

# The concurrent validity and between-session reliability of a 1000m time trial for the assessment of aerobic fitness in elite development soccer players

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## Headline

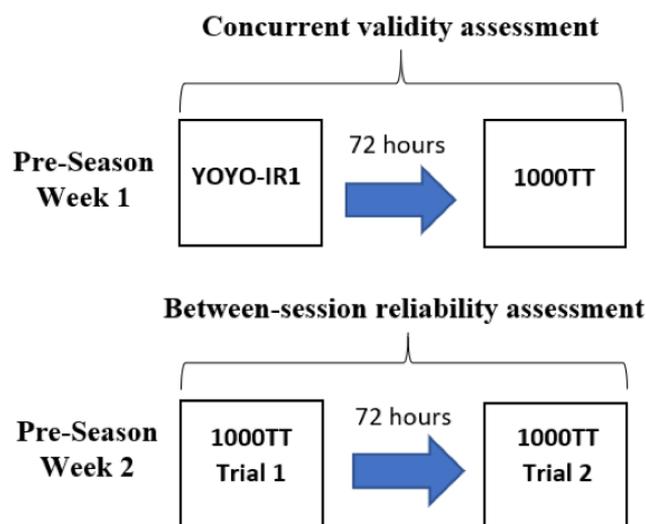
Several validated and reliable assessments of aerobic performance currently exist to bench-mark elite soccer players (1-3). In an applied setting, there is a need to make fast decisions on the physical status of players that are accurate but not over-bearing to other aspects of the training programme such as technical and tactical development. In this sense, a fast and relatively non-intrusive measure of maximal aerobic performance should be appealing to practitioners and coaches and may facilitate more frequent opportunities to test. The 1000TT is currently used within international football to assess player aerobic performance (14).

## Aim

The aim of this study was to test the concurrent validity of a 1000m time trial (1000TT) for the assessment of aerobic performance compared to the Yo-Yo Intermittent Recovery Test Level 1 (YOYO-IR1). The secondary aim was to determine the between-session reliability of the 1000TT in elite development players.

## Design

A single-group, concurrent validity and between-session reliability design was used



**Fig. 1.** Schematic of experimental timeline for assessing concurrent validity of a 1000m time trial (1000TT) compared with the Yo-Yo Intermittent Recovery Test 1 (YOYO-IR1) and between-session reliability of the 1000TT.

## Methods

### Athletes

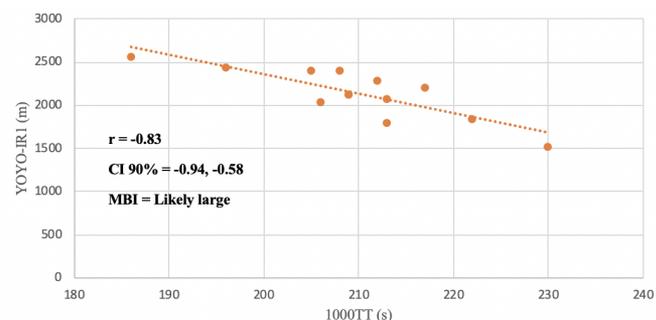
16 male elite development players (under-23s) (age:  $19.2 \pm 1.1$  years; height:  $183.3 \pm 6.1$  cm; body mass:  $76.1 \pm 7.8$  kg) from the professional development squad of a Scottish Premiership club agreed to take part in the present study. Data were collected in line with the football club's daily practices which all conformed to the declaration of Helsinki.

### Procedures

All trials were conducted during the first 2-weeks of pre-season and followed a standardised warm-up. To assess concurrent validity, 13 participants performed the YOYO-IR1 on the



**Fig. 2.** Outline of 1000m time trial (1000TT) protocol consisting of a 100m shuttle track divided into lanes with poles at either end.



**Fig. 3.** Relationship between the 1000m time trial (1000TT) and the Yo-Yo Intermittent Recovery Test 1 (YOYO-IR1). Pearson's product moment correlation coefficient ( $r$ ) with 90% confidence intervals (CI) and magnitude-based inference (MBI) of the relationship.

morning of the first day of pre-season followed by the 1000TT 72 hours later. During the second week of pre-season, 10 participants performed a further two 1000TT trials separated by 72 hours to capture the between-session reliability. The experimental timeline is shown in Figure 1. All trials were held in the morning prior to any other form of training and followed a standardised breakfast.

### YOYO-IR1

The YO-YO IR1 has been extensively examined in elite soccer in both adult (3) and youth (4) populations and has shown positive correlations with match-related physical performance (4) and the ability to discriminate between playing levels (5). The test was performed following the methodology Krustrup et al. (1) and was completed on an indoor artificial turf surface. The individual scores were expressed as distance covered in metres (m).

### 1000TT

The 1000TT consisted of a maximal 10x100m shuttle run. The shuttle track was divided into lanes with training poles at either end (Figure 2). To ensure the required distance was achieved, participants were instructed to touch the pole as they changed direction at either end. Players times were recorded by stopwatch, and if required, confirmed by video analysis (both trials were filmed). Both trials were performed on grass (surface: firm/dry; conditions: still, 17-20°C). Individual scores were expressed as time to completion in seconds (s).

### Statistical Analysis

Descriptive statistics are reported as group mean score  $\pm$  standard deviations (SD). To test the concurrent validity of the 1000TT, Pearson's product moment correlation coefficient ( $r$ ) was calculated to establish the strength and direction of the relationship with the YOYO-IR1. Data were analysed using SPSS (IBM Corp. 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). The following criteria were adopted to interpret the magnitude of the relationship; 0.0-0.1 trivial; >0.1-0.3 small; >0.3-0.5 moderate; >0.5-0.7 large; 0.7-0.9 very large; 0.9-0.99 nearly perfect; 1.0 perfect (6) and a qualitative magnitude-based inference (MBI) was applied. Between-session reliability was calculated and expressed as typical error (TE), coefficient of variation (CV%) and interclass correlation (ICC) using a custom spreadsheet (7). To offer practitioners a value for meaningful change in the 1000TT, a minimum detectable change (MDC) at a confidence level of 75% was calculated using the following equation;  $MDC = TE \times 1.15 \times \sqrt{2}$  (13).

**Table 1. Between-session reliability statistics for the 1000m time trial (1000TT). Typical error (TE), interclass correlation coefficient (ICC), coefficient of variation (CV%) and minimum detectable change (MDC) with 75% confidence level.**

	Trial 1-2
TE (90% CI)	2.86 s (2.08, 4.71)
ICC (90% CI)	0.82 (0.51, 0.94)
CV% (90% CI)	1.06 (0.68, 1.44)
MDC	4.56 s (2.2%)

### Results

Group mean values ( $\pm$  SD) for the YOYO-IR1 and 1000TT [concurrent validity assessment] were 2138m (292.8) and 209.7s (10.9), respectively. The statistical analyses are shown in Figure 3. Group mean values ( $\pm$  SD) for the 1000TT [between-session reliability assessment] were 210.5s (4.9) [Trial 1] and 210.7s (6.9) [Trial 2], the statistical analysis is shown in Table 1.

### Discussion

The main finding of this study was that, when compared with the YOYO-IR1, the 1000TT demonstrated a linear relationship that was likely large and to this effect provides a valid measure of aerobic performance in elite soccer players. Secondly, the 1000TT demonstrated good between-session reliability and therefore may offer practitioners a robust method to track change in aerobic performance capabilities. Given the relative ease and speed of delivery (as part of an extended warm-up, for example), the 1000TT may offer a more streamlined alternative to the current gold-standard tests such as the YOYO-IR1 and 30-15 intermittent fitness test (30-15IFT) (2), and in this sense has potential to facilitate more frequent testing during the competitive season.

An attractive feature of the 1000TT is that by simply dividing 1000 by the time to complete the run in seconds, maximal aerobic speed (MAS) can be calculated thus providing usable data for training drill prescription alongside a tangible measure of change in performance. MAS has previously been shown to be positively associated with match-running performance in elite rugby union players (8). In a previous study, Kelly and Wood (9), reported a strong correlation between MAS derived from a novel 1200m shuttle run and the 30-15IFT in a range of team sport athletes of different levels (not soccer players) ( $r=0.73-0.93$ ). Although MAS is typically assessed over longer distances ( $\geq 1200m$ ) in order to prolong the oxidative demands, the current findings indicate that a valid indication of aerobic performance may be gauged using a shorter protocol. Previous research has found positive correlations between laboratory-derived MAS ( $vVO_{2max}$ ) and time-trial performances of different durations (1200-3200m) (10, 11), although the former reported the strength of the associations was greater in longer trials ( $>1600m$ ). To this effect, when deriving MAS from shorter time trial protocols, such as the 1000TT, practitioners should approach the transferability of intensity for running drills with caution.

Knowledge of the measurement error associated with a chosen testing protocol is crucial to accurately interpret the meaningfulness of the observed scores. The between-session CV% for 1000TT (1.06%) is considerably lower than the equivalent values reported previously for the YOYO-IR1 (4.9%) (1). Although the reliability of the 1000TT has not previously been documented in the literature, the 2.2% MDC found in this study is in line with Fitzpatrick et al. (2018) (12) who referenced an MDC of 1.3% on a 1500 time-trial in a similar cohort.

In conclusion, the findings of this study indicate a 10x100m shuttle run time trial may offer practitioners and coaches a streamlined protocol to reliably capture aerobic performance capabilities which is deliverable with minimum intrusion to other aspects of the programme.

### Practical Applications

- The 1000TT can be used to benchmark aerobic performance under time-constraints. The mean duration of the test in the current study was 3 minutes 30 seconds.

- A change in performance of 4.6 seconds (which equates to approximately 22m over 1000m) provides a threshold for detectable change (with 75% confidence) although practitioners are encouraged to form their own reliability data, where possible with larger sample sizes.
- The 1000TT may be used to calculate MAS and assign players to specific groups during supplementary conditioning drills. For example, to ensure the appropriate intensity and desired outcome is achieved, players may be grouped according to MAS in 0.5 metres per second (m/s) increments (i.e. 4, 4.5, 5m/s).
- From a practical perspective, the change in 1000TT performance that would equate to a 0.5m/s increase in MAS, and a real-world change in fitness grouping, would be approximately 22s.
- As the MDC (4.56s) is smaller than the practically relevant change outlined above (22s), the 1000TT has the capability to capture meaningful change in aerobic performance in elite soccer players.

### Limitations

- A limitation of the present study is the small sample size, although this is common in studies of players at a professional level. In the future, more research should be conducted to repeat this design with larger samples.
- For logistical reasons, the YOYO-IR1 (artificial turf) and 1000TT (grass) were performed on different surfaces. Although this is clearly not best experimental practice, the conditions on the grass were firm and dry and therefore the confounding influence was considered small.
- The trials were performed during a period typically characterised by high training load (first 2-weeks of pre-season) and to this effect, negative fatigue-related carry-over between trials cannot be discounted.

### Dataset

Dataset available on SportPerfSci.com.

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