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Original Research

Criterion-related validity of four clinical tests used to measure hamstring flexibility in professional futsal players

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ABSTRACT

Objective: To examine the criterion related validity of the sit-and-reach test (SR), toe touch test (TT), modified sit-and-reach test (MSR) and back-saver sit-and-reach test (BSSR) for estimating hamstring flexibility measured through the passive straight leg raise test (PSLR) in professional futsal players.
Design: Correlation laboratory study.
Setting: Controlled laboratory environment.
Participants: One hundred and three futsal players (55 males age 26 ± 4 years, 48 females age 23 ± 5 years).
Main outcome measures: Two trials of SR, TT, MSR, BSSR (left and right) and PSLR right and left (hamstring criterion measure) in a randomized order.
Results: Regression analysis was performed to examine the association of SR, TT, MSR and BSSR with PSLR in both males and females separately. In males, only MSR test had moderate association criterion with PSLR ($R^2 = 0.57$). In females, SR ($R^2 = 0.86$), TT ($R^2 = 0.85$), MSR ($R^2 = 0.53$) and average BSSR ($R^2 = 0.82$) were associated with PSLR.
Conclusions: SR, TT, MSR and BSSR had moderate criterion related validity for estimating hamstring flexibility in female but not male professional futsal players. The authors recommend that researchers, clinicians, and physical therapists adopt one angular test as a measure of hamstring muscle length in futsal players.

1. Introduction

Less-than ideal flexibility of soft tissues has been proposed as a predisposing factor for increasing the likelihood of hamstring muscle injury (Hartig & Henderson, 1999; Kujala, Orava, & Jarvinen, 1997), low-back pain (Biering-Sorensen, 1984; Somhegyi & Ratko, 1993) and changes in lumbo pelvic rhythm (Esola, McClure, Fitzgerald, & Siegler, 1996). In addition, in sport therapy environments short hamstrings have been related with muscle strains (Croisier, Forthomme, Namurois, Vanderthommen, & Crielaard, 2002), development of patella tendinopathy (Witvrouw, Bellemans, Lysens, Danneels, & Cambier, 2001) and patellofemoral pain (Witvrouw, Lysens, Bellemans, Cambier, & Vanderstraeten, 2000), muscle damage following eccentric exercise (LaRoche & Connolly, 2006; McHugh et al., 1999) as well as a reduction in performance (Andersen, 2006; Kovacs, 2006).

Several field and clinical tests have been used to measure hamstring muscle flexibility, such as sit-and-reach tests, the straight leg raise test, hip joint angle test and the knee extension angle test. The sit-and-reach tests are probably the most common measurement tools used for evaluating hamstring and lower back flexibility (Baltaci, Un, Tunay, Besler, & Gerceker, 2003; Holt, Pelham, & Burke, 1999). In fact, these techniques have been included in several fitness test batteries (Australian Council for Health Physical Education & Recreation [ACHPER, Handbook for the Australian Fitness Education Award manual], 1996; Canadian Society for Exercise Physiology [CSEP], 2003; Cooper Institute for Aerobics Research [Fitnessgram], 2004; Council of Europe Committee for the Development of Sport [Eurofit], 1993; The President's Council on Physical Fitness and Sports, 2007). However, there are a number of differing sit-and-reach test protocols that include: the sit-and-reach

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test (SR), standing toe touch test (TT), modified sit-and-reach test (MSR), V sit-and-reach test (VSR), unilateral sit-and-reach test (USR) and back-saver sit-and-reach test (BSSR) (Hui & Yuen, 2000; López, Sáinz de Baranda, Rodríguez, & Ortega, 2007).

All sit-and-reach tests involve hip, lumbar and thoracic spine flexion, and therefore they are an indirect measure of hamstring flexibility. There are inevitably some differences among sit-and-reach tests regarding participant positioning (uni- or bilateral, sitting or standing, hip position) and the equipment used (measuring with or without a box, executed on the table or floor). However, regardless of the differences in administration of the test, the literature suggest that sit-and-reach tests have moderate criterion-related validity when used to reflect hamstring muscle flexibility, but do not appear to provide a valid assessment of back motion in young adults (Baltaci et al., 2003; Chung & Yuen, 1999; Hoeger & Hopkins, 1992; López et al., 2007; López-Miñarro, Sainz de Baranda, & Rodríguez-García, 2009; López-Miñarro, Sainz de Baranda, Rodriguez-Garcia, & Yuste, 2008; Minkler & Patterson, 1994) or children and adolescents (Castro-Piñero et al., 2009; Cornbleet & Woolsey, 1996; Hartman & Looney, 2003; Jackson & Baker, 1986). Furthermore, reliability studies on sit-and-reach tests have reported high test–retest correlation coefficients, ranging from $r = 0.89$ to $r = 0.98$ (Hoeger & Hopkins, 1992; Hui & Yuen, 2000; Jackson & Baker, 1986; López-Miñarro, Sainz de Baranda, & Rodriguez-Garcia, 2009; López-Miñarro et al., 2008).

Professional athletes are an important population where the application of sit-and-reach tests may be useful because the procedure is simple to administer, is easy for the athletes to follow instructions and view scores, requires minimal skills training and large numbers can be tested in a short period of time. However, very few studies have analyzed the criterion-related validity of sit-and-reach tests for estimating hamstring muscle flexibility in high performance athletes (Pastor, 2000).

It has been suggested that the specificity of each sport modality related to its technical skills, specific movements, training methods and physical capacities may predispose participants to individual musculoskeletal adaptations (Chandler et al., 1990). For example, Pastor (2000) showed that swimmers have a large flexion range of motion of the thoracic and lumbar spine (high thoracic kyphosis) and therefore the use of sit-and-reach tests may not be appropriate. A failure to detect injury risk in a test with low validity (final score altered) may result in the prevention of appropriate specific stretching programs, increasing the risk of sport injuries as a result of low hamstring muscle flexibility (Sexton & Chambers, 2006). In this sense, the criterion-related validity of sit-and-reach tests for estimating hamstring muscle flexibility should be specific for each sporting modality.

Futsal (indoor football/soccer) has enjoyed a spectacular increase in popularity over recent years and is played worldwide in both professional and amateur leagues by men and women of all ages including children (Barbero-Álvarez, Soto, Barbero-Álvarez, & Granda-Vera, 2008). To our knowledge no studies have established the criterion related validity of several sit-and-reach tests for estimating hamstring flexibility in professional futsal players. Therefore, the purpose of this study was to examine the criterion related validity of SR, TT, MSR and BSSR for estimating hamstring flexibility determined using an inclinometer through the PSLR in male and female professional futsal players.

2. Method

2.1. Participants

A total of 103 athletes (48 females and 55 males) without known impairment of the musculo-skeletal system affecting the spine or the lower extremities participated in the study. The participants were professional futsal players (4–7 training sessions per week, 1.5 h per session) with more than 8 years of sport practice. All participants played in the first (gold division) or second (silver division) Spanish Futsal Division. Twenty-four males and 38 females were recruited from 5 different futsal clubs participating in the Spanish Futsal First Division during the final phase of the season (play-offs held in Murcia, Spain). In addition, 31 males and 10 females were recruited from local futsal clubs, all of which participate in the Spanish Futsal Second Division.

The mean height and body mass for females was 168 ± 7 cm and 62.9 ± 8.1 kg, respectively; and for the males 178.6 ± 4.9 cm and 77.2 ± 9.9 kg, respectively. The mean age was 23 ± 5.3 years for the females and 26 ± 4.5 years for the males. The participants were provided written informed consent after being given verbal and written information about the study procedures before testing. The study was approved by the Ethics and Research Committee of the Catholic University San Antonio.

2.2. Procedures

A week before the testing session, the participants were familiarized with how to perform the tests and they performed three practice trials for each test. Prior to all testing, all participants performed five minutes of warm-up (jogging) and standardized static stretching exercises, emphasising the lower back and hamstring muscles (Baltaci et al., 2003; Hartman & Looney, 2003; Hemmatinezhad, Afsharnezhad, Nateghi, & Damirchi, 2009; Hoeger, Hopkins, & Button, 1990; López-Miñarro et al., 2009). Warm-up and static stretching exercises were performed because all the tests required a large hamstring tension stimulus. Other reasons for performing warm-up and pre-stretching exercises were: to lessen the effects of muscle lengthening from repeated trials during data collection and to reduce the variability and standard error of measurements by minimizing the effect of different body temperatures on muscle flexibility (Dixon & Keating, 2000). Earlier studies have reported that after 120–150 s of static stretching, the viscoelastic properties of muscles were deformed enough to produce a permanent change, lasting at least 20 min (Ford & McChesney, 2007; Power, Behm, Cahill, Carroll, & Young, 2004). Thus, to ensure stability in the hamstring viscoelastic properties through the length of the testing session, participants performed one repetition of 4 different un-assisted (2 standing and 2 sitting) static stretching exercises, holding the stretch position for 45 s (total = 180 s) (Ayala & Sainz de Baranda, 2010). Between each stretching repetition, the participant's hip extensor muscles were returned to a neutral position for a 20 s rest period. The order of the stretching exercises was randomized in each testing session.

After warm-up and stretching, participants were instructed to perform SR, TT, MSR, BSSR (left and right leg) and PSLR (left and right leg) tests in a randomized order using Web-based software (http://www.randomizer.org). Participants were tested wearing sports clothes (short and t-shirt) (Castro-Piñero et al., 2009) and without shoes (López et al., 2007; Rodríguez-García, López-Miñarro, Yuste, & Sainz de Baranda, 2008). The participants were allowed to rest for 3 min between tests (Hemmatinezhad et al., 2009). All measurements were carried out during the same testing session, administered at the same time every day and under the same environmental conditions (room temperature at 25 °C). Moreover, tests were always administered by the same two experienced clinicians (one conducted the tests and the other recorded the data).

2.3. Measures

PSLR has been considered as the hamstring flexibility criterion measure because it only involves hip joint movement in contrast