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Inter Tester Reliability of Fitmust Hand Held Dynamometer among Healthy Participants

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Abstract

Background: Strength testing is one of the primary assessment tools for physical strength examination, and an increase in strength is the aim of many rehabilitation programs. Manual muscle testing (MMT) is the most commonly used strength testing method in clinical settings. It is a subjective measurement technique whereby the tester applies resistance to a maximum voluntary muscle contraction. The reliability of the Fitmust hand-held dynamometer is not previously reported in the literature.
Aims and Objectives: The study aims to test the reliability of the Fitmust hand-held dynamometer for lower limb muscles in comparison with the Jamar Hand Held dynamometer.
Methods: Maximum voluntary isometric contraction of hip extension, knee extension, and plantar flexion is measured by two different therapists on different days using fit must hand-held dynamometer for 40 healthy participants of age category 18- 30 years.
Result: Reliability was evaluated by computing Intra-class Correlation Coefficients (ICC), which analyse the consistency between two or more quantitative measures, and Cronbach's Alpha which measured agreement.
Conclusion: Inter-tester reliability data obtained for Assessor 1 and 2 were consistent for knee measurements. However, data for the hip and ankle varied considerably. Assessors 1 and 2 demonstrated a 'moderate to excellent' association for knee Measurements.

Keywords

Muscle Strength, Muscle Strength dynamometer, Reliability of Results

Introduction

Manual muscle testing (MMT) is a commonly used method of strength testing in the clinical setting and is a subjective measurement technique whereby the tester applies resistance to a maximum voluntary muscle contraction (Scott *et al*.,2004) Strength testing is one of the important parts of physical examination and an increase in strength is the aim of many rehabilitation programs (Fairey *et al*.,2002). It is a quick and easy procedure of calculating readings that can be useful in differential diagnosis, and treatment of neuromuscular and musculoskeletal disorder. Measuring the peripheral muscle strength manually requires patient's cooperation (Sessler *et al*.,2002).

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The dynamometer can detect this change in a more objective manner as even minimum muscle strength loss can have an impact on the physical function (Baldwin, Paratz and Bersten, 2013). These devices usually record the force produced by loading through tension or compression and often used for quantification of muscle strength (Baldwin, Paratz and Bersten, 2013, Fan *et al*.,2010). Various factors should be considered while testing muscles which includes test standardization, appropriate positioning, observation of how the patient performs the test and avoidance of pain and discomfort which may stop the participant from performing a maximum contraction (Cuthbert and Goodheart, 2007).

The Isokinetic machine is considered the gold standard in muscle testing with validity score of 9-10 and reliability score of 11 well documented. However, this equipment is time consuming to use, more expensive and is not readily accessible to most practitioners (Li et al.,2006). Hand Held Dynamometers is an alternative to the isokinetic machine as they are relatively portable, time-efficient and inexpensive (van der Linden *et al*.,2004**).** and have also been shown to be valid and reliable when compared to the isokinetic machine (Li *et al*.,2006).

Comparison of the Jamar with other instruments has been a field of interest. King and Berryhill compared the BTE Work Simulator with the Jamar and concluded that there was inter instrumental reliability. The ratio between the left and right hand is also highly correlated (King, 1991). A new dynamometer the Fitmust was patented in 2022 (Aswa Wear Tech Sadandanagar Bengaluru). No literature has reported reliability measures of this instrument.

The reliability of an instrument must be determined in order to eliminate it as a source of error (Bohannon, 1999; Örtqvist *et al*.,2007). Reliability of an equipment is the extent to which an experiment, test, or measuring procedure yields the same result on repeated trials (Portney and Watkins.,1993). The need of the study is to know how far the instrument is useful for measuring the strength of the muscle. The aim of this study therefore was to investigate intra- tester reliability of the Fitmust in three of the lower limb muscle groups. The main limitation of HHD studies to date is the influence of tester strength, which inherently affects the ability of the tester to stabilize the dynamometer appropriately. (Li *et al*.,2006) Measurements obtained may therefore vary according to the tester’s strength (Bohannon,1999)

Methodology

A convenient sample of 40 healthy participants of both male and female from a university population volunteered to participate in this study. To be included in the study, participants had to be healthy and between the ages of 18 and 30 years. Participants were excluded if they had a history of lower extremity injury in the three months prior to testing or if they had a history of any medical condition that would prevent exercise participation. Subjects were instructed to refrain from strenuous activity or alcohol for 24 hours prior to testing, and to refrain from eating for at least 3 hours before the test for standardization. Ethical approval was obtained from the SRM College Hospitals & research center ethics committee (8501 / IEC/ 2023) and subjects gave written, informed consent prior to participation.

Study procedure

The testers involved in this study were two physiotherapy research scholars. The testers were trained and instructed in the use of the Fitmust and Jamar Hand held dynamometer prior to commencing of tests. Verbal instructions for each test were standardized as follows: "Push as hard as you can", in a loud voice. Isometric strength was measured using a make test, that has been shown more reliable than the break test. The make test is carried out by the examiner holding the dynamometer stationary while the subject exerts a maximal force against it (Ramalingam, Jagatheesan and Suganthirababu, 2023).

Figure 1. Knee extension measurement using Fitmust Dynamometer

Figure 2. Hip extension measurement using Jamar Dynamometer

Figure 3. Hip Extension measurement Fitmust Dynamometer

Table 1. Participants Testing Positions

Movement	Position	Dynamometer Position	Instruction	Reference
Knee Extension	Sitting in quadriceps bench Hips & knees in 90° flexion Hands on thigh, palmar surface upwards	Anterior leg proximal to ankle	Straighten out your knee	Wang, Olson & Protas (2002)
Hip Extension	Prone lying on plinth Knee extended Hands by their side palmar surface upwards	Posterior thigh proximal to knee	Lift your leg off by keeping your knee straight	Taylor, Dodd and Graham (2004)
Ankle Dorsi flexion	High sitting on plinth Ankle in neutral Hands by their side	Dorsum of foot	Point your toes upwards	Nollet and Beelen (1999)

Double blinding of Assessor and subjects were done. Participants were instructed to warm up by doing simple stretches for five minutes and then performed stretches to the major muscle groups of the lower extremity, holding each stretch for 10 seconds. Lower limb strength was measured using the Fitmust &Jamar HHD which measures peak force in Isometric contraction. Both measured forces in Kg. Testing was carried out on two different days, one week apart. Lower limb strength was measured using the both Jamar and Fitmust hand-held device which measures peak force. It is a load-cell based strain gauge type of dynamometer whereby a force distorts a strain gauge and converts it to an electrical signal in Fitmust and mechanical energy in Jamar.

Statistical Reasoning

Reliability was evaluated by computing Intra-class Correlation Coefficients (ICC) which analyze the consistency between two or more quantitative measures (Ortqvist et al.,2007) and Cronbach's Alpha which measured agreement. Intra-class correlation coefficients were calculated from a single measure chosen as the maximum value obtained during testing and ICC, one way random, was used to evaluate intra-tester reliability while ICC (Fairey *et al*.,2002). It has been reported in the literature that 'moderate'- association can be judged by ICC values between 0.50 - 0.75 and 'good' to 'excellent' association over 0.75.32 (Portney and Watkins,1993)

Results and Discussion

Forty healthy participants were recruited to participate in this study. The mean age was 18- 35 years. Intra-class correlation coefficients were calculated from a single measure chosen as the maximum value obtained during testing and ICC, one way random, was used to evaluate intra-tester reliability while ICC. Inter-tester reliability results for participants are presented in Tables 2. ICC values for the knee testing protocol were good to excellent (0.75 and 0.88). ICC values obtained by tester 1 & tester 2 for the hip and ankle demonstrated moderate association (0.78 and 0.86).

Table 2. Inter-tester reliability results – Tester 1

Intraclass Correlation Coefficient					
		95% Confidence Interval		F Test with True Value 0	
	Intraclass Correlation	Lower Bound	Upper Bound	Value	df1
Single Measures	.181	.075	.331	2.329	39
Average Measures	.571	.327	.748	2.329	39

Table 3. Inter-tester reliability results - Tester 2

Intraclass Correlation Coefficient					
		95% Confidence Interval		F Test with True Value 0	
	Intraclass Correlation	Lower Bound	Upper Bound	Value	df1
Single Measures	.213	.100	.368	2.624	38
Average Measures	.619	.399	.778	2.624	38

Table 4. Summary Item Statistics-1

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance
Item Means	10.296	7.575	11.675	4.100	1.541	3.467

Table 5. Summary Item Statistics - 2

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance
Item Means	10.055	7.000	11.821	4.821	1.689	4.460

Table 6. Tester -1 & 2 Comparison of Jamar Dynamometer

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.778	.767	6

Table 7: Tester -1 & 2 Comparison of Fitmust Dynamometer

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.834	.821	6

This study paper aimed to investigate the inter-tester reliability of the Fitmust Hand Held Dynamometer in comparison with Jamar Hand Held Dynamometer. The Jamar dynamometer was used as the "gold standard" for this study because it has been supported by numerous research studies and is considered the market's most popular hand grip evaluation instrument. Our results indicated moderate to excellent inter-tester reliability based on maximal isometric contractions, as recorded by Clarke *et al.* (2011).

It has been reported that ‘moderate’ association can be judged by ICC values between 0.75 - 0.88 were found to be good to ‘excellent’ as recorded by Portney and Watkins (2000). However, to consider an instrument suitable for clinical use, the ICC value must be over 0.90. Values calculated in this study reflect those reported by other authors who examined the same muscle groups as studied by Rankin et al.,1998. ICC values obtained by testers 1 & 2 for the hip and ankle demonstrated moderate association (0.78 and 0.86).

Testers 1 and 2 demonstrated a ‘moderate to excellent’ association for knee measurements (0.72- 0.88, respectively). Testers also reported difficulty holding their arms toward high force levels due to the inability to elevate the bed to a mechanically advantageous position. A high level of localized tenderness was also reported by participants when the dynamometer was placed during the testing protocol, similar to Krause *et al*.2007. From the inter-tester reliability, there is a mild difference in the readings. This variation may be due to less inherent variability, tester strength (Bohannon,1999), and subconscious participant inhibition with perceived weaker testers. (Roebroeck, Harlaar and Lankhorst, 1998). In anticipation of impending force levels exerted by the participants, the tester may have applied pressure to the limb, evoking a myostatic stretch reflex which could result in more pressure force production. (Agre *et al*.,1987).

The Intra Class Correlation Coefficient between testers 1 & 2 was found to be of good correlation. The correlation coefficient was 0.213 for a single measure & 0.619 for average measures of tester-1&2 (Agre *et al*.,1987). The correlation coefficient was 0.18 for a single measure & 0.57 for the average measure of tester-1&2. Moreover, these results are to be interpreted with most care, as the sample size in this study was less than 50. Research indicates that 95% limits of the agreement will be wide if a sample size of at least 50 is not adhered to (Rankin and Stokes,1998). The main limitation of hand-held dynamometer studies to date is the influence of tester strength, which inherently affects the ability of the tester to stabilize the dynamometer appropriately.

Conclusion

The results of this study suggest that the Fitmust HHD has moderate to excellent inter-tester reliability with Jamar HHD based on maximal isometric contractions of the hip extensors, knee extensors and ankle dorsi -flexors. Our results shows that the Fitmust HHD can be considered a reliable instrument for testing muscle strength of knee extensors, hip extensors and ankle plantar-flexors. This preliminary study may therefore guide other research in the area in the possible future use of the Fitmust HHD for clinical and research purposes.

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