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Original Research

Absolute and relative reliability of isokinetic and isometric trunk strength testing using the IsoMed-2000 dynamometer

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ABSTRACT

Objectives: The present study aimed to assess the between day reliability of isokinetic and isometric peak torque (PT) during trunk measurement on an isokinetic device (IsoMed 2000).
Design: Test-retest-protocol on five separate days.
Participants: Fifteen healthy sport students (8 female and 7 male) aged 21 to 26.
Main Outcome Measures: PT was assessed in isometric back extension and flexion as well as right and left rotation. Isokinetic strength was captured at a speed of 60°/s and 150°/s for all tasks.
Results: For none of the assessed parameters a meaningful variation in PT during test days was observed. Relative reliability (ICC = 0.85–0.96) was excellent for all tasks. Estimates of absolute reliability as Coefficient of Variation (CoV) and Standard Error of Measurement (SEM in Nm/kg lean body mass) remained stable for isometric (6.9% < CoV < 9.4%; 0.15 < SEM < 0.23) and isokinetic mode (60°/s: 3.7% < CoV < 8.6%; 0.08 < SEM < 0.24; 150°/s: 6.9% < CoV < 12.4%; 0.10 < SEM < 0.31). In contrast, reliability between familiarization day and day 1 was lower (6.6% < CoV < 26.2%; 0.10 < SEM < 0.65).
Conclusions: Trunk strength measurement in flexion and extension or trunk rotation in either isometric or isokinetic condition is highly reliable. Therefore, it seems possible to elucidate changes which are smaller than 10% due to intervention programs when a preceding familiarization condition was applied.

1. Introduction

Well trained trunk musculature and good core performance are considered important for daily life and sports performance (Behm, Leonard, Young, Bonsey, & MacKinnon, 2005; Granacher, Gollhofer, Hortobagyi, Kressig, & Muehlbauer, 2013; Jørgensen et al., 2010). Weak trunk muscles have been linked to episodes of back pain and may also be a risk factor for lower limb injuries (Demoulin et al., 2012; Leetun, Ireland, Willson, Ballantyne, & Davis, 2004; Zazulak, Hewett, Reeves, Goldberg, & Cholewicki, 2007). A likely clinical implication is that lower trunk muscle strength is related to back pain (Bayramoglu et al., 2001; Lee et al., 1999). Also, coaches consider core muscle training as an important means to enable proper load transfer and high performance outputs. Although trunk and core muscle strength are still widely considered important by health practitioners and sports coaches, data on the reliability of measurement procedures is still lacking (Delitto, Rose, Crandell, & Strube, 1991; Demoulin et al., 2012; Friedlander et al., 1991; Karatas, Gögüs, & Meray, 2002; Newton & Waddell, 1993).

Isokinetic dynamometry is a well-accepted tool for assessing strength of the upper and lower extremities (Hislop & Perrine, 1967) as well as trunk muscles (Newton & Waddell, 1993). Isokinetic strength testing is a useful approach to assess trunk extension and flexion in healthy individuals as well as low back pain patients (Mueller, Stoll, Mueller, & Mayer, 2012). In order to assess trunk strength many different devices have been developed for standing (Akebi, Saeki, Hieda, & Goto, 1998; Delitto et al., 1991; Guilhem, Giroux, Couturier, & Maffiuletti, 2014; Karatas et al., 2002; Keller, Hellesnes, & Brox, 2001; Kurz, Anders, Walther, Schenk, & Scholle, 2014) or sitting positions (Danneskiold-Samsøe et al., 2009; Dvir & Keating, 2001). Isokinetic (peak torque and workforce) (Delitto et al., 1991) and isometric parameters (peak force and rate of force development or rate of torque development (Beimborn & Morrissey, 1988)) are regularly assessed.

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Consequently, measurement of peak torque is commonly used to estimate trunk strength and serves as a valid outcome parameter of trunk extension and flexion in both healthy subjects and patients with low back pain (Mueller et al., 2012).

In general, performance analyses require reliable data collection in order to detect meaningful changes following e.g. specific training interventions or to estimate cross-sectional group differences (Atkinson & Nevill, 1998). Furthermore, reliable data recording is needed to quantify baseline variability of a given variable due to system-immanent errors and/or biological variability (Hopkins, 2000). Thus, meaningful changes of a given variable due to an acute or longitudinal intervention rather than due to its variation can be precisely estimated (Haley & Fragala-Pinkham, 2006). In this regard, absolute variability estimates (e.g. standard error of measurement or coefficients of variation, and minimal detectable changes) have not yet been reported for isokinetic and isometric trunk muscle testing using the IsoMed 2000 device.

Although selected reliability data of isokinetic devices for lower limb strength (Dirnberger, Huber, Hoop, Kösters, & Müller, 2013; Impellizzeri, Bizzini, Rampinini, Cereda, & Maffiuletti, 2008; Maffiuletti, Bizzini, Desbrosses, Babault, & Munzinger, 2007) and trunk muscles are available (Guilhem et al., 2014), reliability estimates for the back module of the IsoMed 2000 are not available to date. Thus, the present study aimed at investigating absolute and relative reliability data for the IsoMed 2000 during isokinetic and isometric testing conditions.

2. Material and methods

The present cross-sectional reliability study was designed as a within-group repeated measures study. The study design included five different points of measurement on five days. A minimum of two days of rest between days was guaranteed. The first day was set to accommodate the participants to the measurement procedure and the device (Newton & Waddell, 1993). For all tests the same time of day (±2 h) was chosen. Subjects were instructed not to change their behavior regarding physical activity for study period. All participants completed the five tests within a maximum of three weeks. Therefore, we assumed no relevant changes in trunk strength performance during this time period affecting our outcomes. As all strength values remained stable over the study period, this assumption has been confirmed.

2.1. Participants

In line with similar reliability studies (Impellizzeri et al., 2008; Karatas et al., 2002), fifteen young, healthy and active sport students (8 women: age: 24.6 (SD 2.3) years, height: 1.64 (0.05) m, body mass 56.8 (2.3) kg, body fat 17.4 (4.0)%, lean body mass 47.0 (3.7) kg; and 7 men: age: 24.3 (1.6) years, height: 1.82 (0.04) m, body mass: 72.3 (4.8) kg, body fat 9.3 (3.3)%, lean body mass 66.9 (7.4) kg) without any experience in isokinetic or isometric trunk strength assessment participated in this study. All of them participated in daily sport activities in the context of their studies. None of them reported any physical exclusion criteria or impairments (e.g. back pain, drug intake). Participants were asked to avoid maximal physical exertion for 48 h prior to testing.

The study protocol was performed in accordance with the ethical standards of the Declaration of Helsinki and was approved by the local ethics committee. The participants all volunteered and provided informed consent prior to the start of the study.

2.2. Procedures

Prior to each testing condition all participants underwent a general warm-up on a bicycle ergometer for 10 min. The exercise workload corresponded to level 3 of the CR-10 scale of perceived exertion and cadence was kept constant at 70 rpm. Subsequently, a submaximal warm-up on the isokinetic device was completed for each task, beginning with five concentric repetitions at a speed of 120°/s, followed by 5 repetitions at 90°/s.

Trunk strength assessment during flexion and extension was performed on an isokinetic dynamometer (IsoMed 2000; D&R Ferstl, Hemnau, Germany) at a speed of 60°/s, 150°/s as well as isometrically (Karatas et al., 2002). The participants were fixed in a sitting position at the shanks, thighs, and shoulder girdle (Fig. 1A). The point of rotation of the device was verified with a laser pointing at the upper margin of the iliac crest. Each participant completed two trials with five repetitions for the isokinetic mode, starting with the trunk flexion and a subsequent trunk extension sweeping

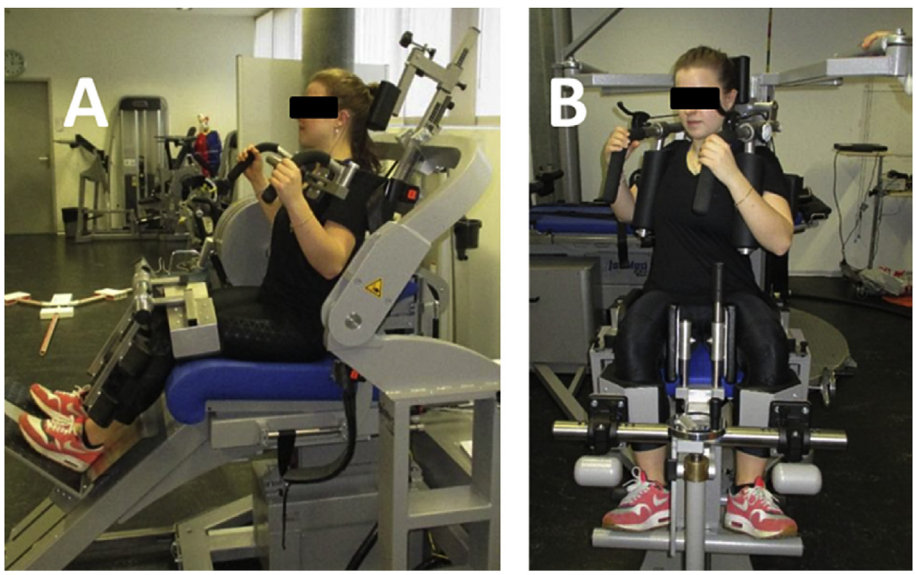

Fig. 1. Positioning for the testing of trunk extension, flexion (A) as well as rotation (B) on the IsoMed 2000 device.

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