Familiarisation and Reliability of the Isometric Mid-Thigh Pull in Elite Youth Soccer Players

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IMTP | Reliability | Soccer | Youth

Headline

To identify if a 'true' change in a measure of physical performance has occurred due to a specific stimulus, such as a training programme, an understanding of the minimum detectable change of that measure is required (1). When working with a new group of players, a confounding factor that may affect measurement error is the players' familiarisation with the assessment. Documenting the number of assessments it takes to reach an acceptable level of reliability, and therefore the point at which players are said to be 'familiar' with the assessment is a key piece of information that is rarely documented within the literature. With specific regard to the isometric mid-thigh pull (IMTP) there is no consensus within the literature on an optimal number of familiarisation sessions required (2) and therefore warrants further investigation.

Aim

The aim of this study was therefore to assess the changes in reliability of the IMTP over four familiarisation sessions in a group of elite youth soccer players.

Methods

Athletes. Twenty-one elite youth male soccer players (mean ± SD, age: 18.4 ± 2 years; height: 179.5 ± 6.3 cm; body mass: 72.9 ± 6.8 kg) playing within the professional development phase of an English Premier League Academy agreed to participate in the present study. Before inclusion, players were examined by the club medical staff and were deemed to be free from illness and injury. Data were collected as part of the clubs monitoring procedures, which all conformed to the recommendations of the Declaration of Helsinki.

Design. Repeated-measures reliability study.

Methodology. To prepare for testing participants performed a standardised warm up prior to each testing session, as described in Figure 1. IMTP testing was performed once per week over four consecutive weeks on portable force platforms sampling at 1000 Hz (ForceDecks, London, United Kingdom) and using a portable IMTP rig (Absolute Performance Ltd, ISO Pull Attachment). Prior to testing, participants were assessed to find correct bar height and position as described by Comfort et al (2). Once in position, players were strapped to the bar in accordance with previous research (3). The specific joint angles were replicated for each player between sessions, to ensure that any observed differences were not as a result of changes in posture. All subjects received standardised instructions to pull as fast and as hard as possible and push their feet into the force plate until being told to stop, as these instructions have been shown to be optimal results (3). Once the body was stabilised (verified by ForceDecks software) the IMTP was initiated with the countdown '3, 2, 1 pull,' with players ensuring that maximal effort was applied for a minimum of three seconds. Minimal pre-tension was allowed to ensure there is no slack in the body prior to initiation of pull. The same verbal encouragement was given for all players on all trials. Players performed a minimum of two trials interspersed with 30 second rest periods.

All force-time data recorded during the IMTP were inspected using ForceDecks software (Version 2.0.7075, ForceDecks, London, United Kingdom) to determine specific force-time characteristics. The onset threshold for identifying movement was set at 20 N (4). The maximum force generated during the IMTP was reported as the absolute peak force ($PF_{absolute}$) measured in Newtons (N). This was subsequently divided by body weight (kg) and reported as relative peak force ($PF_{relative}$) measured in Newtons per kg ($N.kg^{-1}$). Additionally, time-specific force values at 100 ms ($Force_{100}$) were calculated. Force at 100 ms was selected as contact time during acceleration and maximal velocity has been recorded between 0.129 and 0.106 s (5).

Statistical Analysis

For all variables means ± standard deviations (SD) are presented. The best trial completed within each testing session was used for analysis. Test re-test reliability was calculated for each variable and expressed as a typical error (TE), coefficient of variation (CV%) and interclass correlation (ICC), calculated using a custom spreadsheet (6). To assess the ability of each variable to assess 'real' change the minimum detectable change (MDC) was also calculated at a 75% confidence level (1). Additionally, to allow practitioners to determine the level of confidence for a given change score, the MDC curve was calculated.

Results

No systematic changes in group mean data were observed for $PF_{absolute}$, $PF_{relative}$ and $Force_{100}$ over the four testing sessions (Table 1). Test re-test reliability statistics for $PF_{absolute}$,

Fig. 1. Standardised warm up protocol

$PF_{relative}$ and $Force_{100}$ are displayed in Table 2. Additionally, MDC curves based on the test re-test reliability between sessions three and four are displayed in Figure 2.

Discussion

The key finding of this study is that reliability of the IMTP improved over the course of four familiarisation sessions in elite youth soccer players. Therefore, it is advisable that in order to obtain actionable data, a minimum of four sessions are used to familiarise players who have had no prior experience with the IMTP protocol.

The IMTP is a commonly used tool to assess an individual's maximal strength and time-dependent force characteristics (7). This data can then be used to prescribe and monitor strength training programmes to improve an athletes' physical performance. This is an appealing test to use as the IMTP has been shown to correlate with drop jump, sprint and change of direction performance (8-10), which are key physical qualities for elite soccer players (11, 12).

To determine the reliability of the IMTP the current study assessed the TE, ICC, CV% as well as reporting the MDC (75% confidence level). This data should assist the practitioner in making an informed decision as to whether the observed change is due to measurement error or a given intervention (1, 13). The current study reported ICC values of 0.88 and 0.87 for $PF_{absolute}$ and $Force_{100}$, respectively. This is slightly lower than previous research that reported ICC values of 0.96 for $PF_{absolute}$ and 0.91 for $Force_{100}$ in elite youth soccer players (14). Similarly, somewhat higher CV% values were reported in the current study compared to that of Dos'Santos et al. (14). This slight discrepancy in reliability values may be due to different levels of experience with the IMTP assessment. The participants in the Dos'Santos et al, (14) study had prior experience to the IMTP, therefore greater familiarisation of the test than the participants in the current study.

In agreement with the current study, Beckham et al (15) found that regardless of weightlifting experience and no prior familiarisation with the IMTP; $PF_{absolute}$ and Force at 90 ms were reliable measures in recreationally active males following five familiarisation sessions. This included testing of two different positions with a total of 60 trials. However, as $PF_{absolute}$ was only analysed after sessions two and five, it is difficult to say if four familiarisation sessions would have yielded similar results.

Within the current study, 24 trials were undertaken across four testing sessions, this is considerably less than that of the Beckham et al (15) study (60 trials) , however, more than that undertaken by Kuki et al (2017). In contrast to the present study, Kuki et al (9) reported a CV% of greater than 10% for both $PF_{absolute}$ and $Force_{100}$ in collegiate soccer players. The authors suggest that a lack of familiarisation could be the reason for these scores as participants only performed 2 practice attempts the day before. In the current study the CV% improved with each testing session for both $PF_{absolute}$ and $Force_{100}$. This further highlights the need for adequate familiarisation when completing IMTP assessments with a novice group of athletes.

A novel aspect of the current study is the creation of the MDC curve in order to assess changes in IMTP variables. The issue with a 'threshold' based approach to reliability is that it creates a dichotomous outcome; a measure is either seen as reliable or unreliable based on a predetermined cut off point, e.g. CV% > 10%. However, reliability data should only be examined in conjunction with sensitivity data, allowing the relationship between the 'signal' and the 'noise' of an assessment to be determined (16). The MDC may be a more appropriate measure of reliability as it provides a confidence level for a given change. However, the confidence level used within the literature can vary, e.g. 75%, 90% or 95%, and this again provides a threshold that will be used as an 'acceptable' level of reliability. The MDC curves presented in the current study (Figure 2) allow researchers and practitioners to determine the confidence level for any given change score and select a confidence level that is relevant to their environment.

In conclusion it is recommended that a minimum of four familiarisation sessions, with a total of 24 trials, are required to attain reliable data for the IMTP test, with participants who are inexperienced with the testing process.

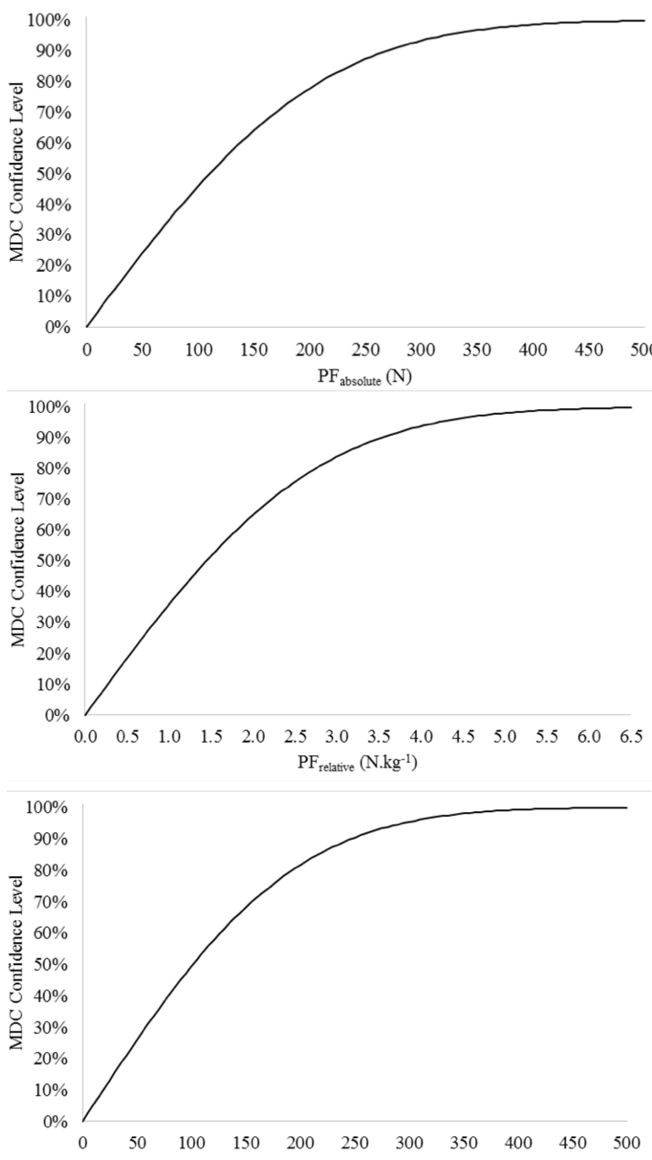

Fig. 2. Minimum detectable change (MDC) curves based on test re-test reliability data collected in sessions 3 and 4 for statistics for absolute peak force ($PF_{absolute}$), relative peak force ($PF_{relative}$) and Force at 100 ms ($Force_{100}$). The curve is interpreted by drawing a vertical line up from the observed change (x-axis) and drawing a perpendicular horizontal line at the intercept of the curve, finding the corresponding MDC confidence level at the y-axes.

Table 1. Descriptive statistics for absolute peak force ($PF_{absolute}$), relative peak force ($PF_{relative}$) and Force at 100 ms ($Force_{100}$). Data are presented as group means (± SD).

	Session 1	Session 2	Session 3	Session 4
$PF_{absolute}$ (N)	2240 (292)	2182 (328)	2305 (353)	2307 (381)
$PF_{relative}$ (N.kg-1)	30.3 (3.2)	28.8 (4.0)	30.7 (5.1)	30.3 (5.0)
$Force_{100}$ (ms)	1215 (312)	1215 (319)	1201 (238)	1267 (285)

Table 2. Test re-test reliability statistics for absolute peak force ($PF_{absolute}$), relative peak force ($PF_{relative}$) and Force at 100 ms ($Force_{100}$). Data are presented as typical error (TE), interclass correlation (ICC), coefficient of variation (CV%), and minimum detectable change (MDC) (75% confidence level).

		Trial 1-2	Trial 2-3	Trial 3-4
$PF_{absolute}$ (N)	**TE (90% CI)**	179 (143, 243)	174 (139, 236)	131 (105, 178)
	ICC (90% CI)	0.69 (0.44, 0.84)	0.76 (055, 0.88)	0.88 (0.77, 0.94)
	CV% (90% CI)	8.1 (6.4, 11.1)	7.8 (6.2, 10.8)	5.8 (4.6, 8.0)
	MDC (%)	309 (13.7)	272 (12.1)	188 (8.3)
$PF_{relative}$ (N.kg-1)	**TE (90% CI)**	2.2 (1.8, 3.0)	2.4 (1.9, 3.2)	1.8 (1.5, 2.5)
	ICC (90% CI)	0.64 (0.37, 0.81)	0.76 (0.54, 0.88)	0.88 (0.76, 0.94)
	CV% (90% CI)	7.9 (6.2, 10.8)	8.0 (6.3, 11.0)	6.1 (4.8, 8.4)
	MDC (%)	4.3 (14.2)	3.5 (11.8)	2.5 (8.2)
$Force_{100}$ (ms)	**TE (90% CI)**	176 (140, 239)	141 (113, 192)	101 (80, 137)
	ICC (90% CI)	0.71 (0.47, 0.85)	0.77 (0.56, 0.88)	0.87 (0.74, 0.93)
	CV% (90% CI)	16.9 (13.3, 23.6)	11.8 (9.3, 16.3)	8.8 (7.0, 12.2)
	MDC (%)	255 (20.8)	228 (18.7)	173 (14.1)

Practical Applications

- A minimum of four familiarisation sessions, each with six IMTP trials (1 x 50%, 75% and 90% perceived maximum effort and 3 x 100% perceived maximum effort) should be used when performing this assessment with novice participants.
- The MDC curves presented allow practitioners to determine the MDC confidence level for any given change score.
- The methods used in the current study to assess familiarisation and reliability should be applied to all other physical assessments used in research and practice. Knowledge of familiarisation is highly valuable to practitioners when implementing a new assessment or when working with new athletes.

Limitations

- Use of 30 second recovery periods between maximum trials may only be sufficient for partial recovery. However, $PF_{absolute}$ scores in the current study are similar to that of other studies with a similar population.
- Four familiarisation sessions were used in the current study due to logistical constraints, it is advisable that practitioners determine their own optimum number of familiarisation session for not only the IMTP but all physical assessments.

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