Journal of Strength and Conditioning Research Publish Ahead of Print
DOI: 10.1519/JSC.0000000000000846

Manuscript Title: The reliability and usefulness of the 30-15 Intermittent Fitness Test in Rugby League.

Submission Type: Original Investigation

Short Title: Intermittent running testing in Rugby League.

Authors:
Tannath J. Scott [1,2], Jace A. Delaney [1,2], Grant M. Duthie [1,2], Colin Sanctuary [1,2], David A. Ballard [2], Jeremy A. Hickmans [1,2] and Ben J. Dascombe [1,3]

Affiliations
[1] Applied Sport Science and Exercise Testing Laboratory,
Faculty of Science and Information Technology,
University of Newcastle,
Ourimbah, NSW 2258

[2] Newcastle Knights Rugby League Club,
Mayfield, NSW, 2304

[3] Priority Research Centre in Physical Activity and Nutrition,
University of Newcastle,
Callaghan, NSW 2308

Corresponding Author:
Mr. Tannath Scott
Applied Sports Science and Exercise Testing Laboratory
School of Environmental and Life Sciences
Faculty of Science and Information Technology
University of Newcastle
PO Box 127, Ourimbah, NSW 2258
Ph: +61 2 423695386
Email: tannath.scott@uon.edu.au; tscott@newcastleknights.com.au

Financial Support: No external financial support was received for this study

ABSTRACT

This study examined the reliability and usefulness of the 30-15 Intermittent Fitness Test (30-15_{IFT}) within rugby league. Fifty-five young rugby league players participated in the study. These included representative players from Under 16's (n=19, 15.6 ± 0.3 yr, 78.1 kg ± 10.9 kg), Under 18's (n=21, 17.4 ± 0.5 yr, 86.9 ± 11.2 kg) and Under 20's (n=15, 19.4 ± 0.5 yr, 95.9 ± 8.7 kg) squads within a professional rugby league club. Players performed the 30-15_{IFT} twice within nine days of each other. Maximal intermittent running velocity (V_{IFT}) and heart rate at exhaustion (HR_{peak}) were collected for both tests. Intra-class coefficients (ICC) for the 'Combined' and Under 20's were very large (r > 0.7); while the ICC for Under 16's and Under 18's were almost perfect (r > 0.9). Coefficients of variation (%CV) were 1.9% (95% CI, 1.6-2.4) for the combined test-retest of the 30-15_{IFT} and 0.6% (0.5-1.0) for HR_{peak}. As the typical error of measurement (TE) (0.36 $km{\cdot}h^{-1}$) was greater than the smallest worthwhile change (SWC) (0.21 $km{\cdot}h^{-1}$) value, the usefulness of the V_{IFT} was rated as 'Marginal'. The TE for HR_{peak} was similar to the SWC, rating the usefulness of this variable as 'OK'. Despite the usefulness of the 30-15_{IFT} being deemed 'Marginal', a change as small as 0.5 $km{\cdot}h^{-1}$ (1 stage) in V_{IFT} could be considered substantial or 'real'. As a consequence the 30-15_{IFT} presents as both a reliable and useful field test in the assessment of intermittent fitness for rugby league players.

Key Words: intermittent fitness, testing, maximum heart rate

INTRODUCTION

Rugby League is a physically demanding contact sport that involves frequent high-intensity movements (e.g. repeated high-speed running, sprint efforts and tackling) that are interspersed with periods of low intensity activity (e.g. standing, walking and jogging) [1, 25, 27]. Given this high-intensity intermittent nature, rugby league players must possess a well-trained high-intensity intermittent running ability in addition to a high aerobic capacity ($\dot{V}O_2max$). Time motion analysis studies have demonstrated the intermittency of rugby league match-play finding that players playing in the Australian-based National Rugby League (NRL) competition spend 10-17% of total match time undertaking high-intensity running movements that typically present in short bursts [1, 18, 25]. Moreover, a recent study of positional match demands over a complete rugby league season found that high-intensity running (> 14 $km \cdot h^{-1}$) contributed to 14% and 17% of the distance covered by forwards and backs respectively [1]. Further to these intermittent running demands, Sirotic et al. [25] reported that players performed 30 or more sprints per match although these rarely exceed 50-m or 6-s. These sprint distances (mean value) ranged from 16.0-m for the fullback to 21.1-m for the other outside backs (centre and winger). Moreover, this study reported mean recovery periods between sprint bouts varied from 149-s to 284-s depending on positions. Collectively, these findings highlight that rugby league match play is highly intermittent, providing valuable information for testing and training.

In addition, past time-motion analysis studies have also demonstrated the high aerobic demands of rugby league match-play [1, 22, 25]. Gabbett and colleagues [11] recently reported that $\dot{V}O_2max$ could discriminate between elite (55.7 ± 2.9 $ml \cdot kg^{-1} \cdot min^{-1}$) and regional (53.2 ± 3.9 $ml \cdot kg^{-1} \cdot min^{-1}$) players. Importantly, this might reflect past observations that an individual's $\dot{V}O_2max$ may be a central factor in the recovery process between high-intensity efforts as well as positively associated with prolonged high-intensity running exercise performance [24]. It has recently been demonstrated [12] that professional rugby league players with a greater prolonged high-intensity intermittent running ability (classed as 'high fitness') covered significantly more total distance (6800 ± 1969 m and 4535 ± 1326 m, respectively), high-speed distance (> 18 $km \cdot h^{-1}$) (490 ± 141 m and 336 ±159 m, respectively) and played more time (70.1 ± 20.6 min and 47.5 ± 13.9 min, respectively) during a match than 'low fitness' individuals. Therefore, it appears reasonable to suggest that improvements in $\dot{V}O_2max$ may significantly influence match-play performance in rugby league. Taken together, the sprint requirements and aerobic demands of rugby league demonstrate the intermittent nature of rugby league match play.

As such, there is considerable value for rugby league conditioning and coaching staff to be able to assess $\dot{V}O_2peak$ and high-intensity intermittent running (HIR) ability to monitor the effectiveness of implemented conditioning regimes. Historically, $\dot{V}O_2peak$ in field-based sports has been routinely assessed using either the multi-stage fitness test (MSFT), or the Yo-Yo Incremental Recovery Test Level 1 (Yo-Yo IR1) and 2 (Yo-Yo IR2). Nonetheless, these protocols have limitations in the testing and prescription of these highlighted physiological capacities for intermittent team sport athletes [5]. For example, the MSFT may obtain a maximal running velocity, however certain physiological determinants of intermittent performance (e.g. inter-effort recovery ability and anaerobic reserve capacity) are not evaluated [13]. In contrast the Yo-Yo IR1 and Yo-Yo IR2 examine these physiological determinants, providing a measurement of aerobic intermittent performance, yet they do not deliver a reference speed that can be used in the prescription of high-intensity intermittent runs [5, 20].

Recently, the 30-15 Intermittent Fitness Test (30-15_{IFT}) has been introduced to be a practical alternative to the commonly used field tests mentioned above [6, 8, 13, 23]. The 30-15_{IFT} is an intermittent, incremental shuttle-run test that is designed to elicit heart rate peak (HR_{peak}) and $\dot{V}O_2$peak, in addition to providing an overall measure of intermittent fitness [7]. The validity and reliability of the 30-15_{IFT} has recently been demonstrated among basketball, handball and ice hockey (modified from running to ice skating) cohorts [5, 9]. What makes this test appealing to practitioners is its validity in the individual prescription of high-intensity intermittent running, utilising the final running velocity reached at the end of the 30-15_{IFT} (V_{IFT}) [5], overcoming the previous limitations of field-based tests discussed above. As such, prescribing training based on V_{IFT} appears to increase the homogeneity across the playing group and further standardising training content at a team level [5]. In addition the 30-15_{IFT} has been perceived to be less "painful" than continuous field-based tests in 70% of team sport athletes examined [3].

Despite the specificity of this test to rugby league, no literature has investigated the validity and reliability of the 30-15_{IFT} in rugby league. Due to the greater body mass of rugby league players, it is likely that they would be required to produce a greater mechanical and metabolic load throughout the movement patterns involved in the 30-15_{IFT} [7, 13]. Therefore, it is essential to re-investigate the reliability of this test among this population. The primary aim of the present study was to examine the reliability (including both V_{IFT} and HR_{peak}) of the 30-15$_{IFT}$ within rugby league. A secondary purpose of the study was to assess the usefulness of the 30-15$_{IFT}$ among this cohort.

METHODS

Experimental Approach to the Problem

In order to standardise testing, all tests were performed at the end of the pre-season period before the competitive season. To limit the circadian effect on performance as well as to reduce the effect of external factors (such as heat), the testing procedures were either performed during the morning period (9.00 – 11.00 h) or evening period (16.00 – 18.00 h), when team practice usually took place. Testing sessions were repeated within nine days of each other. Two weeks prior to testing, subjects underwent a familiarisation session so they were aware of the running patterns and audio signals of the 30-15$_{IFT}$. Players were asked to refrain from undertaking any strenuous exercise in the 24-hour period prior to testing. Due to the specificity of the test and subsequent conditioning prescription, players tested in their training clothes and own football boots. The team dietician provided nutritional and hydration strategies to all players as per club guidelines. In order to ensure sufficient carbohydrate intake during this week, nutritional records were taken as was typical of club player monitoring policy. All sessions were performed in temperatures between 21-24°C. Reliability of the 30-15$_{IFT}$ was examined using the intraclass correlation coefficient (ICC) as well as the typical error of measurement (TE), expressed as a coefficient of variation (%CV), similar to methods previously reported [9].

Subjects

The subject pool (n=55) was comprised of players competing in the NSW Harold Matthews competition (Under 16's) (n=19, 15.6 ± 0.3 yr, 176.6 ± 6.3 cm, 78.1 kg ± 10.9 kg, 62.2 ± 22.3 mm Σ7SF), in the NSW S.G Ball competition (Under 18's) (n=21, 17.4 ± 0.5 yr, 178.8 ± 5.5 cm, 86.9 ± 11.2 kg, 65.8 ± 20.8 mm) and in the National Youth Competition (Under 20's) (n=15, 19.4 ± 0.5 yr, 95.9 ± 8.7 kg, 185.2 ± 3.3 cm, 67.8 ± 15.1 mm). Players completing in both the Harold Matthews and S.G Ball competition were involved in 5.9 ± 0.7 $hr{\cdot}wk^{-1}$ of physical training, while players from the Nation Youth Competition completed 10.8 ± 2.1 $hr{\cdot}wk^{-1}$. All players provided written informed consent prior to participation and were cleared of injury by the team's medical staff prior to completing the testing sessions. Parental or guardian consent was obtained before junior players were permitted to participate. The University of Newcastle Human Research Ethics committee approved the study methods.

Procedures

The 30-15 Intermittent Fitness Test

The $30\text{-}15_{IFT}$ consists of 30-s shuttle runs interspersed with 15-s periods of passive recovery. The initial running velocity was set at 8 $km{\cdot}h^{-1}$ for the first 30-s run and increased by 0.5 $km{\cdot}h^{-1}$ for every subsequent 45-s stage. Players ran back and forth between two lines set 40-m apart at a pace governed by a pre-recorded beep. This pacing strategy allowed subjects to run at appropriate intervals and helped them adjust their running speed as they entered into 3-m zones at each end as well as the middle

(20-m line) when a short beep sounds (Figure 1). During the 15-s recovery period, each player walked forward to the closest of the three lines (at the middle or at one end of the running area, depending on where the previous stage was completed), in preparation for the next stage. The test ended when a player could no longer maintain the imposed running speed or when they were unable to reach a 3-m zone around each line at the moment of the audio signal on three consecutive occasions. If players were unable to complete the stage, then their score was recorded as the stage that they last completed successfully, and the running velocity recorded as their maximal $30\text{-}15_{IFT}$ running velocity (V_{IFT}) [4, 5].

INSERT FIGURE 1 ABOUT HERE

Heart Rate Measurement

Heart rate (HR) was recorded for a sub-sample (n=13) of (NYC) players using Polar T^2 system using R-R technology (Polar Electro Oy, Finland). Heart rate was continually recorded at 1 Hz throughout each $30\text{-}15_{IFT}$. Peak HR (HR_{peak}) was recorded as the highest HR recorded during the final 30-s of the test.

Statistical Analysis

Data are presented as either mean ± SD or mean with 95% confidence intervals (95% CI) where specified. The distribution of each variable was examined using the Shapiro-Wilk normality test, and homogeneity of variance was verified with the Levene test.

Paired sample t-tests were used to identify any significant differences between test-retest data. Change in mean between trials, ICC and TE, expressed as a coefficient of variation (CV), were calculated through an available online spreadsheet [16]. As a criterion to declare the variable reliable, the CV was set at <5% [14]. Hopkins [15] has previously proposed that the smallest worthwhile change (SWC) is significant in the assessment of performance markers due to the noise associated with physical testing. As such, the SWC was calculated between trials for the final velocity reached at the completion of the test (equal to 0.2 multiplied by the between subject SD, based on Cohen's effect principle) [17]. In line with previous research, if the TE was higher than the SWC, the evaluation of test was 'marginal', if the TE was similar to the SWC, the evaluation was 'OK'; and if the TE was less than the SWC, an evaluation of 'good' was given to the test [28].

RESULTS

Data Collection

Due to difficulties such as injury and illness several players (n=5) were unavailable for both testing days. These players were removed from the study with the final sample size (n=55) reflective of the number of players who completed both test-retest sessions. The HR data presented represents a sub-sample of 13 players from the NYC (U20's) Squad.

Reliability

The change in mean between trials is reported in Table 1, while TE, ICC and CV% are presented in Table 2. These tables report reliability values for each age group as well as playing position. The coefficient of variation (%) values reported (1.9%) are less than what is typically deemed reliable (<5%). This finding is consistent across all ages and all playing positional groups. An example of the individual heart rate responses during the repeated 30-15$_{IFT}$ trials is illustrated in Figure 2 for 1 subject. Pairwise analysis revealed no significant differences between either V_{IFT} or HR_{peak} ($p < 0.05$) between the two trials.

INSERT TABLE 1 AROUND HERE

INSERT TABLE 2 AROUND HERE

Test Usefulness

Typical error of measurement values for V_{IFT} was slightly greater than the calculated SWC, so it was classified as 'Marginal' for this variable (Table 2). Typical error of measurement values for HR_{peak} was similar to the calculated SWC, rating the usefulness of this variable as 'OK'.

INSERT FIGURE 2 AROUND HERE

DISCUSSION

The purpose of this study was to examine the reliability and usefulness of the 30-15$_{IFT}$ within rugby league players. It was suggested that due to the separate morphological profiles, physiological and physical characteristics of rugby league players, the reliability of the 30-15$_{IFT}$ may have differed when compared to previously examined cohorts (e.g. Ice hockey and European handball players). The main finding of the present study was that the 30-15$_{IFT}$ showed good reliability across all playing groups within rugby league.

In agreement with previous research, our study found that the reliability of the 30-15$_{IFT}$ was very good, with a TE of 0.36 km·h^{-1} (CV 1.9%). These values are very similar to that reported previously by Buchhiet [4], who demonstrated the test-retest reliability of the 30-15$_{IFT}$ to be very good (TE of 0.30 and CV value of 1.7%) among 20 regional-to-national level European handball players. Additionally, this result is comparable to findings previously reported in similar field based tests such as the Yo-Yo IR1 [%CV for distance completed of 4.9-8.7% [19, 26]] and Yo-Yo IR2 [%CV values for distance completed of 7-13% [2, 21, 26]. Indeed, Thomas et al [26] examined the reliability of the Yo-Yo IR1 among 16 recreationally active subjects, and reported %CV values for distance completed of 8.7%, Yo-Yo IR1 scores of 1.9% and a TE of 0.26. Further, the present study found the ICC of 30-15$_{IFT}$ was very similar to that previously reported for the Yo-Yo IR1 (ICC of 0.89 and 0.95 ($p < 0.01$), respectively).

Interestingly, a recent study examining the relationship between the performance of the Yo-Yo IR1 and the 30-15$_{IFT}$ demonstrated a large correlation ($r = 0.75$) between 30-15$_{IFT}$ and Yo-Yo IR1 running performance [10]. The sensitivity across an 8-week training intervention between the two tests was also shown to be similar, despite these tests evaluating slightly different physiological capacities [10]. Given that these tests are exhaustive, they incorporate complex physiological components (including cardiopulmonary, metabolic and neuromuscular related elements) that may vary and subsequently affect performance differently on a daily basis [2], the reliability results of the present study appear particularly significant.

A further aim of the study was to evaluate the reliability of HR_{peak} assessed from the 30-15_{IFT}. The reliability of HR measures (Table 2, Figure 2) supports previous research that has examined the reliability of HR_{peak} during a modified 30-15_{IFT} on ice, reporting a CV value of 0.7% [9]. Although the sample size used to investigate the reliability of HR_{peak} may be small [17], previous research examining similar protocols with a comparable magnitude of subjects (n = 12), concluded that the good reliability likely limits the effect of the smaller sample size used [9]. Collectively, these results may be indicative of the specificity of this test to rugby league players in an ecologically valid environment. However, before this conclusion can be drawn, it is important to further investigate the validity of the 30-15_{IFT} and the contributing factors of this performance in rugby league.

A secondary purpose of the study was to assess the usefulness of the 30-15_{IFT} among a rugby league cohort. Despite the usefulness of the 30-15_{IFT} being deemed 'Marginal', it must be noted that both the TE and SWC change are less than 1 stage. Therefore, from a practical point of view, a change as small as 0.5 $km{\cdot}h^{-1}$ (1 stage) in V_{IFT} could be considered substantial or 'real'. Although suggesting a SWC based on a whole squad's data could be considered a 'blanket approach', it might be deliberated as more appropriate for coaching and conditioning staff in a field setting. Indeed, it may be more accurate to calculate the inter-individual SWC (CV x 0.2, half of CV [15]). However, this would require a large amount of individual testing results to be deemed sensitive, as well as specific spreadsheets that make this method impractical for large squad's in team sports, particularly when there are high level's of homogeneity among the squad

[9]. The results of this study support previous findings that a change of 1 stage is meaningful [4, 6]. Additionally, the usefulness of the HR_{peak} taken from the tests was rated as 'OK' (Table 2). It may then be concluded that HR_{peak} can be reliably measured using the $30\text{-}15_{IFT}$. However, due to the relationship between field-based $\dot{V}O_2max$ tests and HR_{peak}, supplementary examination into the validity of this measurement against a gold standard $\dot{V}O_2max$ protocol is justified amongst this present population group.

The outcome of the present study suggests the $30\text{-}15_{IFT}$ is a reliable test among a rugby league cohort. Rugby League players are typically mesomorphically built and are therefore different to previously examined players (e.g. European Handball). Moreover, the present study has provided evidence to coaching staff within similar team sports (e.g. rugby union) on what may be considered a 'real' change as well as establishing the usefulness of this test within rugby league. Although this study provides an assessment on the reliability of this test, further studies may focus on the validity and contributing factors of $30\text{-}15_{IFT}$ performance in order to establish further relationships between $30\text{-}15_{IFT}$, rugby league and its specificity to training regimes. Research may aim at more acutely examining the results of this data across positional groups as well as playing level. It may be reasonable to suggest that due to the morphological differences between forwards and backs, the current test may be able to distinguish playing groups. Indeed, recent evidence has suggested various anthropometric measurements and $\dot{V}O_2max$ can differentiate between levels of competition [11]. Therefore, future studies may focus on examining the influence of playing levels on $30\text{-}15_{IFT}$, given the contribution of these former characteristics to $30\text{-}15_{IFT}$ performance.

PRACTICAL APPLICATIONS

The $30\text{-}15_{IFT}$ is a reliable and useful test to concurrently evaluate prolonged HIR ability and $\dot{V}O_2peak$ in rugby league players. From our results it is reasonable to suggest the $30\text{-}15_{IFT}$ is reproducible and specific to rugby league players. The test is inexpensive, can simultaneously accommodate testing around 20 players comfortably, can be completed within 30 minutes, and requires little equipment and resources. The strong practicality of this test is that it can be accurately used for prescribing intermittent shuttle running compared to other similar field tests [5]. We suggest the $30\text{-}15_{IFT}$ is appropriate in monitoring the aerobic fitness specific to rugby league players, and other intermittent team sports (e.g. rugby union, Australian football), throughout the course of the pre-season and competition phases. Based on the TE and SWC values presented in this study, we suggest a change of 1 stage ($0.5\ km{\cdot}h^{-1}$) can be interpreted as a 'real' change in performance. Due to the nature of the testing environment, the authors suggest that interpretation of data must take into account of weather and ground conditions.

REFERENCES

1. Austin, D, and Kelly, S. Positional differences in rugby league match-play through the use of global positioning systems (GPS). *J Strength Cond Res* 27: 14-19, 2013.
2. Bangsbo, J, Iaia, FM, and Krustrup, P. The Yo-Yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports. *Sports Med* 38: 37-51, 2008.
3. Buchheit M. The 30-15 Intermittent Fitness Test: a new intermittent running field test for intermittent sport players - Part 1. *Approches du Handball* 87: 27-34, 2005.
4. Buchheit M. The 30-15 intermittent fitness test: reliability and implication for interval training of intermittent team sport players. Presented at ECSS, Belgrade, 2005.
5. Buchheit, M. The 30-15 intermittent fitness test: accuracy for individualizing interval training of young intermittent sport players. *J Strength Cond Res* 22: 365-374, 2008.
6. Buchheit M. The 30-15 Intermittent Fitness Test: 10 year review. Doha, Qatar: Physiology Unit, Sport Science Department, ASPIRE, Academy for Sports Excellence, 2010.
7. Buchheit, M, Al Haddad, H, Millet, GP, Lepretre, PM, Newton, M, and Ahmaidi, S. Cardiorespiratory and cardiac autonomic responses to 30-15 intermittent fitness test in team sport players. *J Strength Cond Res* 23: 93-100, 2009.
8. Buchheit, M, Laursen, PB, Kuhnle, J, Ruch, D, Renaud, C, and Ahmaidi, S. Game-based training in young elite handball players. *Int J Sports Med* 30: 251-258, 2009.

9. Buchheit M, Lefebvre B, Laursen PB, and Ahmaidi S. Reliability, usefulness, and validity of the 30-15 Intermittent Ice Test in young elite ice hockey players. *J Strength Cond Res* 25: 1457-1464, 2011.

10. Buchheit M and Rabbani A. 30-15 Intermittent Fitness Test vs. Yo-Yo Intermittent Recovery Test Level 1: Relationship and Sensitivity to Training. *Int J Sports Physiol Perform* 9: 522-524, 2014.

11. Gabbett, TJ, Jenkins, DG, and Abernethy, B. Relative importance of physiological, anthropometric, and skill qualities to team selection in professional rugby league. *J Sports Sci* 29: 1453-1461, 2011.

12. Gabbett TJ, Stein JG, Kemp JG, and Lorenzen C. Relationship between tests of physical qualities and physical match performance in elite rugby league players. *J Strength Cond Res* 27: 1539-1545, 2013.

13. Haydar, B, Haddad, HA, Ahmaidi, S, and Buchheit, M. Assessing inter-effort recovery and change of direction ability with the 30-15 Intermittent Fitness Test. *J Sports Sci Med* 10: 346-354, 2011.

14. Hopkins WG. Measures of Reliability in Sports Medicine and Science. *Sports Med* 30: 1-15, 2000.

15. Hopkins WG. How to interpret changes in an athletic performance test. *Sports Sci* 8: 1-7, 2004.

16. Hopkins WG. Reliability from consecutive pairs of trials (Excel spreadsheet). A new view of statistics sportssciorg: Internet Society for Sport Science Available at: sportsciorg/resource/statsxrelyxls, Accessed July 2013.

17. Hopkins, WG, Schabort, EJ, and Hawley, JA. Reliability of power in physical performance tests. *Sports Med* 31: 211-234, 2001.

18. King T, Jenkins D, and Gabbett T. A time-motion analysis of professional rugby league match-play. *J Sports Sci* 27: 213-219, 2009.

19. Krustrup P and Bangsbo J. Physiological demands of top-class soccer refereeing in relation to physical capacity: effect of intense intermittent exercise training. *J Sports Sci* 19: 881-891, 2001.

20. Krustrup P, Mohr M, Ellingsgaard H, and Bangsbo J. Physical demands during an elite female soccer game: importance of training status. *Med Sci Sports Exerc* 37: 1242-1248, 2005.

21. Krustrup, P, Mohr, M, Nybo, L, Jensen, JM, Nielsen, JJ, and Bangsbo, J. The Yo-Yo IR2 test: physiological response, reliability, and application to elite soccer. *Med Sci Sports Exerc* 38: 1666-1673, 2006.

22. McLellan, CP, Lovell, DI, and Gass, GC. Performance analysis of elite Rugby League match play using global positioning systems. *J Strength Cond Res* 25: 1703-1710, 2011.

23. Mosey, T. High intensity interval training in youth soccer players- using fitness testing results practically. J *Aust Strength Cond* 17: 49-51, 2009.

24. Sirotic, AC and Coutts, AJ. Physiological and performance test correlates of prolonged, high-intensity, intermittent running performance in moderately trained women team sport athletes. *J Strength Cond Res* 21: 138-144, 2007.

25. Sirotic, AC, Knowles, H, Catterick, C, and Coutts, AJ. Positional match demands of professional rugby league competition. *J Strength Cond Res* 25: 3076-3087, 2011.

26. Thomas, A, Dawson, B, and Goodman, C. The yo-yo test: reliability and association with a 20-m shuttle run and $\dot{V}O_2max$. *Int J Sports Physiol Perform* 1: 137-149, 2006.

27. Waldron, M, Twist, C, Highton, J, Worsford, P, and Daniels, M. Movement and physiological match demands of elite rugby league using portable global positioning systems. *J Sports Sci* 29: 1223-1230, 2011.

28. Weir, JP. Quantifying test-rest reliability using intraclass correlation coefficient and the SEM. *J Strength Cond Res* 19: 231-240, 2005.

FIGURE LEGEND

Figure 1: Demonstration of the 30-15$_{IFT.}$ Taken from Buchheit [5].

Figure 2: Heart rate (HR) response to the 30-15 Intermittent Fitness Test during two different trials (Trial 1 and Trial 2) in a representative subject.

Tables

Table 1. Maximal intermittent running velocity (V_{IFT}) observed for the 30-15 Intermittent Fitness Test ($30\text{-}15_{IFT}$).

		V_{IFT} ($km \cdot h^{-1}$) (mean ± SD)		
$30\text{-}15_{IFT}$	**Players**	**Trial 1**	**Trial 2**	**Δ**
Squad				
NYC (U20's)	15	18.3 ± 0.8	18.4 ± 0.8	0.1 ± 0.5
SG Ball (U18's)	21	18.5 ± 1.2	18.6 ± 1.3	0.1 ± 0.5
Harold Matthews (U16's)	19	18.4 ± 1.0	18.6 ± 1.0	0.1 ± 0.5
Combined	55	18.4 ± 1.0	18.5 ± 1.1	0.1 ± 0.5
Heart Rate ($b \cdot min^{-1}$)				
NYC Sub-sample	13	194 ± 6	194 ± 6	-0.1 ± 1.8

Table 2. Measures of reliability for maximal intermittent running velocity (V_{IFT}) and peak heart rate (HR_{peak}) during the 30-15 Intermittent Fitness Test ($30\text{-}15_{IFT}$).*

	Players	ICC	TE	(95% CI)	(95% CI)	CV (%)	(95% CI)	SWC	Test Rating
Squad									
NYC (U20's)	15	0.83	0.36	(0.26 - 0.57)	(0.56 - 0.94)	2	(1.4 - 3.1)	0.16	Marginal
SG Ball (U18's)	21	0.92	0.37	(0.29 - 0.54)	(0.81 - 0.97)	2.1	(1.6 - 3.0)	0.25	Marginal
Harold Matthews (U16's)	19	0.94	0.25	(0.19 - 0.38)	(0.86 - 0.98)	1.8	(1.3 - 2.7)	0.22	OK
Combined	55	0.89	0.36	(0.30 - 0.44)	(0.81 - 0.93)	1.9	(1.6 - 2.4)	0.21	Marginal
Heart Rate ($b\cdot min^{-1}$)									
NYC Sub-sample	13	0.96	$1\ b\cdot min^{-1}$	(0.89 – 2.05)	(0.89 - 0.99)	0.6	(0.5 - 1.0)	$1\ b\cdot min^{-1}$	OK

*ICC = intraclass correlation coefficient; TE = typical error of measurement; CI = confidence intervals; CV = coefficient of variation; SWC = smallest worthwhile change

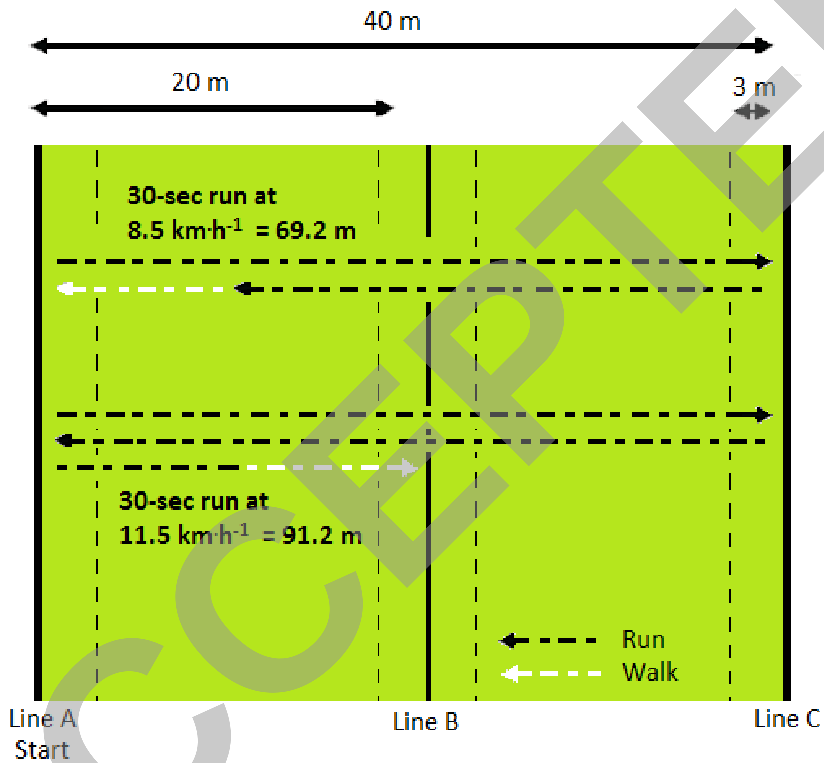
40 m
20 m
3 m
30-sec run at
8.5 km·h-1 = 69.2 m
30-sec run at
11.5 km·h-1 = 91.2 m
Run
Walk
Line A
Start
Line B
Line C

Figure 1

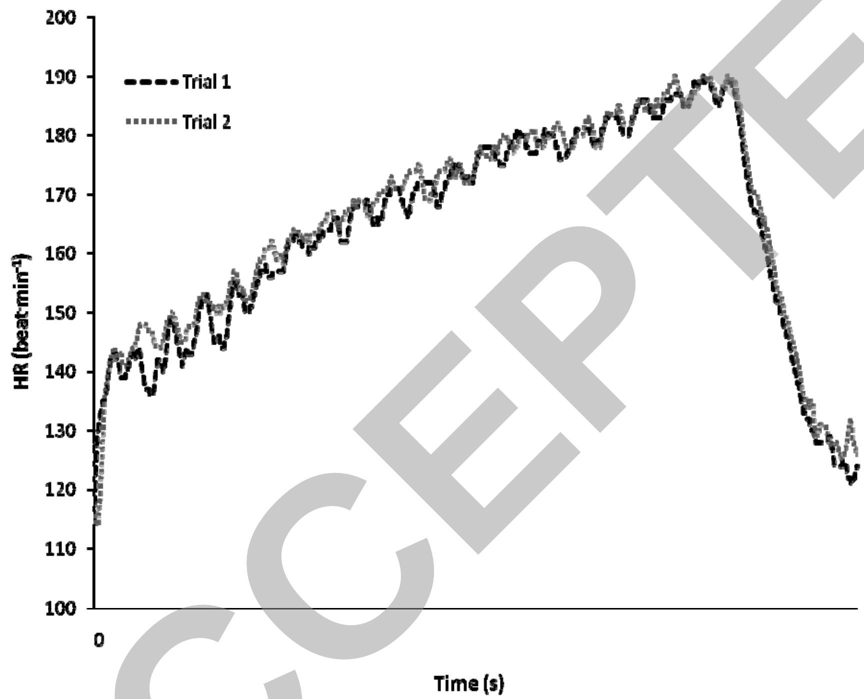
200
190
180
170
160
150
140
130
120
110
100
Trial 1
Trial 2
HR (beat·min⁻¹)
0
Time (s)

Figure 2