Portable Digital Force Gauge Handheld Dynamometer Test-retest reliability to measure quadriceps and hamstring muscle Isometric Knee strength in Healthy adults.

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Abstract

Background of the Study On the other hand, a more affordable and portable device that can also be used to gauge muscular strength is the handheld dynamometer (HDD). Because it takes less training to utilize, it may be more beneficial in clinical settings. Its reliability hasn't been thoroughly evaluated, though. This study aims to assess the intra-observer reliability of the Mark-10 Digital Force Gauge, a portable instrument used to evaluate isometric knee extensor and flexor strength in healthy persons, between tests.

Methods and Materials Twenty-six fit participants in this test-retest reliability study, individuals in Narayana Medical Institutions, both male and female (n = 26), were involved. A single, skilled assessor used a Mark -10 Digital Force Gauge Handheld Dynamometer (HHD) to measure knee flexion and extension isometric strength at two different angles (45 and 90 degrees). The measurements were obtained over the course of two sessions, separated by seven days. In the analysis, the maximum as well as the mean and average of the three repeats were computed, together with the measures' standard deviation (SD) and smallest genuine differences. Strength and functional variable intraclass correlation coefficients (ICCs) were computed.

Results There were twenty-six patients in this experiment. Participants ranged in age from 18 to 30, with a mean age of 22.53 (SD ± 3.39) years. The average age of the man in this was 22.62 ± 3.43, while the average age of the female was 22.46 ± 3.5, as seen in Figure 1. The subjects' strength in the extensor and flexor muscle groups was higher, according to the results of the retest. The ICCs for both muscle groups range from 0.87 to 0.98. The female group's ICCs (0.98) revealed higher scores than the male group's when knee extension and flexion were measured at 45˚ and 90˚.

Conclusion

When measuring knee extension muscular strength, a Digital Force Gauge Handheld Dynamometer appears to be a dependable choice, especially when two measurements are taken and their average is given.

Keywords: Digital Force Gauge – Test retest- Knee Flexion-Extension

INTRODUCTION

A significant issue impeding mobility and independent life is functional impairment. In India, almost 44% of the aging population has a functional disability[1]. Measuring knee muscle strength is especially adequate, as it displays a key role in the maintenance of functional capacity for activities of daily living[2]. An essential consideration when assessing the knee joint in rehabilitation settings is muscle strength in various knee joint positions[3].

The reliability of these procedures must be established before any measurements or assessments are applied for clinical or research-related purposes and these assessments are based on these essential evaluations since, without them, we are unable to determine the validity of any inferences made (Koo and Li, 2016)[4]. The ICC is currently used frequently to assess interrater, interrater, or test-retest reliability. (Portney and Watkins, 2000)[5]. The gold-standard method for measuring muscle strength in knee extension is the isokinetic dynamometer (ID), but it is challenging to use in clinical settings because it is expensive, non-portable, and necessitates prior specialized training. The handheld dynamometer (HDD), on the other hand, is a less expensive, portable tool that can also be used to measure muscle strength. Its use requires less training, which might make it more useful in clinical practice[6].

It has been discovered that the handheld dynamometer (HDD), a tool frequently used in clinical settings to measure muscle, correlates with isokinetic strength scores[7]. Wang et al. (2002) evaluated the test-retest reliability of the Handheld dynamometer in 41 patients living in the community (23 females and 18 males), with a mean age of 76 years, and in that study, the author discovered the Handheld dynamometer was accurate for one trial, the test-retest interclass correlation coefficient ranged from 0.95 to 0.99, and for the mean of two trials, it ranged from 0.97 to 1.0[8].

However, questions still remain on the accuracy of HDD. The current muscle strength testing equipment is not always appropriate to precisely measure the high forces generated by this muscle group. Therefore, a tool that measures muscle strength and is practical, feasible, accurate, and reliable in clinical settings is needed. The purpose of this work is to measure the test-retest intra-observer reliability of the Mark-10 Digital Force Gauge, a portable tool for measuring isometric knee flexor and extensor strength, in healthy adults.

Material and Methods:

Study design: This study used a descriptive test-retest design in a physiotherapy laboratory setting. Study period: 1 month

Study setting: Outpatient Department of Physiotherapy in Narayana Medical College and Hospital, Nellore.

Study population: It comprises a healthy male and female population who were 18 - 30 years of age on the Narayana Medical Institution Campus.

Sample size Calculation: Based on two observations per participant, an anticipated intraclass correlation coefficient (ICC) of 0.70, and an acceptable amplitude of the confidence interval (CI) for the ICC of 0.40, the sample size was determined, resulting in a population of 26 people[9].

Criteria for Inclusion and Exclusion: The inclusion requirements include healthy people between the ages of 18 and 30. Disabled people and those who have recently experienced trauma are not included in the sample.

Material

A Mark-10 Digital Force Gauge (MDFG) Hand Held Dynamometer (HHD) (Model EKE-500-1E, 3951875; Mark-10 Corporation, 11 Dixon Avenue, Copiague, NY 11726) (Figure 1) was used to evaluate the strength of the unilateral knee extensors and flexors. The gauge can be powered by an AC adaptor or an 8.4V NiMH rechargeable battery. A baseline of a 500 lb F/2500 N digital force gauge dynamometer, which measures muscle strength in Newton (force). This device has two ends: a push side and a pull side. Its sole seven buttons serve as its principal purpose and are on/off, zero, and Turn: By doing this, the display's orientation is reversed. Enters the main menu after zeroing and peaking the principal reading. It goes backward in the menu hierarchy by one step. Depending on the configuration, it either communicates the current reading to an external device or stores a value in memory. Changes the measuring modes on and off. Series E gauges have the following possible working modes: Peak Compression (PC), Peak Tension (PT), Average Mode (AVG), and Real-Time (RT) Capturing Data (CAPT) The on/off button turns on and off the equipment. The zero and max buttons make sure you start at zero measurement. The lb/kg button switches between pounds, kilograms, and Newton (N). The max button memorizes the last maximum reading. The max clear button clears the last maximum reading. A two-inch-wide digital screen indicates the battery life, the strength measurement, and the selected weight in pounds or kilograms. The other things needed are a couch, a computerized goniometer, and rolled towel padding. The Baseline Digital Force Gauge can be used with interchangeable handles and accessories. Straight pad; huge curved pad; handheld dynamometer (Figure 2). An adult population of twenty-six fit male and female volunteers was gathered from the campus of Narayana Medical Institutions. The study was authorized by the Institutional Ethical Committee (NARC-IEC/Phd-001-2022), and all subjects gave written informed permission.

Procedure:

Every volunteer underwent two separate tests during the same morning session, from 9 a.m. to 12 p.m., using the test-retest approach. About seven days following the initial session, the tests were administered again in the same order by the same examiner under the same circumstances as the first examination. (Graph) For all measurements, the principal evaluator was responsible. A test session lasted roughly five minutes in total. The strength tests were carried out by this lead investigator, who had fifteen years of expertise. The physical therapy department's senior physiotherapist read and documented the results from the dynamometers. A 10-hour course on lower limb muscle-strength assessments with the Mark-10 Digital Force Gauge (MDFG) Hand Held Dynamometer (HHD) was given to both examiners.

The volunteers had their backs properly supported while they sat high on the couch. To get acquainted with the Digital Force Gauge, volunteers completed a warm-up and three submaximal isometric contractions for each test position. They conducted three maximal voluntary isometric contractions for five seconds for each muscle group, pausing for 60 seconds in between repetitions and five minutes in between tests. The examiner went over the contraction with the subject before measuring each muscle group. To sustain the force, they originally showed during the test, we gave oral encouragement and instructed them to exert their maximum voluntary effort.

Prior to every muscular strength test, the force gauge dynamometer position was calibrated using predetermined landmarks. The distance between the medial and lateral malleoli and the shin pad was 10 cm (Figure 3). The instrument shaft was kept perpendicular to the anterior side of the tibia's mid-shaft during the measurement of the knee joint's extensors (Figure 4). This same angle needed to be maintained when measuring the knee joint's flexors to the posterior aspect over the musculo-tendinous junction of the calf muscles. The volunteers were then instructed to push or pull against the dynamometer while keeping the limb in the designated position. Given the right command, subjects were instructed to apply as much force as they could to the gauge pad by pushing or pulling.

For both the flexion and extension of the knee, two angles 90 degrees and 45 degrees were extracted, and the isometric strength was expressed in Newton force (N). For every volunteer, this process was carried out three times. During the course of each iteration, the maximum output was chosen and recorded. The limb was positioned over the sofa at the proper angles of 45° and 90° for each muscle activity.

Figure:1

Figure:2

Figure:3

Figure:4

Data Analysis

The SPSS statistical software for Windows, version 25.0[10], was used for all data analysis. The demographic variables were subjected to a descriptive analysis. The data analysis employed distinct means for each muscle group, computed for knee flexion and extension at 45˚ and 90˚. For each individual score, the 90% confidence intervals (CIs) and the infraclass correlation coefficients (ICCs) were calculated. 90% confidence intervals and ICCs were estimated in order to assess the knee flexion and extension at 45˚ and 90˚ for reliability.

RESULTS

In this investigation, 26 patients were involved. The age range of participants was 18 to 30 years old, with a mean age of 22.53 (SD ± 3.39) years old. Figure 1 shows that the mean age of the male in this was 22.62 ± 3.43, and the mean age of the female was 22.46 ± 3.5. In this study, the population was split evenly between men and women.

Table: 1 Demographic Variables of Participants

Variables	Mean ± Std.	P Value
Male	22.62 ± 3.43	<0.001
Female	22.46 ± 3.5	<0.001

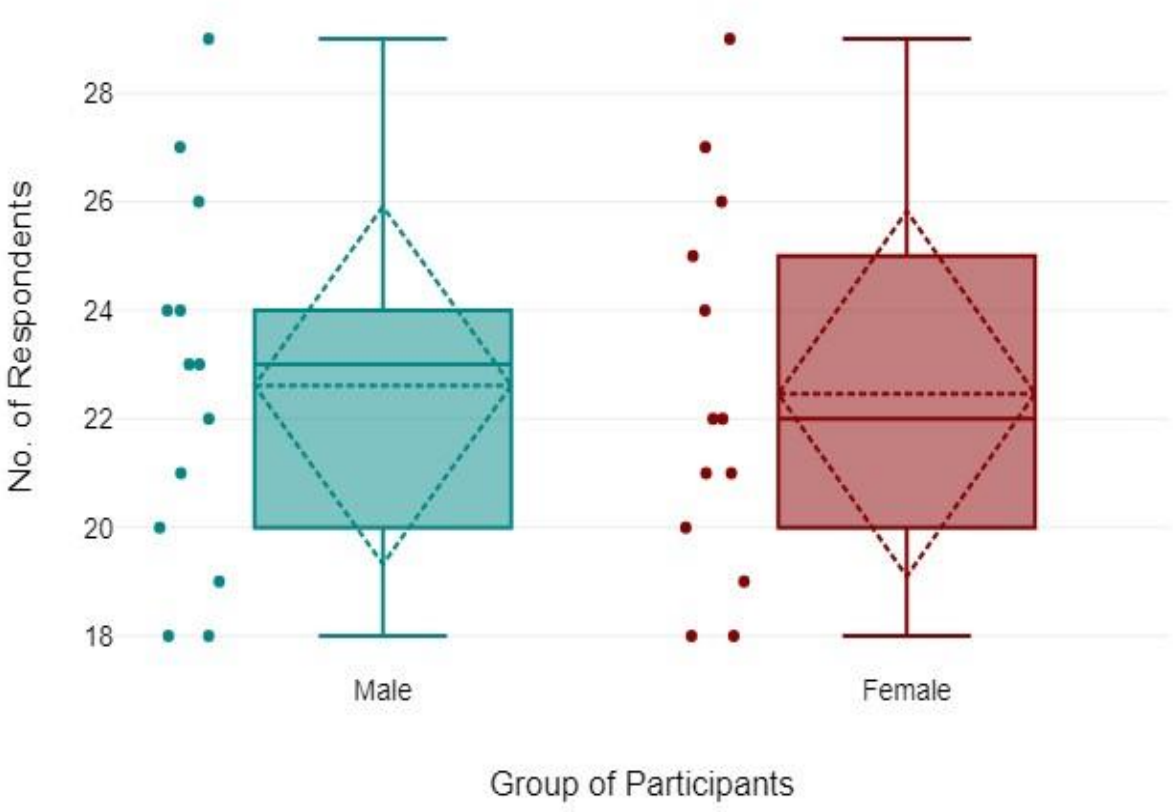

Fig:1 Box-plot graph of Demographic Variables of Male & Female Respondents (Mean ± std.)

Table: 2

Test-retest of Isometric Knee flexor and extensor using Digital Force gauge (HHD) in 45° & 90° angle.

Joint	Motion	Angle	Test Mean ± Sd.			Retest Mean ± Sd.		
			Male	Female	P Value	Male	Female	P Value
Knee	Flexion	45°	127.46 ± 2.47	87 ± 4.64	<0.001	128.54 ± 2.82	87.08 ± 4.42	<0.001
		90°	130.54 ± 2.37	87 ± 4.62	<0.001	131.23 ± 2.68	87.15 ± 4.52	<0.001
	Extension	45°	140.77 ± 2.65	135.62 ± 3.45	<0.001	140.46 ± 2.6	136.23 ± 3.54	<0.001
		90°	158.77 ± 2.39	135.38± 3.38	<0.001	158.69 ± 2.69	135.77 ± 3.39	<0.001

Table: 3 Test-retest Reliability score of Isometric Knee flexor and extensor using Digital Force gauge (HHD) in 45° & 90° angle

Variables	Joint	Motion	Angle	r	p
Male	Knee	Flexion	45°	0.87	<0.001
			90°	0.94	<0.001
		Extension	45°	0.92	<0.001
			90°	0.95	<0.001
Female		Flexion	45°	0.98	<0.001
			90°	0.98	<0.001
		Extension	45°	0.98	<0.001
			90°	0.98	<0.001

The test and retest isometric force output scores and reliability for each male and female subject are shown in Table 1. At 45˚ and 90˚ degrees, the knee flexor and extensor muscle scores are displayed. Electronic Force Gauge in female subjects, there were differences in the Handheld Dynamometer scores between the knee extensors and flexors strength at 90˚ and 45˚ during the test or retest periods. Both male and female knee extensors (quadriceps) produced the most force, whereas the average force score for knee flexors (hamstrings) was the lowest. Retest results revealed that subjects' strength across the extensor and flexor muscle group was higher. Table 3 displays both muscle groups' ICCs varied from 0.87 to 0.98. When knee extension and flexion were measured at 45˚ & 90˚, the ICCs showed higher scores (0.98) in the female group than when they were measured in the male group. The reliability study assessments were completed twice, one week apart, by every subject who was participating in the study. One week had passed since the original test. In this investigation, the overall reliability score ranged from 0.87 to 0.98.

DISCUSSION

The Reliability of the Mark-10 digital force gauge handheld dynamometer for assessing muscle strength in healthy volunteers is being investigated for the first time in the physiotherapy laboratory setting. The test-retest reliability coefficients exceeded 0.9 for all variables, which indicates that the digital force gauge has the highly necessary reliability for such research, and was the study's main objective. In this study, the test-retest reliability ICCs were all determined to be "excellent".

Since support is required to measure the muscle groups in the lower extremities, the Digital Force Gauge Handheld Dynamometer has the advantages of mobility and convenience of use. The drawback of the hand-held method is that the dependability of the measures is contingent upon the examiner's strength and ability to keep the testing posture against the participant's resistance. These results are consistent with other research on Western populations that found that adult healthy physiotherapy students using the Handheld Dynamometer had good test-retest reliability for these outcome measures. These values are significantly higher than those reported by Cheryl et al[11].

In contrast, the study's mean knee extension values at 90˚ and 60˚ were 61.98 (26.57) and 53.12 (22.47), respectively. The study found that the test-retest reliability of knee flexor strength using a Handheld Dynamometer was often greater than in nonathletic individuals, where ICCs as high as 0.965 have been reported[12]. The mean strength values obtained from our investigation were much greater than those from earlier studies that used a Mark-10 Digital Force Gauge Handheld Dynamometer to test the strength of Knee flexors and extensors muscle groups. Current study we have assessed muscle strength with Newton (N) which is the first time tool ever used.

It has previously been demonstrated that increased muscle group strength negatively impacts the validity of HHD testing[13]. The study found that the strongest muscle groups, the knee flexor and knee extensor at 90˚ hip flexion, had the greatest reliability measures. A notable advantage of this research is that it tested occupations that have been approved for the evaluation of the students. These assessments are more applicable to clinical practice because they are administered to healthy physiotherapy students within their functional range. Current finding in Knee Flexors and Extensors Strength Intra-ratter reliability in healthy male and female were (r = 0.87 to 0.98) range that is the muscle torque was performed with excellent interrater reliability (intraclass correlation coefficients ranging from (0.74 to 0.92) for all Flexion and Extension of Knee tested.

In this study, a few shortfalls are also there. The study samples were chosen at our convenience. Furthermore, there was a chance of bias because the researcher was not blind to the outcomes of previous experiments. Moreover, the same investigator performed all of the measurements. When measured by the same examiner, isometric flexor and extensor strength can be obtained with good to outstanding test-retest repeatability using a digital Force Gauge Handheld Dynamometer.

CONCLUSION

The Digital Force Gauge (DFG) Handheld Dynamometer is a reliable tool to use in assessing lower limb muscle force generation, according to the findings of the current and prior reliability studies. Comparatively easy to use and portable compared to other standard muscular strength measurement equipment. Some issues remain unresolved, such as whether this method can precisely follow a patient's functional assessment over time.

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