

# ORIGINAL RESEARCH

## RELIABILITY, COMPARABILITY, AND VALIDITY OF FOOT INVERSION AND EVERSION STRENGTH MEASUREMENTS USING A HAND-HELD DYNAMOMETER

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### ABSTRACT

**Background:** There are conflicting results with respect to the validity and reliability of lower extremity strength measurements using a hand-held dynamometer (HHD) in the healthy population. Previous studies exploring foot inversion and eversion strength using a HHD were carried out with predominantly clinically affected participants in different positions. The question arises whether HHD measurements of isometric foot inversion and eversion strength performed with participants in different positions are valid, reliable and comparable and can be used alternatively.

**Purpose:** The aims of this study were to investigate: a) the intra- and inter-tester reliability of measurements of foot inversion and eversion strength in different participant positions using a belt-stabilized HHD; b) the comparability of results obtained in different positions; and c) the concurrent validity of the aforementioned measurements using an isokinetic dynamometer.

**Methods:** Thirty adults (12 females and 18 males; mean age  $22.5 \pm 3.9$  years) volunteered to participate in this study. Maximal isometric foot inversion and eversion torques (Nm) were measured with participants lying supine, sitting with knees extended and lying on their side using a belt-stabilized HHD. Measurements were performed independently by two physiotherapists over two days and were repeated using an isokinetic dynamometer. Validity and intra- and inter-tester reliability were determined using the intra-class correlation coefficient (ICC). A two-way ANOVA ( $p < 0.05$ ) and post-hoc tests with Bonferroni correction were used to compare data from different positions. Bland-Altman plots were used to demonstrate the range of error and difference between HHD and isokinetic measurements.

**Results:** Intra-tester reliability for inversion and eversion torques was fair to excellent in all positions (ICC = 0.598–0.828). Excellent inter-tester reliability was found for eversion torques in all positions (ICC = 0.773–0.860). For inversion torques, inter-tester reliability was fair to excellent (ICC = 0.519–0.879). ICC values of 0.205 to 0.562 indicated a low to fair concurrent validity. A significant difference was observed between the torques of the supine and side-lying positions as well as sitting and side-lying positions ( $p < 0.05$ ). Bland-Altman plots showed that the mean of the differences for inversion and eversion torques deviates considerably from zero, indicating that measurements with the HHD in the three positions produce lower values compared to using the isokinetic dynamometer.

**Conclusions:** Inversion and eversion strength measurements with subjects in different positions using HHD seem to be reliable, but consistently underestimated torque output when compared with measurements using isokinetic dynamometry. While the HHD outcomes measured in supine and sitting positions seem to be comparable, those measured in supine/sitting and side-lying positions differed.

**Keywords:** different test positions; dynamometry; eversion; inversion; reproducibility

**Level of Evidence:** Diagnostic study, Level 3

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