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Systematic Review

30–15 Intermittent Fitness Test: A Systematic Review of Studies, Examining the VO_2max Estimation and Training Programming

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Abstract: This study presents an overview of current scientific articles that address the reliability and validity of the 30–15 intermittent fitness test (30–15 IFT) as an assessment of aerobic capacity, as well as its use in terms of training programming. The search for and analysis of papers was conducted in accordance with PRISMA guidelines. A database search was performed through PubMed, PMC, Med Line, Cochrane Library and ScienceDirect, as well as directly from the author who first presented the IFT 30–15. Type of study: research was included in this paper on condition that (i) the original scientific paper was available in its entirety; (ii) the IFT 30–15 was used to evaluate or verify validity and reliability; and (iii) the IFT 30–15 was used for the purpose of evaluation of training programming. Of the 213 relevant studies identified, 21 were included in the quantitative analysis. All research was conducted on a sample of athletes who are exclusively engaged in team sports. As for the use of the subject test when it comes to programming individualized intermittent training to strengthen aerobic capacity, it seems that the IFT 30–15 test is appropriate and extremely useful for team sports. Regarding the reliability of tests identified in the reviewed literature, all studies indicate that the 30–15 IFT is a reliable test for assessment of aerobic capacity.

Keywords: anaerobic capacity; physical fitness; training; exercise performance

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1. Introduction

In sports medicine diagnosis, it is essential to select the tests that point to certain motor and functional abilities, based on which we can indirectly, with high accuracy, establish or assess the current status and development level of these abilities. Using objective assessment methods, we draw certain conclusions that we use for the improvement of these abilities [1]. Firstly, to improve certain abilities, it is necessary to accurately and objectively determine the level of development in order to improve said ability. As sports science is rapidly developing, expanding and finally getting attention and visibility within scientific social networks and platforms, new methods for assessment of abilities and levels of training are being increasingly explored and established.

Aerobic capacity is one of the most important determinants for team-sport success [2]. In order for an athlete's aerobic capacity to be at the optimal level, adequate programming and training processes are required. Training programming is crucial for optimization of training responses in order to achieve physical aims by dividing the training period into various phases, periods and cycles. Designing a proper training program for a particular team sport helps with unique challenges due to the variety of training goals, volume of concurrent training and practices, and extended season of competition [3]. As all of team sports are high-intensity, aerobic capacity is one of the most important variables for team-sport success [2]. Therefore, is necessary to determine the optimal test protocol that can be used in daily monitoring of these abilities [4].

Conducting different types of tests in team sports has proven to be valuable by being highly reproducible, standardized and precisely reliable in terms of evaluating players' physical abilities, determining their individual strengths and weaknesses and assessing the effect of various training processes in order to significantly improve athletic performance [5]. These tests provide both staff and players with useful information concerning how to improve team performance, as well as individual performance, by exploiting the results [6]. Putting to use these tests may provide improved insight into a player's strengths and weaknesses, suggest suitable training loads and help to monitor the effectiveness of training [7]. There are numerous studies that describe the importance of field tests and their effects on team-sport fitness [7–10].

Although the Yo-Yo Intermittent Recovery Test Level 1 (Yo-YoIR1) is considered to be the most popular test for assessment of aerobic capacity and is one most frequently used tests, a new test has appeared as an alternative [11]. Intermittent Fitness Test 30–15 (IFT 30–15) is used as a field test to indirectly assess maximal oxygen uptake (VO_2max), as well as to program training to develop aerobic endurance. However, the test also includes several additional factors [12]. It requires around 20–30 min to be completed and allows large groups of athletes to be tested simultaneously [13].

This type of test, made for specific sports in order to express the nature of different team sports, has begun to attract the attention of researchers and coaches. The test uses a progressive intermittent test protocol, which includes change of direction and a higher maximal speed compared to the customary protocols. Moreover, according to Buchheit [11], the final speed reached at the end of the 30–15 test (Vift) is concurrently associated with aerobic capacity, anaerobic capacity, the neuromuscular system, as well as with inter-effort recovery.

In recent years, there have been several studies published that examined the validity and reliability of the 30–15 IFT test in diverse participants groups [14–19]. Current research has shown unclear results concerning the 30–15 IFT test. Jeličić et al. [16] found that the usefulness of the 30–15 IFT test was marginal and, on the other hand, its validity and reliability in assessment of maximal aerobic fitness in female basketball players was poor. Poor correlation between this test and acceleration, speed and change of direction was noticed by Scott et al. [12] What is more, they found the 30–15 IFT test to be a valid measure for prolonged high-intensity running (PHIR). Thomas et al. [1] reported a correlation of this test with maximal velocity, which may be seen as moderate reliability (ICC of 0.80), while Kelly et al. [18] reported excellent reliability (ICC of 0.99).

There is a need to summarize all studies that have investigated the 30–15 IFT test, which consists of all these movements and may be a relevant tool in team sports. Since there has been no systematic review on this topic, this paper aims to provide a summary of previous scientific publications that have used this test for reliability, validity and aerobic capacity assessment, as well as a summary of studies that have used this test for training programming. It is hypothesized that the 30–15 IFT test will show high reliability, validity, and practical usefulness in training programing.

2. Methods

2.1. Search Strategy

The search for and analysis of papers was conducted in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines [20]. The research includes papers published in the period from 2008 to May 2021. A search of the network was performed using several databases (PubMed, PMC, MedLine, Cochrane Library and ScienceDirect) and the keywords: IFT 30–15 or 30–15 Intermittent Fitness Test appearing as a part of a title, an abstract or keywords of a paper. Literature search, quality assessment and data extraction were carried out, as well as a review of reference lists from the downloaded studies. After cross review, the identified studies either were rejected or selected for further analysis.

2.2. Inclusion Criteria

Type of study: research was included in this paper on condition that (i) the original scientific paper was available in its entirety; (ii) the IFT 30–15 test was used to evaluate or verify validity and reliability; and (iii) the was IFT 30–15 used for the purpose of evaluation of training programming.

Type of respondents: Both female and male athletes practicing team sports in elite competitive or professional ranks with no acute or chronic diseases were included. Inclusion criteria were not applied when it comes to either the basic level of fitness of the respondents or sports experience. There were no exclusion criteria concerning the division of respondents into groups.

The criteria for the exclusion among the selected papers required for this review were: papers not written in English, papers whose text was available partially only, books, doctoral dissertations and review articles.

2.3. Systematic Review Process

Each study was read and coded according to the variable descriptions: study titles, size of sampling, sports, objective of studies, variables and, eventually, the study outcomes.

2.4. Data Extraction

The data were independently extracted by two authors (M.G. and M.S.) and then cross reviewed for adequate data collection. Eventual disagreements were resolved by consensus or by a third reviewer (N.T.). Then, the data were extracted and transferred to an Excel spreadsheet. Cochrane Consumer and Communication Review Group's standardized data-extraction protocol was used to extract: study information, including author and year of publication, information such as sample size and age, study objective, variables used and results.

2.5. Quality Assessment

Risk of bias was assessed according to the PRISMA 19 guidelines; that is, using the PEDro scale [21] to determine the quality of reviewed studies and the potential risk of bias (Tables 1 and 2). Two independent reviewers assessed quality and risk of bias using checklists. Concordance between reviewers was estimated using k-statistics data to review the full text and assess relativity and risk of bias. In case of discordance as to findings of the risk of bias assessment, the obtained data were assessed by the third reviewer, who also made the final decision. The k-rate of concordance between reviewers' findings was k = 0.94.

Table 1. PEDro Scale for studies where IFT 30–15 is used to verify validity, reliability and aerobic capacity assessment.

	Criterion											
Study	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**∑**
Buchheit et al., 2008	Y	N	N	N	N	Y	N	Y	Y	Y	Y	5
Buchheit et al., 2009	Y	N	N	N	N	N	N	Y	Y	Y	Y	4
Malone et al., 2017	Y	N	N	N	N	N	N	Y	Y	Y	Y	4
Kelly et al., 2018	Y	N	N	N	N	N	N	Y	Y	Y	Y	4
Jeličić et al., 2019	Y	N	N	N	N	N	N	Y	Y	Y	Y	4
Bruce & Moule, 2017	Y	N	N	N	N	N	N	Y	Y	Y	Y	4

Table 1. *Cont.*

Study	Criterion											
	1	2	3	4	5	6	7	8	9	10	11	∑
Valladares-Rodriguez et al., 2017	Y	N	N	N	N	N	N	Y	Y	Y	Y	4
Scott et al., 2017	Y	N	Y	N	N	Y	N	Y	Y	Y	Y	6
Ković et al., 2016	Y	N	N	N	N	Y	N	Y	Y	Y	Y	5
Thoman et al., 2016	Y	N	N	N	N	N	N	N	Y	Y	Y	3
Scott et al., 2015	Y	N	N	N	N	N	N	Y	Y	Y	Y	4
Buchheit & Rabbani, 2014	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5
Besson et al., 2013	Y	N	N	Y	N	Y	N	Y	Y	Y	Y	6
Natera et al., 2019	Y	N	N	N	N	N	N	Y	Y	Y	Y	4
Scanlan et al., 2020	Y	N	N	N	N	N	N	Y	Y	Y	Y	4

Legend: 1—eligibility criteria were specified, 2—subjects were randomly allocated to groups, 3—allocation was concealed, 4—the groups were similar at baseline regarding the most important prognostic indicators, 5—there was blinding of all subjects, 6—there was blinding of all therapists who administered the therapy, 7—there was blinding of all assessors who measured at least one key outcome, 8—measures of at least one key outcome were obtained from more than 80% of the subjects initially allocated to the group (dropouts), 9—all subjects for whom outcome measures were available received the treatment or control conditions as allocated or, where this was not the case, data for at least one key outcome were analyzed by "intention to treat", 10—the results of between-group statistical comparisons are reported for at least one key outcome, 11—the study provides both point measures and measures of variability for at least one key outcome, Y—criterion is satisfied, N—criterion is not satisfied; ∑—total points awarded.

Table 2. PEDro Scale for studies where IFT 30–15 is used for training programming.

Study	Criterion											
	1	2	3	4	5	6	7	8	9	10	11	∑
Buchheit et al., 2008	Y	Y	N	N	N	N	N	Y	Y	Y	Y	5
Buchheit et al., 2008	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	7
Buchheit et al., 2009	Y	N	N	N	N	N	N	Y	Y	Y	Y	4
Al Haddad et al., 2011	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	6
Buchheit et al., 2011	Y	N	N	N	N	N	N	Y	Y	Y	Y	4
Hernandez-Davo, 2020	Y	N	Y	N	Y	Y	N	Y	Y	Y	Y	7

Legend: 1—eligibility criteria were specified, 2—subjects were randomly allocated to groups, 3—allocation was concealed, 4—the groups were similar at baseline regarding the most important prognostic indicators, 5—there was blinding of all subjects, 6—there was blinding of all therapists who administered the therapy, 7—there was blinding of all assessors who measured at least one key outcome, 8—measures of at least one key outcome were obtained from more than 80% of the subjects initially allocated to the group (dropouts), 9—all subjects for whom outcome measures were available received the treatment or control conditions as allocated or, where this was not the case, data for at least one key outcome were analyzed by "intention to treat", 10—the results of between-group statistical comparisons are reported for at least one key outcome, 11—the study provides both point measures and measures of variability for at least one key outcome, Y—criterion is satisfied, N—criterion is not satisfied; ∑—total points awarded.

3. Results

3.1. Quality Assessment

Based on the points each study scored on the PEDro scale, the final quality assessment scores were defined. With a grand total of 0–3 points, studies were classified as "poor"; 4–5, "fair"; 6–8, "good"; and, 9–10 "excellent" [22]. Of all studies included, only one study showed poor quality, 15 studies showed fair quality, and the other five studies showed good quality.

3.2. Selection and Description of Studies

The search of literature databases resulted in 190 initially identified studies. One hundred and thirty (130) articles were discarded based on their titles or abstracts. Sixty (60) full texts were taken into consideration and fully read, and 21 of them were selected for the final review. More details concerning the process of identifying and searching for studies are been presented in the diagram (Diagram 1). Overall, 21 scientific papers were addressed in this study: (a) when the IFT 30–15 is used to verify validity, reliability and aerobic capacity assessment (15), (b) when the IFT 30–15 is used as a tool in training programming (6). In general, the IFT 30–15 was used in those publications on a sample of professional or amateur, young or elite players of team sports. The selected studies and all their variables are presented in Tables 3 and 4. Figure 1 (the PRISMA flow diagram) shows the process of collecting suitable studies based on the predefined criteria.

Table 3. Research studies where IFT 30–15 was used to verify validity, reliability and aerobic capacity assessment.

Study	Sample	Aim	Sample of Variables	Results
Buchheit et al., 2008 [4]	N = 13 Soccer, handball, basketball, tennis (male)	Examine the ability of the CV and the EI to assess endurance performance during intermittent exercise.	VO_2max, VIFT	Only EI estimated endurance capacity during repeated intermittent running.
Buchheit et al., 2009 [23]	N = 9 Elite handball players (male)	Determine whether a 4-a-side HB game is an appropriate aerobic stimulus to reach and potentially enhance VO_2max and whether HR is a VA of VO_2 during a handball game.	VO_2max, HR/VO_2max and blood lactate	VO_2max values derived from usual running maximal graded test are not relevant to an accurate estimate of maximal cardiorespiratory fitness in handball players; 95% of VIFT corresponded to 119.4 [118.6; 120.2%] of vVO_2max.
Malone et al., 2018 [24]	N = 37 Elite soccer player (male)	Examine the association of HSR and SR with injuries among elite soccer players.	VIFT	HSR (CI: 1.98–4.42, $p = 0.023$) SR distances (CI: 2.98–5.50, $p = 0.033$)
Kelly et al., 2018 [18]	N = 10 Wheelchair rugby players (male)	To determine the reliability of the 30–15 IFT-28m for elite WR players and to determine the reference measures of intermittent fitness of elite WR players.	30–15 IFT-28m, peak heart rate, blood lactate	This study shows that the 30–15 IFT-28m is a reliable test among WR players. 30–15 IFT-28 (ICC = 0.99, CV = 1.9) HRP (ICC of 0.95, CV = 4.5) Blood lactate (ICC = 0.98, CV = 5.5)
Jeličić et al., 2020 [16]	N = 19 National Croatian League (female)	To determine the reliability, validity and usefulness of the 30–15 IFT in female basketball players.	VO_2max, VIFT, HRmax	VO_2max (CV = 4.9%, ICC = 0.85) VIFT (CV = 6.0%, ICC = 0.85) HRmax (CV = 4.8%, ICC = 0.96) The present findings support the 30–15 IFT as a practical testing option for basketball practitioners to assess fitness capacities in female players.
Bruce and Moule, 2017 [25]	N = 26 Sub-elite netball players (female)	To assess the suitability of the 30–15 IFT as a test in netball using female athletes.	VIFT, Yo-yo IRT level, variables of 6 weeks resistance training	30–15 IFT and yo-yo IRT (r = 0.71, $p = 0.003$ (95% CI: 0.35–0.89) 30–15 IFT is a suitable testing tool to measure HIIT running performance.
Valladares-Rodriguez et al., 2017 [26]	N = 27 Elite futsal (13 male; 14 female)	To determine the reliability and usefulness of the 30–15 IFT.	VIFT, HRpeak	VIFT demonstrated very good reliability between sessions, both for male (ICC = 0.92) and female (ICC = 0.96) players.
Scott et al., 2017 [12]	N = 63 Elite and junior-elite rugby league players (male)	Examine the validity of the 30–15 IFT within four rugby leagues.	VIFT, HRpeak, VO_2max, Speed and COD Test, maximal aerobic capacity, AAS	(VO_2max; r = 0.63, VO_2maxMSFT; r = 0.79)
Čovic et al., 2016 [15]	N = 17 Elite soccer players (female)	To examine the reliability, validity and usefulness of the 30–15 IFT	VO_2max and HRmax at CT and IFT 30–15	VIFT (ICC = 0.91; CV = 1.8%), HRpeak (ICC = 0.94; CV = 1.2%), and VO_2max (ICC = 0.94; CV = 1.6%) obtained from the 30–15 IFT were all deemed highly reliable ($p > 0.05$).
Thoman et al., 2016 [1]	N = 14 Semi-professional soccer players (male)	To determine the reliability of 30–15 IFT	VIFT (ICC, CV, SWC)	The CV was 2.5% for between-session reliability of the 30–15 IFT.

Table 3. *Cont.*

Study	Sample	Aim	Sample of Variables	Results
Scott et al., 2015 [27]	N = 55 Young league rugby players, U16, U18, U20 (male)	Examined the reliability and usefulness of the 30–15 IFT	VIFT, HRpeak	The 30–15 IFT presents as both a reliable and useful field test in the assessment of intermittent fitness for rugby league players.
Buchheit and Rabbani, 2014 [28]	N = 14 Young elite soccer players (male)	To examine the relationship between performance of the Yo-YoIR1 and the 30–15 IFT and to compare the sensitivity of both tests to training.	Final speeds of yo-yo IRT 1 and 30–15 IFT	There was a large correlation between 30–15 IFT and Yo-YoIR1 (r = 0.75, 90% [CL] 0.57; 0.86).
Besson et al., 2013 [29]	N = 10 Semiprofessional hockey players (male)	To compare submaximal and maximal cardiorespiratory responses between the 30–15 IIT and the 30–15 IFT	30–15 IIT and 30–15 IFT, HR measurements, blood lactate, gas measurements, VT, CRP, maximal effort	Compared with the field-running version of the test (30–15 IFT), (HRpeak) and (VO_2peak) were lower; peak lactate was higher during the 30–15 IIT.
Natera et al., 2019 [30]	N = 8 Highly trained Rugby Union players (male)	To investigate the performance implications of ambient temperature variations between outdoor and indoor performance testing on two separate occasions in the 30–15 IFT	Final running speed of the 30–15 IFT, HR, HR, Max HR, HRR, HRavg and sub-maximal HR corresponding	Greater running speeds during the 30–15 IFT were achieved when the test was conducted indoors (19.4 ± 0.7 km·h^{-1} vs. $18.6 \pm$ $p = 0.002$, $d = 1.67$)
Scanlan et al., 2021 [19]	N = 20 National Croatian League (female)	To compare the aerobic capacity of elite, female basketball players between playing roles and positions	VO_2peak	Players completed a maximal field-based 30–15 IFT to estimate VO_2peak. Starters possess a significantly higher VO_2peak than bench players, and backcourt players hold a significantly higher VO_2peak than frontcourt players.

CV, coefficient of variation; YYIR, yo-yo intermittent recovery level 1; CV, critical velocity; EI, endurance index; HB, handball; VA, valid index; WH, wheelchair rugby players; HRP peak heart rate; AAS, average aerobic speed; HR maximum, maximum heart rate; Max HRR, heart-rate recovery; HRavg, heart-rate average; RS, repeated sprint; HBT, handball-based training, UM-TT, University of Montreal Track Test; 20mSRT, shuttle-run test; iEI; intermittent endurance index; HSR, high-speed running; SR, speed running; MRS, maximal running speed; HRV, heart-rate variability; HR, heart rate; MAS, maximal aerobic speed; VIFT, final running rate velocity 30–15 IFT.

Table 4. Research studies where IFT 30–15 was used for training programming.

Study	Sample	Aim	Sample of Variables	Results
Buchheit et al., 2008 [31]	N = 17 Adolescent handball players (male)	Examine the effects of RS versus HIT on performance and postexercise parasympathetic reactivation.	Mean and peak HR, 30–15 IFT, CMJ, 10 m sprint, RSA, postexercise HR recovery	HIT was more effective than RS training at improving postexercise parasympathetic function and physical performance.
Buchheit, 2008 [32]	N = 59 Basketball, handball players (32 male; 27 female)	Gather evidence supporting the accuracy of 30–15 IFT for individualizing interval training.	Vo_2max, MAS, UM-TT, 20 m 20 mSRT, 110 m sprint, CMJ, HR recovery	For interval training programming, MRS appears to be an accurate reference speed.
Buchheit et al., 2009 [23]	N = 33 Elite adolescent handball players (male)	HIT vs. HBT	10 m sprint, CMJ, RSA, handball throw velocity, VIFT (30–15 IFT), iEI	Both HIT and HBT were found to be effective training modes.
Al Haddad et al., 2011 [33]	N = 15 Basketball, handball, soccer, tennis players (male)	Assess the reliability of short-term resting HR variability HRV and postexercise parasympathetic reactivation.	HRV and HRR indices at rest and submaximal and supramaximal exercise	Discrepancy in CVs of vagal-related heart rate indices. Supramaximal exercise was shown to worsen the reliability if HRV-spectral indices

Table 4. *Cont.*

Study	Sample	Aim	Sample of Variables	Results
Buchheit et al., 2011 [34]	N = 17 Variety of team-sport athletes (15 male; 2 female)	Assess the reliability of postexercise NIRS-derived measurements and their sensitivity to different exercise intensities in the field.	Submaximal shuttle-runs, shuttle-run sprints, postexercise recovery condition, NIRS half-recovery time, mean response time	Kinetic of postexercise NIRS showed CV values ranging from 6% to 37%, with no substantial differences between exercise intensities or NIRS-derived variables.
Hernández-Davó, 2020 [17]	N= 50 U-18, handball (*n* = 19), tennis (*n* = 12), and soccer (*n* =19) players(male)	Evaluate the influence of the length used during the 30–15 IFT (40-m vs. 28-m), analyze the relationships between MRS achieved in the two different 30–15 IFT lengths and sprinting, jumping, and change-of-direction performance.	MRS, 30–15 IFT, CMJ, 20 m sprint, 5-0-5 test	Fifferent MRS values in the 30–15 IFT-40 and the 30–15 IFT-28. Relationships between MRS tests, CMJ, 20-m linear sprint, and the 5-0-5. Significant practical implications for HIIT prescription in tennis players.

RS, running speed; HIT, high-intensity training; RSA, repeated sprint abilities; VO_2max, maximal oxygen uptake; HSR, high-speed running; MRS, maximal running speed; NIRS, near-infrared spectroscopy; HRV, heart-rate variability; HR, heart rate; MAS, maximal aerobic speed; VIFT, final running-rate velocity 30–15 IFT; Vmax, maximal velocity; HB, handball; HRP, peak heart rate; AAS, average aerobic speed; MaxHR, maximal heart rate; HRR, heart-rate recovery; HRavg, heart-rate average; HBT, handball training; RS, repeated sprint; HBT, handball-based training; UM-TT, University of Montreal Track Test; 20 mSRT, shuttle-run test; iEI, intermittent endurance index; CMJ, counter-movement jump; 505, agility test.

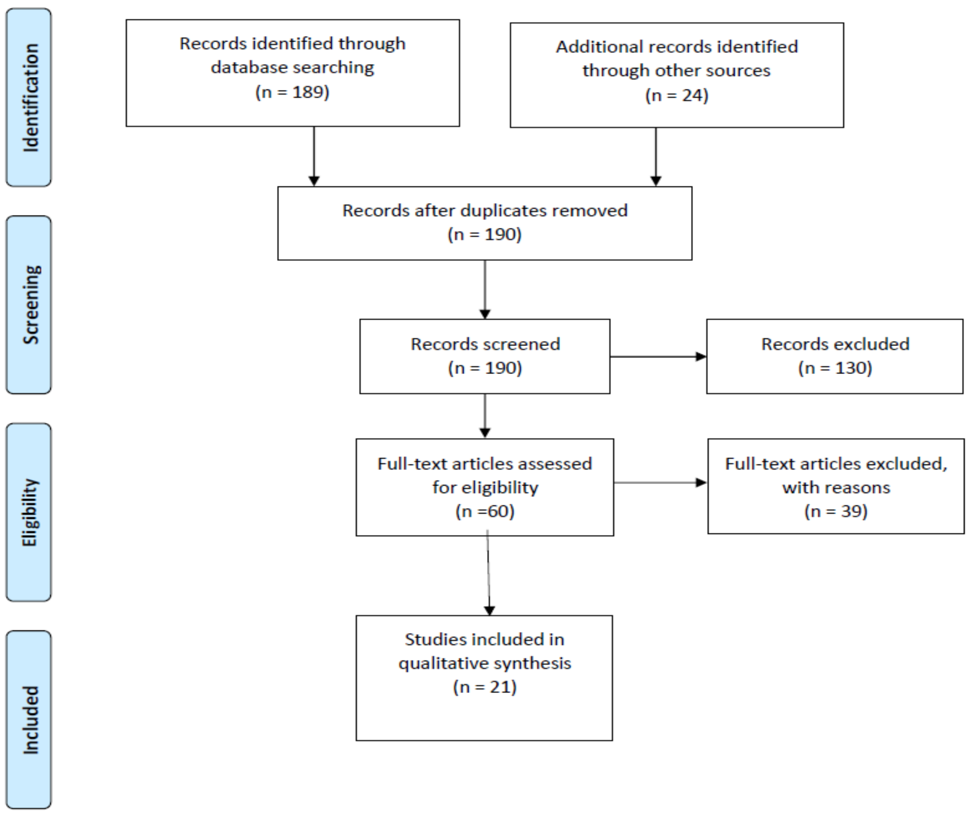

Figure 1. Collection of adequate studies on the basic pre-defined criteria (PRISMA flow chart).

A total of 21 studies met the inclusion criteria. All studies were conducted between 2009 and 2020. Most research was conducted on a sample of soccer players (4), rugby players (3), handball players (3), players from diverse team sports (5), basketball (2), hockey (1), futsal (1), wheelchair rugby (1) and netball (1). There was a total of 433 participants. Studies where IFT 30–15 was used to verify validity, reliability and aerobic capacity assessment included 342 participants, and the number of participants per study ranged from 9 to 63. Moreover, 246 participants were male and 96 were female. As far as studies in which IFT

30–15 was used for training programming, there were 191 participants in total, with the number of participants per study varying from 15 to 59; 162 were male and 29 were female.

4. Discussion

4.1. Reliability, Validity and Aerobic Capacity Assessment

Table 3 shows the research that includes verification of reliability, validity and aerobic capacity assessment of the IFT 30–15. Bruce and Moule [25] conducted a six-week strength-training intervention that involved a sample of 26 female sub-elite netball players and compared 30–15 IFT scores and Yo-yo IRT 1 level scores. The results indicate a very strong relationship between these two tests. The authors propose the 30–15 IFT for measuring HII (high-intensity intermittent-based running performance) and indicate that this test is suitable for the abovementioned purpose [25]. Regarding the elite futsal players (ICC = 0.92) and female players (ICC = 0.96), this test, including the Vift value, also proved to be reliable [26]. Scott et al. performed checks of 30–15 IFT validity in four rugby leagues and found that the test was valid [27]. Furthermore, Čović et al. [15] also confirmed the validity and reliability of this test for the assessment of intermittent aerobic fitness with a sample of 17 elite soccer players (Vift—ICC = 0.91; CV = 1.8%; HRpeak—ICC = 0.94; CV = 1.2%; and VO_2max—ICC = 0.94; CV = 1.6%). Another study, confirmed by the previous one, was conducted on a sample of 14 soccer players in order to verify the reliability of the test. The authors of this study concluded that the test was reliable (CV = 2.5%) for the evaluation of cardiorespiratory fitness specific to team sports [1]. Similar observations and similar conclusions were made by other authors, who also found the IFT 30–15 to be a reliable and useful field test for assessment of cardiorespiratory fitness of young rugby league players [27]. Buchheit, as the originator and creator of the abovementioned test, discovered in his research a high correlation between the results of the 30–15 IFT and those of the Yo-Yo IR1 (r = 0.75; 90%; CL = 0.57; 0.86). However, he eventually concluded that it was possible that the two tests might be assessing slightly different physical characteristics and capacities but that the sensitivity to training in both tests was almost equal [28]. Jeličić et al. [16] studied the reliability of the 30–15 IFT, comparing it with the treadmill test. The respondents were young female elite basketball players. This study arrived at the following results: VO_2max (CV = 4.9%, ICC = 0.85), VIFT (CV = 6.0%, ICC = 0.85) and Hrmax (CV = 4.8%, ICC = 0.96), based on which the author concluded that the 30–15 IFT is a practical way to assess the fitness abilities of young female basketball players. Kelly et al. [18] conducted research where they tried to determine the reliability of the 30–15 IFT-28m test on a sample of 10 elite wheelchair rugby players. The authors concluded, based on gathered results, that the test is reliable when used on these respondents (30–15 IFT28m, CV = 1, 9%, ICC = 0, 99; Peak heart rate, CV = 4, 5%, ICC-0.95; Blood lactate (CV = 5, 5%, ICC = 0.98). There are studies that have compared the submaximal and maximal cardiorespiratory response between 30–15 IIT and 30–15 IFT on a sample of 10 semi-professional hockey players [29]. They concluded that, compared to the field test (30–15 IFT), maximal cardiorespiratory responses (HRpeak and VO_2peak) on the 30–15 IFT were lower, while the maximal lactate was higher during the 30–15 IFT.

This overview study shows that 30–15 IFT has an excellent reliability relating to VO_2max testing, as demonstrated by high ICC values ($\geq$0.85) and low CV values ($\leq$4.9). In addition, it shows an outstanding reliability with regard to VIFT, which is demonstrated by high ICC values ($\geq$0.85) and low CV values ($\leq$6.0). The 30–15 IFT proved to be reliable for both Hrmax and HRpeak based on the retrospectively provided values (CV = 4.8%, ICC = 0.96; ICC = 0.94 n CV = 1.2%).

In any case, due to a low number of sports covered by this overview study, it is necessary to examine the validity of the 30–15 IFT for other team sports, especially those with an intermittent activity structure, where the application potential of this test is high. On the other hand, a potential disadvantage of this validity assessment is the small number of respondents sampled in the reviewed papers (the highest number of participants was 63).

The 30–15 IFT is a field test used in certain cases to assess cardiovascular capacity. The presented formula for calculating VO_2max has attracted the attention of several authors (Table 3).

Considering that Vift obtained during the 30–15 IFT test is simultaneously related to aerobic capacity, anaerobic capacity (or at least the percentage of used AVR), the neuromuscular system and as inter-effort recovery, Buchheit suggested that this test should be used to reproduce and evaluate physical capacity that occurs during high-intensity interval training involving change of direction. The 30–15 IFT is not highly-specific for particular sports but for the training sessions commonly performed in intermittent sports [35].

Darrall-Jones et al. [36] used the same test to assess the performance of 67 elite rugby players and to calculate MAS (maximal aerobic speed) and ASR (anaerobic speed reserve) using the obtained Vift 30–15 value and VO_2max. MAS represents the lowest running speed at which maximal oxygen uptake occurs, such as the velocity at the maximal oxygen uptake (VO_2max). The final speed obtained in the test can also be largely related to anaerobic capacity [32] or to the results of tests that evaluate anaerobic capacity, such as the 300 m shuttle-run test, repeated-sprint tests or the 5-0-5 COD (12,24). Research aimed at determining the effects of certain programs without using the 30–15 IFT as an indicator of aerobic capacity was conducted among handball players [23] and elite competitive handball players [37]. Research was also conducted to determine the difference in aerobic capacity depending on the position and role on a team of elite female basketball players, where the 30–15 IFT was used to assess VO_2peak. Among female basketball players, starters have better aerobic capacity than bench players, just as backcourt players have better aerobic capacity than frontcourt players [19].

The primary variables of the 30–15 IFT are running speed (Vift) for the last completed stage of running, VO_2max and HRpeak [28,35]. There are several studies that use the 30–15 IFT for measuring VO_2max, which gives coaches an adequate perspective concerning their athletes' aerobic [12,16,19]. "Corrective equations:" are used for assessment of VO_2max, and they consist of the last completed stage, age and body weight [11]. A high correlation between VO_2max and 30–15 IFT was found in soccer [1,15,32], basketball [16], rugby [12,30], ice hockey [14], and handball [23] players. Furthermore, the correlation is present in both indoor and outdoor applications of the test [19]. Based on the abovementioned facts, the 30–15 IFT is indisputably correlated with VO_2max; therefore, it can be used for quality estimation of aerobic fitness in team sports.

4.2. Training Programming

Table 4 shows the overview of research where the IFT 30–15 is used for training programming. The Vift obtained by the 30–15 IFT test is simultaneously connected with aerobic capacity, anaerobic capacity (or at least with the portion of the used AVR), the neuromuscular system and internal recovery. Based on this, Buchheit suggests that the test should be used in order to reproduce and evaluate physical capacities that occur during high-intensity interval training that includes change of direction. The 30–15 IFT is highly-specific, not for sports but for training that is usually used in sports with impermanent-intermittent intensity [35]. A study conducted on a sample of 17 adolescent handball players aimed to compare the effects of repeated sprint abilities (RSA) and HIIT. Vift was used as a value based on which the training was programmed. This model has shown to be positive; that is, as the more effective model to increase physical performance (mean and peak HR, CMJ, 10 m sprint, RSA, peHR recovery) [4]. The same author conducted research with a similar theme a year later, where 33 elite handball players were included, separated into a HIIT group and a group whose training was based on specific handball training (HBT). In this study, both training programs were shown to be equally efficient to approximate progress in performance (10 m sprint, CMJ, RSA, ball throwing speed and iEI) [38]. Buchheit has also tried to gather as much evidence and relevant facts as possible that would confirm the precision of using the 30–15 IFT in order to individualize interval training. Among a mixed sample composed of handball and basketball players, both male and female, he presented the results of a large number of variables on the basis of which he concluded that the mentioned test is a precise and useful tool for the individualization of programming [32]. In order to check the reliability of HR, HRV and parasympathetic reactivations after training, Al Haddad et al. [33] used the mentioned test to program training of different intensities (45%Vift). In another study, Buchheit et al. have evaluated the sensitivity of NIRS (near-infrared spectroscopy) procedures for different intensities in field training using Vift to program the intensity and volume of training [34]. Hernández-Davó [17] determined the influence of the length of the section during the 30–15 IFT (28 m and 40 m) on the maximum speed of running, sprinting, jumping and change of direction, all among a sample of 50 athletes playing different sports (soccer, tennis and handball). The study shows that tennis players have higher MRS during the 30–15 IFT-28. In addition, there is a relation between MRS and CMJ, 20-m sprint, as well as between agility test 5-0-5 performances. The results of this study support the interchangeable use of both 30–15 IFT-40 and 30–15 IFT-28 in team sports [17].

The last recorded study conducted by Darall-Jones et al. [39] was conducted on a sample of 114 elite rugby players divided into four age groups—U16, U18, U20 and seniors—with the aim of comparing differences in values of Vift, as well as to compare body-weight ratio with the final speed obtained in the test. The mentioned research is a good example of reference values in the rugby population.

The contribution of this research to is that even though there are studies that all show reliability and validity of the 30–15 IFT, there is no review concerning program training using this test, which has displayed to be of extreme importance in team sports.

The drawback of this research may lie in the fact that the authors did not have complete access to all databases. The authors decided to summarize all studies under the same analysis set. The limitation of this review is that it only concerned team sports. However, in the future, it is possible to conduct 30–15 IFT research on individual sports, as well as separate research on men and women.

4.3. Practical Applications

The 30–15 Intermittent Fitness test is widely applied in sports, as it measures cardiovascular capacities under various factors. This test gives coaches insight into their athletes' physical condition and helps athletes achieve their maximal athletic results. The advantage of the 30–15 IFT is that it can be used both in individual and team sports and can be individualized to suit any athlete and their current abilities.

5. Conclusions

The IFT 30–15 has been progressively used in team sports over the past 10 years to assess aerobic capacity and develop high-intensity intermittent training programs. In the past decade, authors have been predominantly focused on verifying the reliability of this test. Almost all authors who conducted research concerning the reliability verification of the test claim that the test is reliable in the assessment of cardiovascular capacities under specific conditions associated with particular sports, as it is closely related to the structure of movement in competitions, as well as intensity and volume typical for particular sports. Coaches and experts must have an idea of the advantages and disadvantages of each test, but they also have to pay attention to the purpose and usefulness of the test itself. All reviewed research was conducted on a sample of athletes exclusively involved in team sports. The conducted review of the literature shows that there is an insufficient number of studies directly comparing VO_2max and VO_2max fit in laboratory conditions. Regarding the use of the subject-matter test for the purpose of programming individualized intermittent training to boost the aerobic capacities, this test seems to be appropriate and extremely useful when it comes to team sports. Concerning the reliability of testing identified in the reviewed literature, all research points to the same conclusion: the 30–15 IFT is a reliable test for aerobic capacity assessment.

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