensity range of 70% to 85% is considered ideal. Athletes' success is typically attributed to a unique combination of physical fitness and talent, as well as tactical, technical, and psychological qualities. Physical fitness is regarded as the most important among these criteria in determining an athlete's competitive ability. Physical fitness is critical for improving athletes' performance and is a basic requirement for athletes competing in high-intensity training. Physical fitness loss may compromise an athlete's ability and lead to sports injuries (5). Among the various training methods available, Circuit-training (CT), is a popular training modality that helps improve physical fitness due to the time efficiency

and lighter loads that are typically implemented in such a programme. The goal of free-weight circuit training is to improve body composition, cardiovascular endurance, and functional fitness by performing a series of multi-stimulating and multi-joint exercises in rapid succession with little or no rest in between (6). Low intensity circuit training is defined as 50%-65% of circuit training exercises performed in a planned sequence. Moderate intensity circuit training is defined as 65% - 80% of circuit training exercises performed in the shortest possible time, while High intensity circuit training (HICT) is defined as 80%-95% of intensity (7,8). HICT training increased physical performance indexes such as agility, Sargent jump height, flexibility, and shoulder muscle strength, but it did not cause significant oxidative stress on the football teenager's body (9). This study will provide a comprehensive and up-to-date summary of the available evidence, which can help to evaluate and compare impact of different intensity modulated circuit training on athletes and to find out, what is the best practice for circuit training intensity and duration distribution in athletes? But the comparative benefit of varied intensity of circuit training in relation to the physical variables is not studied yet to focus. Thus, researchers of the current study initiated to fulfill the study gap related to physical components variables in relation to the intensity of circuit training. This issue, to the best of our knowledge, has not yet been investigated in detail. The mixed results of these studies highlight the need for further investigation into the effectiveness of different intensity modulated circuit training on the physical fitness development among the athletes.

MATERIALS AND METHODS

This systematic review was Conforming to the guidelines set by the Preferred Reported Items for Systematic Reviews and Meta-Analysis (PRISMA) (10).

Eligibility criteria

Thus, studies were included if they met the following criteria:

→ A full text, peer-reviewed study published in English, describing the use of healthy Athletes (male) aged between (10–25 years) to explore the effects of varied intensity circuit training interventions on physical fitness;

→ randomized controlled trial (RCT), non-randomized controlled trial (non-RCT) with two or more groups, and single-group trials with pretest and post-test design;

→ Investigate the effects of varied intensity circuit training on physical fitness among athletes and assess at least one physical fitness component outcome;

→ There were no restrictions on the sample size, study location, and intervention time for the included studies;

→ Participants assess absolute intensity by monitoring their heart rate either manually or with a heart rate monitor during exercise.

Studies were excluded if they met several exclusion criteria:

→ Studies that combined circuit training interventions with additional non-exercise training (e.g., psychological interventions) and interventions including unsupervised training courses were not included in the study;

→ Studies published articles, meeting abstracts, case reports, and short communications in languages other than English were excluded.

Information sources

The lead investigator (S.S) and a research assistant conducted electronic searches. The Pub-Med and Google scholar databases were used. Articles published from October 2013 to October 2023 were considered.

Search Strategy

In each database, Keywords were selected through experts' opinion and a systematic literature review. Using Boolean logic, the following combination of keywords was used in the search databases: literature review, a search was conducted by title, taking a predefined combination of keywords: ("circuit training" OR "varied intensity circuit training" OR "Low intensity circuit training" OR "Moderate intensity circuit training" OR "high intensity circuit training") AND ("physical fitness" OR "cardiorespiratory fitness" OR "skill related physical fitness" OR "speed" OR "power" OR "agility" OR "flexibility" OR "balance" OR "coordination" OR "health related physical fitness" OR "aerobic endurance" OR "muscular strength" OR "muscular endurance" OR "body composition") AND ("players" OR "active adult" OR "athlete" OR "sportsman" OR "sportsperson").

Study Selection

One author completed the screening. First, duplicates were removed by Zotero reference management software and titles and abstracts were examined to identify studies that met the inclusion criteria. Second, the full texts of the eligible studies based on the screened studies were read by two authors (SS, GP) to determine their final inclusion.

Data extraction process and data synthesis

After the data search was complete, the full texts were analyzed and after confirming the eligibility criteria, the following data were extracted: (a) First authors name and publication year; (b) Study design; (c) Types of athletes; (e) Participants characteristics age, sex, hight, BMI, weight and sample size by group; (f) session; (g) duration; (h) type of exercise training; (i) Characteristics of varied intensity circuit training intervention (including exercises intensity in individual maximus repetition percentage, sets, repetitions); (j) Characteristics of control group intervention and; (k) Main findings result related to pre-defined outcomes from the experimental group and control group, comparing each other. Data from the included studies were extracted independently by one reviewer (SS), consulted to other researchers (GP). Then, the data were extracted and transferred to an Excel spreadsheet.

Risk of bias Assessment

One authors (GP) assessed study quality and the potential risk of bias according to the PEDro scale (11) in each included study, shown in **Table 2.**

RESULTS

The search results were screened and read by formulating literature inclusion and exclusion criteria. This systematic review contains articles involving RCT and Non RCT on the effects of varied intensity CT on physical fitness among athletes**. In Table 1,** the studies' characteristics are presented.

Study Selection and characteristic

The search strategy yielded a total of 1432 references, firstly, 933 were eliminated due to duplicates, further, a total of 499 studies were screened, 306 were removed by title and 20 by abstract.150 articles were excluded based on the inclusion criteria (75 for age and 75 for study type). Then, thirteen articles were eliminated for other reasons described in **fig. 1**. Lastly, a total of teen full text studies included in the systematic review**.** Each study was read and coded for descriptive variables: age, sample size, sport, duration, type of control group (no exercise, regular training), mode of exercise and intensity of control group exercise, manner and intensity exercise of experimental group, work—rest ratio, rest ratio and length of intervention, as well as the outcome of the study. The included studies 386 male participants in total. The studies included participants from different sports: basketball (12); handball (13), soccer , futsal (3,7,14,15)**,** and volleyball (16). The remaining three studies included participants were not mention about the sports backgrounds (17–19).The duration of the programs varied from 4 to 24 weeks. In addition, the highest number of participants in one study 67 (3), while the lowest was only 21(18) (Table 1). All the studies were RCTs with a pre-post design. Two studies had an experimental (EG) and a control group (CG) (12,15), while six studies included two experimental and one CGs (3,7,13,14,16,18) and two study included only experimental group and no CG group (17,19).

Figure 1. PRISMA flow chart of the study selection process

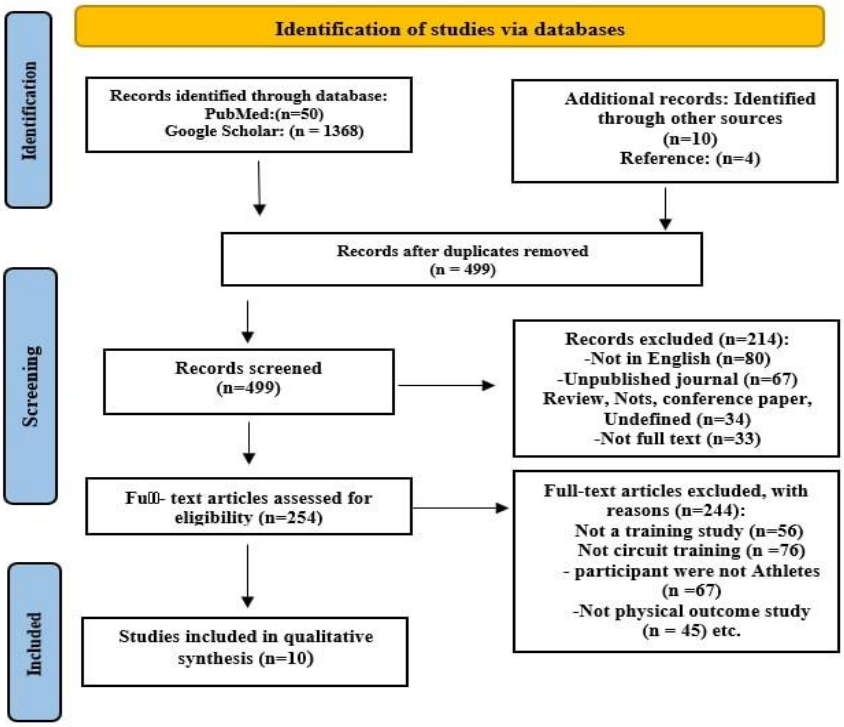

Table 1 Characteristics of studies included in the systematic review

Authors	Design	Types of athletes	Participants[n], sex[M/F], age[yrs.], ht[cm], wt[kg], bf [%], BMI [kg/m2]	Session [n]	Duration [wk]	Type of exercise training	Innervations	Measurement indexes	Outcomes
[15]	Pre-post-test design	football Players	n=27, sex: M, EG=14, age:15.71±0.72, ht:165±8.03, wt:55.93±9.44, bf; NR, BMI:20.36±2.21; CG=13, age:14.92±0.76, ht:164±0.6, wt:55.23±9.62, bf: NR, BMI:20.42±2.72	12	4	HICT CG	2 x (30-40 s), at 91% HRmax; 30-40 s/10 s rest, work: rest, [1:1] CG: Standard FIFA 11+ program at 90% HRmax; 30-40 s/10 s rest, work: rest, [1:1]	leg muscle strength (leg dynamometer), agility (Illinois test), core muscle strength (plank test)	↑ LD, ↑Illinois-Test, ↑ plank test
[3]	Pre-post-test design	soccer players	n=67, sex:M, HICT= 22, age:11.2 ± 0.4, ht:144.7 ± 7.5, wt:37.3 ± 7.9, bf: NR, BMI:17.3 ± 2.1, MICT=24, age:11.1±0.2 ht:143.1±7.2(cm), wt:36.6 ±7.3, bf: NR, BMI:17.5 ±1.9, CG= 21, age: 11.0 ± 0.3, ht: 144.9 ± 6.5 (cm), wt: 38.1 ± 7.6, bf: NR, BMI: 17.8 ± 1.8	72	24	HICT MICT CG	volume19 min, Mon. (set of ex.1), Wed. (set of ex. 2), Fri. (set of ex. 3) 2/30s /170–190 beats·min-1 (85%–95% HRmax) ×30 s, work-rest ratio (1:1). volume 28 min, Mon. (set of ex.1). Wed. (set of ex. 2), Fri. (set of ex. 3) 2/60 s/150–170 beats·min-1 (75%–85% HRmax) ×30 s, work-rest ratio (2:1). CG: Continue their team training routine	balance (one minute on one leg on a 3 cm beam), flexibility (sit and rich), lower body power (standing broad jump), forearm strength (hand grip), core endurance (sit-ups), upper body strength and endurance (bent arm hang), agility (10×5 m shuttle), cardio-respiratory endurance (physical working capacity 170 test), speed and coordination of upper limb movement (PLT – Plate Tapping)	↑one minute on one leg on a 3 cm beam, ↑SAR, ↑SBJ, ↑HG, ↑SUP, ↑BAH, ↑10×5 m SHR, ↑ (PWC170 test), ↑PLT – Plate Tapping. However, the best SAR values were noted both at baseline and post-training in the MCT group.
[14]	Pre-post-test design	football players	n=60, sex:M, HICT= 20, age: 16.20+.69, ht: 1.62+.041, wt:51.70+2.90, bf; NR, BMI: 19.55+.93, MICT=20, age: 16.30+.73, ht: 1.64+.049, wt: 50.55+4.01, bf; NR, BMI: 19.42+1.15, CG=20,	48	16	HICT MICT CG	HICT (85% to 90% of HRmax), MICT (75% to 85% of HRmax), CG-Maintain regular training	explosive strength (standing long jump), agility (zig zag), speed (30-m sprint),	↑ SLJ, ↑ ZZR, ↑30-m sprint, No significant difference observed on agility between HICT and MICT

			age:15.95+.68, ht:1.60+.064, wt:49.75+4.03, bf; NR, BMI:19.14+1.73						
[19]	Pre post test	Trained athlete	n=22, sex: M, HICT=11, age: 27.9 ± 3.8, ht: 181.1 ± 7.3, wt: 66.8±7.4, bf; 12.3±4.4, BMI: 24.8±1.5; HIAT=20, age: 29.4 ± 3.4, ht: 181.1 ± 7.3 cm, wt: 68.6±11.0, bf; 13.6±4.2, BMI: 25.1±2.6	12	4	HIAT HICT	3 times / week, 45 min, 80-85% HRmax, Continuous running. 3 times / week, 45 min, 10 reps 60% 1-RM for each exercise; rest 15-30 sec), ~ 80-85% HRmax.	body composition. (BMI, body mass, fat mass, fat mass percentage, lean mass)	↑BMI, ↑body mass, ↑fat mass, ↑fat mass percentage, ↑lean mass,
[17]	Pre-post-test design	Trained athlete	n=60, sex: M, HICT=60, age:18.92±1.56, ht: NR, wt: 75,86±12,04, bf; 13,43±4,86, BMI: 24,26±2,85	24	8	HICT	3 x (30- s), 5 s rest, work: rest, [1:1], combined 10-station HICT program.	Body composition (weight ratios, body fat ratios, BMI)	↑weight ratios, ↑body fat ratios, ↑BMI
[18]	Pre post test	Trained athletes	n=21, sex: M, HICT Group A=7, age: 31.1 ± 7.9, ht: 178.1 ± 10.9, wt: 77.2 ± 8.1, bf; 11.1 ± 2.9, BMI: 24.4 ± 1.3; HICT Group B=7, age: 27.4 ± 5.9, ht: 172.1 ± 2.7, wt: 70.5 ± 7.1, bf; 10.6 ± 2.1, BMI: 23.9 ± 2.7; CG=7, age: 30.8 ± 5.8, ht: 179.4 ± 9.3, wt: 77.5 ± 8.3,bf; 14.8 ± 4.2, BMI: 24.3 ± 1.4;	12 18	6	HICT A HICT B CG	Training comprised of 4 series of 10 self-loading exercises, including sprints and supporting materials, with 1-2, min. rests between series, exerting an 80-95% of HRmax., work rest ratio 1:1, with 20-25 second intervals between work and recovery. CG did not perform any physical exercise	body composition (fat mass percentage, kg of fat mass), 1 RM strength tests (bench press, back squats)	↑fat mass percentage, ↑kg of fat mass, ↑bench press, ↑back squats,
[12]	Pre-post-test design	Basketball players	n=24, Sex: M, EG=12, Age: 16.85 ± 0.67. years, WT:NR, HT: NR, BMI:NR, CG=12, Age: 16.85 ± 0.67. years, WT:NR, HT: NR, BMI:NR	18	6	CTG CG	CTG performed 2 minutes of work at 90 to 95% of THR, 8 repetitions 1st and 2nd week, 10 repetitions 3rd and 4th week 12 repetitions 5th and 6th	Body composition (Percent body fat, lean body mass, Fat mass) Cardiovascular endurance (Multistage fitness test)	↔Percent body fat, ↔lean body mass, ↔Fat mass, ↑Multistage fitness test

							week. followed by 2 min. of active resting at 70 - 80% of THR. 1:1 work rest ratio; CG: continue their team training routine.		
[7]	Pre-post-test	Football player	n=45, Sex: M, MICT=15, Age:18 and 22 years, WT: NR, HT: NR, BMI:NR, LICT=15, Age: 18 and 22 years, WT: NR, HT: NR, BMI: NR, CG=15, Age:18 and 22 years, WT:NR, HT:NR, BMI:NR	60	12	CTG1 CTG2 CG	CTG1: (65%-80%), CTG2: (50%-65%) CG: participants completed a regular training.	Speed (50-meter dash), Agility (20-meter shuttle run)	↑50-meter dash, ↑20-meter SHR
[13]	Pre post test	Handball players	n= 30, Sex: M, MIGSCTG=10, Age:16.85 ± 0.67 years, WT: NR, HT: NR, BMI:NR, HIGSCTG=10, Age: 16.85 ± 0.67 years, WT: NR, HT: NR, BMI: NR, CG3=10, Age:16.85 ± 0.67 years, WT:NR, HT:NR, BMI:NR	24	8	MIGSCTG HIGSCTG CG	The average time recorded was 78 seconds from which 60 to 70% load was fixed for moderate and 80 to 90% for high intensity. CG: participants completed a regular training	Speed (30-meter sprint), Agility (T- test)	↔30-meter sprint, ↔T- test
[16]	Pre post test	Volleyball players	n=30, Sex: M, MICT EG1=10, Age:18 to 25 years, WT: NR, HT: NR, BMI:NR, LICT EG2=10, Age: 18 to 25 years, WT: NR, HT: NR, BMI: NR, CG EG3=10, Age: 18 to 25 years, WT: NR, HT: NR, BMI: NR	18	6	LICT MICT CG	Low Frequency Circuit Training 2 days/week, Medium Frequency Circuit Training 4 days/week Control Group (CG). HICT:19 minutes, MICT: 28 minutes,	Speed (50-meter dash), Explosive power (standing long jump)	50- meter dash↑, Standing long jump↑, MFCT was significantly better than the LFCT group and control group on speed and explosive power

↔, non-significant within-group change from pretest to post-test; ↑, significant within-group improvement from pretest to post-test; WT, weight; BMI, body mass index, BF, body fat; N, Number of participations; HT, height; F, Female; M, Male; NR, not reported; Freq., frequency; EG, experimental group; CG, control group; CTG, circuit training group; HICT, high intensity circuit training; CT, circuit training; MICT, moderate intensity circuit training; SC, skinfold calliper; PWC, Physical working capacity; VJ, vertical jump; SBJ, standing broad jump; ZZR, zig zag run; BAH, bent Arm Hang; HG, PWC170, physical working capacity 170; hand grip; SAR, sit and rich; SUP, sit-ups; SLJ, Standing long jump; SHR, Shuttle Run; SUS, Sit up;

Study Quality

From the total number of the studies that entered the qualitative analysis, based on the points earned by each study on the PEDro scale, the results of the study quality assessment were defined. The results of the study mean PEDro score of the included studies was 6, which indicates that the included studies were of

good quality, and none of the studies met all the PEDro list quality criteria. The final results of the study quality assessment are presented in **Table 2.**

Table 2 | PEDro scale results

Study	1	2	3	4	5	6	7	8	9	10	∑
[14]	Y	Y	N	Y	N	N	N	Y	Y	Y	6/10
[15]	Y	Y	N	Y	N	N	N	N	N	Y	4/10
[12]	Y	Y	N	Y	N	N	N	Y	Y	Y	6/10
[3]	Y	Y	N	Y	N	N	N	Y	Y	Y	6/10
[17]	Y	Y	Y	Y	N	N	N	Y	Y	N	6/10
[18]	Y	Y	Y	Y	N	N	N	Y	Y	Y	7/10
[19]	Y	Y	N	Y	N	N	N	Y	Y	Y	6/10
[7]	Y	Y	Y	Y	N	N	N	Y	Y	Y	7/10
[13]	Y	Y	N	Y	N	N	N	Y	Y	Y	6/10
[16]	Y	Y	N	Y	N	N	N	Y	Y	Y	6/10

1—eligibility criteria; 2—random allocation; 3—concealed allocation; 4—baseline similarity; 5—blind subject; 6—blind therapists; 7—blind assessor; 8—adequate follow-up; 9—intention-to-treat analysis;10—between-group comparisons; 11—point estimates and variability;
Y—criterion is satisfied; N—criterion is not satisfied; ∑— total awarded points

OUTCOME AND MEASURES

Effect of Varied intensity circuit training on Speed

Four of the teen studies included in this systematic review presented inferences about the effect of varied intensity circuit training on speed performance (7,13,14,16). The speed tests used in these studies included linear sprint test of 30 m (13,14), 50m (7,16). The subjects included young football players (7,14), volleyball players (16), and handball players (13). Three studies showed improvement in linear sprint test (7,14,16). However, only one study did not observe any significant change in 30 m tests (13).

Effect of Varied intensity circuit training on muscle strength

Among the teen studies included in this review, only three studies reported on muscle strength (3,15,18). The aspects valued and assessment tools used were 1 repetition maximum (18), handgrip strength test (3), leg dynamometer test (15), and plank test (15). The subjects include football players (3,15), and trained athletes (18). All study revealed a significant increase in muscular strength after the varied intensity CT intervention.

Effect of Varied intensity circuit training on cardiovascular endurance

Two of the teen studies included in this systematic review presented inferences about the effect of varied intensity circuit training on Cardiovascular Endurance (3,12). The Cardiovascular Endurance tests used in these studies included Physical Working Capacity (3) and Multistage fitness test (12). The study subjects included football players (3) and basketball players (12). Studies observed significant effect of varied intensity CT on cardiovascular Endurance, all study reported positive results in this aspect after the intervention.

Effect of Varied intensity circuit training on power

Among the teen studies included in this review, only two studies reported on power (3,14). The aspects valued and assessment tools used involved Standing Broad Jum test (3) and standing long jump (14). The subjects include football athletes (3,14). One study had a 24-week intervention period (3), while the other study had an intervention period of 16 weeks (14). These studies reveal that varied intensity CT can improve power.

Effect of Varied intensity circuit training on agility

Agility was evaluated in five of the studies that were included in this review (3,7,13–15). five studies valued this criterion through five exercises: shuttle run 10 × 5 m(3), 20 meter shuttle run test (7), zig zag run test (14), IIIinois test (15), and T-test (13). The subjects include football athletes (3,7,14,15), and handball athletes (13). Studies conducted by (13) revealed insignificant differences in agility after the varied intensity CT intervention. In contrast, bserved a significant improvement after the varied intensity CT.

Effect of Varied intensity circuit training on flexibility

Only one study included in this systematic review presented inferences about the effect of varied intensity circuit training on flexibility. The flexibility was measured based on the sit and reach test, commonly used in health-related and physical fitness test batteries to evaluate the hamstring and lower back flexibility (3). The participants of this study were football players. This study revealed a significant improvement in flexibility.

Effect of Varied intensity circuit training on balance

Balance was assessed in one out of the teen studies included in this review (3). This study uses Flamingo Balance test (Balancing for one minute on one leg on a 3 cm beam) to evaluate single leg balance. The study subjects included soccer players and reported positive results in this aspect after the intervention.

Effect of Varied intensity circuit training on body composition

Body composition was evaluated in four studies in this review. Studies assessed by using different measurement tools like body fat mass percentage (12,18,19), body weight (17), body mass index (17,19), lean body mass (12,19), and body fat (12,17–19).The subjects include trained athletes (17–19), and basketball players (12).The results of these studies reveal that Varied intensity CT can improve body composition. Nevertheless, one study reported that 6 weeks of varied intensity CT did not significantly improve after pre-post test scores percent body fat, lean body mass, fat mass (12).

Effect of Varied intensity circuit training on muscle endurance

Muscular endurance was only evaluated in one of the studies that were included in this review (3). Theses study are uses to evaluate muscular endurance the sit up test (3), and bent arm hang test. The study subjects included soccer players (3). reported positive results in this aspect after the varied intensity CT intervention.

Effect of Varied intensity circuit training on coordination

Coordination was assessed in one out of the teen studies included in this review (3). This study uses PLT – Plate Tapping to evaluate speed and coordination of upper limb movement. The study subjects included soccer players and reported positive results in this aspect after the intervention.

DISCUSSION

Speed is defined as the quickness with which a limb moves, whether it is the legs of a runner or the arm of a shot putter. Every sport requires a certain amount of speed. Due to the dependence on the functioning of the central nervous system, speed abilities can only be trained to a very limited extent (13). Four study were included in this review in which one study compare between 3 groups HICT (85% to 90% of HRmax), MICT (75% to 85% of HRmax), CG-Maintain regular training. After 48 session of 16 weeks of training author found that HICT speed improvement were higher compare to moderate intensity CT group or control groups in football player (14). This is due to that the high intensity circuit training was with more repetitive activities as well as relatively more strenuous exercises. Another study found that, when compared to the control group, LFCT and MFCT improved volleyball players' speed (16). Based on the interpretation of the data, there was a significant difference between varied frequencies of CT groups and control group on selected variable of speed further it was concluded that medium frequency circuit training group better than low frequency CT and control group on improving a speed. Similar study conducted by Ahmad Naikoo & Hassan, (2018) subjects were randomly assigned into three equal groups with fifteen subjects each (n = 15) as LICTG (50%-65%), MICTG (65%-80%) and control group (CG). After The experimental groups were subjected to their respective experimental treatments for a period of twelve weeks, five days per week, with a session on each day. The study's findings revealed that both experimental groups (LICT and MICT) differ significantly from the control group (CG) in terms of speed, and there is a significant difference in variable speed between the two experimental groups (LICT and MICT). The MICT group performed better than the LICT group (7). Eight weeks of varied intensities did not reduce sprinting performance among handball players., 60 to 70% load was fixed for moderate and 80 to 90% for high intensity and it was measured by using 50 meter dash (13). The five included study uses to evaluate of agility 10×5 m shuttle, Illinois test, zig zag, 20-meter shuttle run, and T- test. One study intensity was set at 75% to 85% of HRmax for Moderate intensity and 85% to 90% of HRmax for high intensity training using the heart rate monitor. Whereas the HICT group and MICT group didn't show significant difference on their agility with a mean difference of (-.180, P = .099) (14). Agility (10×5 m) improved more in the HCT group than in the MCT group (pre- to post-intervention improvement was 3.4% and 2.1%, respectively) (3). A significant difference among the adjusted post-test means of LICT, MICT and control groups on the variable agility. Where MICT (65-80%) improved greater as compare to LICT (50-65%) (7). HICT group 91% HRmax and CG: Standard FIFA 11+ program at 90% HRmax after 4 weeks of intervention both the groups significantly improve agility. But between group statistically insignificant different observe (15). Specifically, the one study demonstrated a statistically insignificant after the effect of different intensities of game specific circuit training on agility among handball players, agility remained unaffected on MICTG and HICTG after 8 weeks intervention (13). Strength is the foundation for all other components of physical fitness (20). However, just three studies on strength have been published. Which are compare between high intensity vs. control groups, one study focused high intensity, moderate intensity and control groups and another study High intensity two groups which is differentiated based on number of sessions a group 12 session and group B 18 session for 6 weeks and one control groups. Zein et al. (2020) conducted a study between high intensity 91% HR max. vs. control groups the core and leg muscle strength improved after 4 weeks of intervention.

Another study reported Hand grip strength was also improved by high intensity 170–190 beats·min-1 (85%–95% HRmax) and MICT 150–170 beats·min-1 (75%–85% HRmax) intervention (3). HICT was also seen more effective compared to moderate intensity training. After the post-test between two groups statically significant difference observed. Another study Groups A and B significantly improved in strength tests (bench press and back squats), compared to the control group as well as in the intragroup analysis when comparing before and after the intervention. Group A HICT (80-95% maximum cardiac frequency intensity) trained two days a week (n=7), group B HICT (80-95% maximum cardiac frequency intensity) trained 3 days a week (n=7), a 6-week HICT program with strength and resistance self-loading significantly improves maximum strength and local muscle resistance. The maximum strength was measured using 1RM tests in bench press and squat, with a 10% and 20% improvement, respectively, in both experimental groups, being these values statistically significant, while no significant differences were observed between groups A and B (18). This systematic review included only one study that focused on muscle endurance. The groups HICT and MICT had a significant main effect in abdominal muscular strength and endurance (SUP) and upper-body muscular strength and endurance (BAH). When compared to controls, the HCT group performed significantly better than the MCT group, and both training groups performed significantly better. The most significant cardio-respiratory result was a significant increase in the PWC170 index in the HCT group (from 2.26 to 2.54 W/kg), while it decreased non-significantly in the MCT and CON groups (3). Another study found that performing CTG at 90% to 95% of target heart rate improved cardiopulmonary endurance after 6 weeks of intervention (12). Only one study reported about flexibility (3). The increase in hamstring and lower back muscle flexibility in the HICT group was non-significant and reached a lower level at post intervention than in the MCT group. HICT (85%-95% HRmax) and MICT (75%-85% HRmax) for both training groups. The SAR had the highest percentage change from pre- to post-intervention (132.0% vs. 13.9%, respectively) (3). The training effects observed in the HICT group in the same study indicate that the methodological approach used in the high-intensity CT protocol is appropriate for improving body balance. The Flamingo Balance test, developed in accordance with Eurofit standards, is a test that assesses the single-leg balance level and strength of muscles that support this postural position. For both the HCT and MCT groups, the highest pre- to post-intervention percentage changes were for the FLB. Only one study reported on coordination, indicating better improvements in the HCT (85%-95% HRmax) group compared to the MCT (75%-85% HRmax) group (3). Body composition was evaluated in four studies in this review. One study reported 6 weeks of CTG performed at 90% to 95% of Target Heart Rate did not significantly improve after pre-post test scores Percent body fat, lean body mass, Fat mass (12). Another study, after 4 weeks of training, the Aerobic Training and CT group also showed a significant reduction in all body composition parameters. There were no significant differences in body composition parameters between the Aerobic Training group (80%-85% HRmax) and CT groups (80-85% HRmax)(19), except for lean mass, which increased significantly only in the CT group and conformed that improvements in body composition are related to intensity and not to the type of exercise. Also confirmed by Gülfirat [18], Significant changes in weight and fat ratios and body mass index results of pre and post training participants were due to HICT. Another study HICT Groups A and B significantly improved in body composition at 80-95% of HRmax, Group A trained two days a week (n=7), group B trained 3 days a week (n=7) (17). Among the teen studies included in this review, only two studies reported on power (3,14). In which both study intensity fixed at 85% to 90% of HRmax for HICT, and 75% to 85% of HRmax for MICT, greater improvement was seen in HICT groups as compared to MICT and control groups.

LIMITATION

This systematic review has a number of limitations. **First,** there are no reports of reaction time in the research included. Reaction time is a critical component of physical fitness and a vital indicator of a player's physical fitness. **Second**, three of the studies did not include information about the athletes' sports back ground (17–19). **Third**, there is no report on female athletes, suggesting that future studies should include female athletes. **Fourth**, this review chose to include only English-language papers, which indicates that some pertinent empirical material may be omitted. **Fifth**, Two of the studies did not mention about the information of intensity % (16,17). **Six**, three of the studies did not include information about the training protocol in detail (13,14,16). **Seven,** some included studies did not specify their sample size calculation method. **Eight.** most of the studies did not record or regulate exercises conducted by participants beyond the study environment. Finally, there were no follow-up assessments in the studies, both in the short-term and long-term.

CONCLUSION

Based on these results, systematic review of selected studies showed that varied intensity CT helps in development physical fitness components including speed, muscular endurance, agility, muscular strength,

Cardio vascular endurance, balance, coordination, flexibility, body composition and power. From the finding we concluded that the intensity of CT is very crucial for the magnitude of adaptation in CT. Thus, for the effectiveness of CT the plan of trainers or coaches should seriously consider the intensity to bring the intended or required changes. Training with high intensity is more effective in compared to training with moderate intensity. Analysis of the study data revealed notable differences in the impact of HICT, MICT, and LICT on various aspects of physical fitness. HICT demonstrated significant improvements in speed, coordination, balance, muscle strength, power, muscle endurance, cardiovascular endurance, with a moderate impact on body composition. MICT resulted in balanced enhancements across all measured parameters, Whereas the HICT group and MICT group didn't show significant difference on their agility, flexibility. while LICT, yet there is no evidence regarding the effect of LICT on cardiovascular endurance but limited improvements in other fitness dimensions compare to control groups. Meanwhile, there is conflicting evidence regarding the effect on speed, agility, body composition, and yet there is no evidence regarding the effect of CT on reaction time. From our new finding we conclude that varied intensity of training brings different changes in different Physical parameters and similar changes in some variables as well. Thus, the CT intensity should be considered in the coaching plan for players. However, the change on physical parameters depends on type and intensity of training.

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