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Intra-Rater and Inter-Rater Reliability of the Kinvent Hand-Held Dynamometer in Young Adults †

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Abstract: Health professionals like physiotherapists require additional choices in portable dynamometers to conduct evaluations pre- and post-intervention in order to accurately measure the efficacy of treatments and patient progression and to adjust rehabilitation goals. New dynamometers have arrived on the market, but there is no evidence for performance of the Kinvent. This study aimed to investigate intra- and inter-rater reliability (ICC one-or-two-way-random-model/Bland–Altman) of the Kinvent hand-held dynamometer in the muscle groups of the lower and upper limbs (COSMIN guidelines). The Kinvent showed a good to excellent intra- and inter-rater reliability for almost all the upper and lower limbs movements assessed. Ankle dorsiflexion was moderate in all assessments.

Keywords: muscle strength; muscle strength dynamometer; upper extremity; lower extremity; dynamometry; intra-rater reliability; inter-rater reliability; muscle performance

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1. Introduction

Muscle force assessment is often essential in the physical examination of patients [1–3]. In the clinical setting, manual muscle testing stands as the main approach for assessing strength levels. When evaluating muscle strength, it is crucial to consider multiple factors, such as test standardization, proper positioning, the careful observation of the patient's technique during the test, and ensuring an environment to prevent any pain/discomfort that might hinder the participant from achieving a maximal contraction [3]. However, the influence of physiotherapist skill and experience on the results has sparked controversy regarding this test's reliability as an assessment technique and has led to the development of instruments capable of eliminating this problem, such as hand-held dynamometers (HHDs) and isokinetic equipment [1–3]. Isokinetic dynamometry is considered the gold standard in strength assessment with well-documented validity and reliability [4,5]. However, it is equipment that is expensive, time consuming, and difficult to access, making its clinical use questionable. In the light of this, HHDs represent an answer to the aforementioned disadvantages, providing an affordable, portable, and time-efficient solution for measuring isometric strength [1–3]. In recent studies, HHDs have demonstrated validity and reliability when compared to isokinetic dynamometers [1,2,6]. Although studies have reported valid and reliable results when compared to the gold standard, new pieces of equipment have been arrived on the market for the use of professionals such as physiotherapists. In this proceeding review, one study using Kinvent [7] is included in the examined literature, but it does not include lower limbs assessments and the increasing use of this device among physiotherapists requires the determination of its psychometric values. Since other brands of HHD have yielded good results, our hypothesis is that Kinvent will also exhibit good intra- and inter-rater reliability for young adults. Therefore, the study objective was to assess the intra- and inter-rater reliability of the Kinvent HHD in the muscle groups of the lower and upper limbs.

2. Materials and Methods

2.1. Study Design

This study had a cross-sectional design and was carried out as a two-day assessment. The first day included (1) the warmup and (2) three acceptable measurements (out of five attempts, excluding the highest and the lowest) of the maximum voluntary isometric contraction for each muscle group, assessed by both Rater 1 (R1) and Rater 2 (R2). After 48 h, the described procedure was repeated for Rater 1. Intra-rater reliability was assessed across the two days of assessment for Rater 1. Inter-rater reliability was determined by comparing the mean of the three measurements of different movements for each participant made in one day between the two raters. The order, pairing, and assessment of the raters' sequences between upper or lower limb muscles group were randomized each week on the website randomization.com. The primary outcome was the maximum voluntary isometric contraction, which was concealed from the raters. This procedure followed the COSMIN guidelines.

2.2. Participants and Setting

Students from Egas Moniz School of Health & Science, Caparica, Almada, Portugal, representing a convenience sample, were invited to participate in this study during their internships at the Egas Moniz University Clinic in Almada. Entry criteria included participants who reported themselves as healthy on the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+), were of either sex, and were between 18 to 30 years. Participants with a history of major injuries in the three months preceding the testing, permanent impairments, or medical conditions that would hinder participation in exercise were excluded from the study.

2.3. Procedure

The measurements were assessed using the Kinvent (KFORCE Pro, v. 5.4.9) HHD by three physiotherapy professors/raters from the Egas Moniz School of Health Sciences. Participants underwent training and received instructions on how to use the Kinvent prior to data collection. This training was provided by an experienced practitioner (with more than 20 years as a physiotherapist and who had worked with the Kinvent for 2 years), who was familiar with this piece of equipment.

During the assessments, the participants were instructed to exert maximum effort during an isometric contraction to assess isometric strength. To do this, the examiner stabilizes the dynamometer in a fixed position while the participant applies maximal effort against it. Instructions to gradually increase the contraction for one second in order to avoid position and stabilization errors and to "push as hard as you can, as hard as you can" for five seconds were given in a loud voice before and during the test, respectively. Participants were directed to perform three consecutive actions with maximal effort with their dominant limb, with each action lasting five seconds, followed by an interval of 30 s of rest between repetitions to avoid fatigue.

For the lower limbs muscle groups, participants warmed up on a static cycle ergometer, while for the upper limbs, they used a pulley for five minutes before proceeding with strength measurements. The evaluated movements of the lower limbs were hip flexion and abduction, knee flexion and extension, and ankle dorsiflexion on participants' dominant leg. For the upper limbs, the movements were shoulder abduction and flexion, elbow extension and flexion, and wrist extension and flexion. The testing sequence progressed from proximal to distal joints.

2.4. Statistics

Statistical Package for Social Sciences (SPSS®) 26 software (IBM Corp, Armonk, NY, USA) was used for reliability by computing intra-class correlation coefficients (ICCs). ICCs were calculated using a single measurement—specifically, the mean value obtained during testing—to assess intra-rater reliability. An ICC (one-way random model) was employed for evaluating intra-rater reliability, while an ICC (two-way random model) was utilized for assessing inter-tester reliability. The ICC values were classified as moderate (0.50–0.75), good (0.76–0.90), and excellent (>0.90). Bland–Altman plots (BA) were used to complete inter-rater analysis and define absolute reliability.

3. Results

A total of twelve individuals, seven of whom were women (58.34%), of 21.83 ± 3.16 years and 22.76 ± 2.03 kg/m^2, participated in the study. The intra- and inter-rater reliabilities are described in Table 1. The BA confirmed all measures to be strongly or very strongly correlated, except for hip flexion. The upper and lower limits of agreement presented, in general, non-concordant measures.

Table 1. Intra-rater reliability and inter-rater reliability for upper and lower limbs.

Movement (kgf)	Rater 1—Day1 (Mean ± SD)	Rater 1—Day2 (Mean ± SD)	Intra-Rater Reliability		Rater 2—Day2 (Mean ± SD)	Inter-Rater Reliability	
			ICC (95% CI)	*p*		ICC (95% CI)	*p*
Upper limbs							
Shoulder Flex.	19.13 ± 4.58	16.93 ± 5.90	0.707(0.273–0.905)	0.003	16.00 ± 6.13	0.922 (0.273–0.905)	<0.001
Shoulder Abd.	18.80 ± 4.86	16.98 ± 6.42	0.850 (0.575–0.945)	<0.001	16.14 ± 5.65	0.917 (0.739–0.975)	<0.001
Elbow Flex.	26.69 ± 8.98	25.38 ± 10.03	0.951 (0.854–0.985)	<0.001	25.30 ± 9.68	0.985 (0.948–0.996)	<0.001
Elbow Ext.	17.77 ± 6.60	16.49 ± 6.69	0.912 (0.734–0.973)	<0.001	16.39 ± 6.69	0.961 (0.872–0.989)	<0.001
Wrist Flex.	17.88 ± 6.28	17.51 ± 7.17	0.854 (0.586–0.955)	<0.001	17.59 ± 6.46	0.894 (0.675–0.968)	<0.001
Wrist Ext.	15.73 ± 5.24	14.84 ± 5.55	0.874 (0.636–0.962)	<0.001	15.65 ± 6.70	0.929 (0.773–0.979)	<0.001
Lower limbs							
Hip Flex.	32.27 ± 9.68	31.94 ± 7.44	0.796 (0.453–0.936)	<0.001	32.08 ± 8.97	0.900 (0.692–0.970)	<0.001
Hip Abd.	35.15 ± 10.26	34.00 ± 8.75	0.840 (0.552–0.951)	<0.001	33.70 ± 9.36	0.916 (0.734–0.975)	<0.001
Knee Flex.	18.90 ± 5.19	18.50 ± 4.95	0.939 (0.811–0.982)	<0.001	18.19 ± 4.87	0.863 (0.594–0.959)	<0.001
Knee Ext.	57.74 ± 17.68	59.06 ± 15.67	0.909 (0.726–0.972)	<0.001	54.02 ± 14.78	0.876 (0.604–0.965)	<0.001
Ankle Dorsiflex.	26.20 ± 7.08	23.86 ± 5.76	0.707 (0.392–0.926)	<0.001	22.85 ± 3.97	0.722 (0.281–0.911)	0.03

Abbreviations: kgf = kilogram-force; SD = standard deviation; ICC = intraclass correlation coefficient; CI = confidence interval; Flex. = flexion; Abd. = abduction; Ext. = extension. There were no missing data.

4. Discussion

The intra-rater reliability showed a similar correlation classification between the upper and lower limbs. However, for the inter-rater reliability, the upper limb correlation classifications were higher than those of the lower limbs. In addition, ankle dorsiflexion was moderate in all assessments. A systematic review [2] demonstrated that this HHD is a valid and reliable instrument for measuring muscle strength, except in regard to the largest joints, such as the knee. This could also explain the wider CI in some measurements. Also, a recent study [8] found a good-to-excellent correlation in isometric lower limb strength and power in a healthy population, with particular emphasis on proximal muscle groups. Our results are in accordance with these findings.

Some limitations need to be considered such as the small sample used (effect size 0.68, α error 0.05, power 80%) and the lack of an available isokinetic dynamometer to compare the results with the gold standard. Another limitation was related to the interval between assessments, which was 48 h. Despite our results, we cannot neglect its influence on correlations, and it will be increased in future experiments.

Despite the limitations, this study brings some strengths, as health professionals like physiotherapists need more HHD options to perform assessments before and after interventions to quantify treatment effectiveness and patient progression and to adjust rehabilitation goals [1–3]. Our research also suggests that Kinvent is a good instrument for use in clinical practice, since it yielded good to excellent intra- and inter-rater reliability for almost all movements assessed. The acquisition of strength measurements using this manual dynamometer was a quick and simple procedure that is able to provide useful information for clinical practice [3]. Another important note concerns the care taken to reduce bias in our methodology through a pilot study; patient and examiner training; random allocation; and statistical analysis methods.

5. Conclusions

The Kinvent showed a good to excellent intra and inter-rater reliability for almost all upper and lower limb movements assessed. Ankle dorsiflexion presented moderate values in all assessments.

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