DEVELOPMENT AND UTILIZATION OF NEW INSTRUMENTS IN ASSESSING HANDGRIP STRENGTH FOR OCCUPATIONAL AND PHYSICAL THERAPISTS

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ABSTRACT

Handgrip strength is essential to perform activities of daily living (ADL), instrumental activities of daily living (IADL), and work. Handgrip weakness is associated with hand dysfunction and diseases. Handgrip strength assessment is commonly performed by physiatrist, occupational and physical therapists with the use of instruments. Several instruments are can be used in assessing handgrip strength, however, there is still a problem when it comes to accuracy and comfortability, especially in persons with hand dysfunction. With these problems, the researcher developed a new instrument for assessing handgrip strength that occupational and physical therapists can utilize. The study was conducted in five (5) hospitals and one (1) clinic. The respondents were thirty (30) occupational and physical therapists, and thirty (30) patients diagnosed with cerebrovascular accident (CVA) with Brunnstrom stage 4 motor recovery. Three (3) valid researcher-made questionnaires were distributed to the respondents. Samar Dynamometer and Jamar Dynamometer were used for assessing the handgrip strength of the respondents. Jamar Dynamometer is the most commonly used instrument in assessing handgrip strength. The occupational and physical therapists encountered a problem in using the instrument is “difficult to calibrate”, “inaccurate”, and “no numerical value”. The Samar Dynamometer is reliable in assessing the handgrip strength of a population with or without hand dysfunction. However, Samar Dynamometer and Jamar Dynamometer had a significant difference in average scores due to different characteristics such as weight, design, and force detection. Samar Dynamometer is highly usable in the practice of occupational and physical therapists. Also, it has a high satisfaction level among the patient. The researcher recommends modifying and upgrading Samar Dynamometer for future utilization. Additionally, deploying the instrument to a larger population of patients for the provision of intratester and intertester reliability and to establish the normative value of handgrip strength among the different populations. Lastly, conduct a study to determine the viability of the Samar Dynamometer as an alternative device to be utilized by the occupational therapist, physical therapist, and hand therapist in assessing handgrip strength.

Keywords: Handgrip Strength, Dynamometer, level of satisfaction, level of usability

INTRODUCTION

Handgrip strength is the force from the hand necessary to hold and manipulate an object which is important in performing occupations such as activities of daily living (ADL), instrumental activities of daily living (IADL), and work. Handgrip weakness is associated with trauma in the hand, carpal tunnel syndrome, arthritis, and other medical conditions, resulting in difficulty performing occupations and decreased quality of life. Also, handgrip strength is a predictor or indicator of a medical health condition. To assess the handgrip strength, a physiatrist, an occupational and physical therapist, uses an instrument to measure the handgrip strength accurately, which can determine the patient's problem, enable the therapist to formulate an appropriate treatment plan, and enable to determine the handgrip strength of the patient after several treatment sessions. Several instruments can be used in assessing handgrip strength. Jamar Dynamometer is the gold standard instrument in assessing handgrip strength and is also the most commonly used in clinics or hospital. However, the measurement can be difficult or inaccurate in elderly patients with arthritic hands or weak muscle force (de Dobbeleer et al., 2018) and patients with leprosy (Scapinelli et al., 2019). Another instrument is the Smedley type. This instrument is commonly used in Asia (Ha et al., 2018). However, there is a systematic bias in underestimating handgrip strength by comparing it with the Jamar Dynamometer, resulting in a higher prevalence of weakness (Kim &Shinkai, 2017). Collins dynamometer has a good correlation with the Jamar Dynamometer. However, measuring handgrip strength using a Collins dynamometer may not be valid because some populations may encounter difficulty grasping the device and applying force (Sanchez Torralvo et al., 2018). Also, the researcher's encountered problems in assessing handgrip strength. The researcher experienced using an alternative way such as letting the patient grasp the therapist's hand and evaluate if it's weak or strong, which is inaccurate. With this problem, the researcher developed a new instrument for assessing handgrip strength that can be utilized by occupational and physical therapists.

LITERATURE REVIEW

Handgrip Strength

In older persons, handgrip strength is linked to sociodemographic factors and body anthropometry. (Ong et al., 2017). In terms of gender, males have a greater grip strength than females (Sharma et al., 2018). Age can be a factor in contributing to grip strength. American males started to decrease handgrip strength at 30 and rapidly decreased handgrip strength at 70 (McGrath et al., 2019). Regarding social-economic position, men with lower income have greater grip strength than higher-income, while females with lower income have lower grip strength than higher-income (Carney &Benzeval, 2018). In addition, Low educational attainment and living in a less urban environment were associated with reduced grip strength in Filipino women. (Adair et al. 2018). Some of the activities also may contribute to handgrip strength. Light manual workers had a stronger grip strength compared to office employees. (Saremi&Rostamzadeh, 2019).

Generally, in terms of anthropometry, the male has a longer hand than the female; therefore, the male has a higher grip strength (Wichelhaus et al., 2018). Furthermore, the dominant hands have a stronger grip than the non-dominant hands. (Tayyari, 2018). Additionally, the most important predictor of handgrip strength is hand length. (Alahmari et al., 2017) and hand circumference has a weak and strong correlation (Tonak et al., 2021). Additionally, height has moderately correlated with handgrip strength (Wang et al., 2018). Another factor that contributes to maximal grip strength is body posture. Measuring grip strength while standing position has higher grip strength than sitting position. Also, the neutral position of the forearm and shoulder gets higher grip strength (Sun Lee & Hwang, 2019). Regarding body mass index (BMI), obese cricket players have higher grip strength than normal BMI (Paul & Srinivas, 2020). However, there is a negative correlation between body mass index (BMI) in normal and obese in both males and females (Dhananjaya et al., 2017). Many researchers studied normative reference values of grip strength in countries such as the United States of America (Wang et al., 2018), Taiwan (Pan et al., 2020), Saudi Arabia (Alrashdan et al., 2021), and Nepal (Bimali et al., 2020) and which categorized by sociodemographic or anthropometry. Kim et al. 2018 researcher found out that the Koreans has higher handgrip strength using the right hand. Handgrip strength was highest in both

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males and females between the ages of 35 and 39, and gradually decreased after that. The researcher also discovered that weight, height, and BMI have the strongest correlation with handgrip strength.
They discovered that there was no significant difference in handgrip strength between ages 18 to 24 and 25 to 59, but a significant difference between 60 years and older when comparing the two groups. Furthermore, Americans who graduated in high school or a higher degree are more likely to have stronger handgrips than individuals who did not complete secondary school (Wang et al., 2018).

Importance of Measuring Handgrip Strength in Health

Handgrip strength testing is a reliable indicator of health problems and negative health consequences in the elderly. As a result, this crucial parameter should be recorded regularly during medical examinations, particularly when frailty is being assessed. (Mehmet et al., 2019). Grip strength testing identifies high-risk factors for osteoporosis patients (Lin et al., 2020), a useful indicator for detecting slow walking in older adults, which can be dangerous. (Lin et al., 2021), grip strength cut points can be a screening tool in healthy and normotensive adults at risk of diabetes (Brown et al., 2020), as a preliminary assessment of the quality of life in community-dwelling senior citizens (Xie& Ma, 2021), as a screening tool for risk of cardiovascular diseases (Celis-Morales et al., 2018) and as a predictor of cognitive impairment risk in individuals with cognitive impairment, as well as monitoring strength capacity in those with cognitive impairment (McGrath et al., 2019). Additionally, low handgrip strength is associated with a high mortality rate in an adult person after one year of hip fracture (Gutierrez-Hermosillo et al., 2020). Routinely measuring grip strength during consultations prevents to decrease in grip strength and discomfort, which can lead to difficulty in performing daily activities. (Ejazi, et al., 2017).

When it comes to low handgrip strength, there are numerous aspects to consider. Low handgrip strength is linked to chronic cardiometabolic diseases, neural morbidity, functional decreases, and mobility constraints. (McGrath et al., 2020). In other studies, older Koreans with an inactive lifestyle are associated with low handgrip strength. Additionally, imbalance diets such as insufficient protein and excessive carbohydrate intake are also associated with men's low handgrip strength. While in women, drinking alcoholic beverages and diabetes may decrease handgrip strength (Kim et al., 2019). In other studies, de Araújo Amaral et al., 2020 list the factors associated with low handgrip strength. Men and women are underweight, have anemia, have diabetes, and are dependent on ADL or occupational tasks. The gap is also distinguished by gender, according to the study. Having a partner, a smoking history, and a negative self-assessment of present health compared to the previous 12 months are all factors to consider in older males. The waist-to-hip ratio, sleeplessness, and physical activity displacement are all factors to consider in older women.

Handgrip weakness is commonly observed in carpal tunnel syndrome (CTS), diabetic neuropathy, peripheral neuropathy, cervical radiculopathy, herniated disc, Saturday night palsy, and ulnar neuropathy (Moawad, 2022). Other conditions are ganglion cyst, arthritis, epicondylitis, sarcopenia, multiple sclerosis, and stroke (Fletcher, 2020). In performing Activities of Daily Living (ADL), grip strength is needed in almost all aspects. Force is required to grip an object to enable it to do the activity. In the study of Cepria-Bernal et al., 2021, they list 21 activities of daily living and identify the grip force while doing the activity using a High Spatial Resolution Pressure Sensor. The maximum grip force needed is 100N which turns the handle to open the door and lifts the briefcase from the ground. The intermediate peak force was measured with 50N, opening and closing water tap, spraying insecticide, and ironing clothes. The other activity was recorded for less than 50N to perform the activity. Additionally, in the study of Fortunato, et al., 2020 found the cutoff grip strength in performing activities of daily living (ADL) in centenarian women. The cutoff point in bathing is 11kg on the right hand, and 9kg on the left hand; dressing is 11kg on the right hand, and 12kg on the left hand; use of the toilet is 10kg on the right hand and 12kg on the left hand; transfer is 11kg on the right hand and 9kg on the left hand, and continence is 11kg on the right hand and 5kg on the left hand. Weakness of handgrip strength in older adults leads to difficulty in performing tasks such as shopping for groceries, preparing meals, and performing housework (Gopinath et al., 2017). Maintaining grip strength may improve health-related quality of life (Halaweh, 2020), independence of activities of daily living (ADL), instrumental activities of daily living (IADL), physical disability, and mobility (Van Omen, 2019).

Role of Occupational and Physical Therapists in Handgrip Assessment

Occupational therapy is a client-centered health profession that focuses on enhancing health and well-being via occupation. Occupational therapy's main objective is to enable patients to participate in daily activities. Occupational therapists work with individuals and communities to increase their ability to participate in the occupations they want, need, or are expected to do, or to change the occupation or the environment to better support their participation. (WFOT 2012). In occupational therapy, assessment or evaluation consists of the occupational profile, occupational performance analysis, and evaluation process synthesis are all part of the process. (OTPF 4). In the Philippines, occupational therapy students should already know different assessment types before they graduate (CHED, 2017), which may apply in future clinical practice. In handgrip assessment, Jamar Dynamometer is a valid tool to be used by an occupational therapist, especially a client with a trigger finger (Langer et al., 2017).

Physical therapy provides services to people and populations for the development, maintenance, and restoration of maximum movement and functional capacity across the lifespan. This includes providing services when aging, injury, sickness, or environmental conditions impair mobility and function. (Philippine Physical Therapy Association). In hand examination in finger flexion or grip, the therapist instructs the patient to grip the finger of the therapist. This examination is graded with “good” or “weak” (Fruth, Stacie 2017). Also, the physical therapist uses instruments in measuring handgrip strength.

Occupational and physical therapists commonly used a biomechanical approach as a remediation or restoration technique to reestablish or establish client-level characteristics of structural stability, tissue integrity, range of motion (ROM), muscle strength, and endurance. This approach will identify the client’s physical abilities required to perform activities.
This approach will help both professionals in planning plans to reach their goals. In occupational therapy practice, it is evident that an occupation-based approach to interventions, combined with the traditional biomechanical approach, effectively produces positive functional outcomes for clients receiving rehabilitation in a hand therapy setting (Malikayil& Jameson, 2020).

Current and Emerging Instrument in Assessing Handgrip Strength

In the study of Lee & Gong 2020, researchers discussed the four characteristics (1) regardless matter how high or low the handgrip strength is, the measurement must be reproducible and accurate; (2) independent of hand size; (3) comfortable for the subjects; and (4) accessible, such as being small and portable. Also, the researcher discussed types of instruments such as hydraulic, pneumatic, and mechanical. An example of the hydraulic type is the Jamar Dynamometer, which is mainly used and can measure up to 90kg. However, the instrument has inaccurate results with a population of elderly with arthritis and weak hands. Another type is pneumatic, which is a modified sphygmomanometer and Martin Vigorimeter. These instruments use comprehensive force on an air-filled bulb or bag with a display of handgrip strength in either millimeter of mercury or pounds per square inch. These instruments are commonly used when a dynamometer is not available due to being expensive. Patients can press these instruments with less effort, which can lessen the pain during assessment. The last type of instrument is mechanical, which is the Smedley type. This instrument is based on tension generated in a steel spring and displays handgrip strength in kilograms or pounds. Also, this instrument is commonly used in Asian countries, especially in Japan.

Another instrument is the Bulb dynamometer. This instrument is more appropriate for a specific population, such as young children and older adults, than the Hydraulic Jamar Dynamometer. However, Individuals with larger hands may have had more trouble squeezing the device because all measurements were taken with a single-size bulb handle. Also, The Baseline® Pneumatic Squeeze Bulb Dynamometer comes without any guidelines or instructions for measuring grip strength, which could lead to discrepancies in how grip strength is reported. (Maher, et al., 2018).

Another instrument is Camry Electronic Hand Dynamometer. This instrument can measure all age groups of adults. The instrument can have the best result when the elbow is fully extended (Mani et al., 2019); however, this position may not be practical for performing almost all types of work and activities of daily living (Tayyari, 2018). Even though there are many instruments for assessing handgrip strength, some researchers are still developing new instruments. An example of a prototype instrument is the BodyGrip which is already validated with Jamar Dynamometer. The features of this prototype dynamometer are lightweight, compact, and has a software application that can be adapted to mobile devices and provides real-time graphical representation that the evaluator can observe (Urbano et al. 2020).

In the study by Ryu et al., 2020, the researcher developed a new instrument for measuring handgrip strength using load-cell sensors with a range of force up to <60kg, which is transferred to a computer to convert the data. This proposed device is portable and can connect to a personal computer through USB. However, this instrument is not connected wirelessly, so the researcher recommends adding these features. In the study of Makino et al., 2018, the researcher developed a new instrument that can measure handgrip strength on each finger. The researcher modified the Smedley Dynamometer and placed four sensors on the grip part of the instrument. This instrument is wirelessly connected to a computer. In the study of Biju et al. 2021, the researcher developed a new instrument for measuring handgrip strength. This instrument is Arduino-based with force resisting sensor and flex sensors placed on gloves. The result is displayed on a screen and includes a scatter plot that updates in real-time to illustrate the average force applied by the grip. However, the researcher recommends increasing the system's accuracy and design.

METHODOLOGY

Research Design

This study utilized a Descriptive Evaluative Research Design. Descriptive evaluation studies describe the process and impact of the development and implementation of a system. The findings are often contextualized within the implementation environment (Gu & Warren, 2017). This study used three parts of researcher-made survey questionnaires which were: (Part I) Instruments used by occupational and physical therapy in assessing handgrip strength, (Part 2) Usability of Samar Dynamometer in the Practice of Occupational and Physical Therapists, and (Part 3) Satisfaction of the patients using the Samar Dynamometer. In this study, the researcher developed a new instrument for handgrip strength assessment that can be utilized by occupational and physical therapists.

Sources of Data

The study had two sources of data; primary and secondary sources. The primary sources of the data were the results collected from the respondent's answers to the survey questionnaire. Secondary data sources served as the key reference tools for identifying relevant literature reviews. Relevant and reliable publications were found in the literature of several academic domains. Most of these publications were taken from research papers, journals, and articles.

Population of the Study

The study was conducted in five private hospitals and one private clinic in Laguna. The respondents consisted of twenty-five (25) physical therapists, five (5) occupational therapists, and thirty (30) patients diagnosed with Cerebrovascular Accidents (CVA) with hand dysfunction. The following inclusion criteria of respondents were as follows (a) An occupational or physical therapist who provides rehabilitation services to a patient with hand dysfunction, (b) An occupational or physical therapist who can perform handgrip assessment using Jamar Dynamometer, (c) a patient diagnosed with Cerebrovascular Accident (CVA), (d) CVA patient with at least stage 4 Brunnstrom motor recovery, and (e) CVA patient who can follow testing procedure. A purposive sample sampling, also known as judgmental, selective, or subjective sampling, is a non-probability sample selected based on the characteristics of a population and the study's objective (Crossman, Ashley 2019). The researcher used purposive sampling to maintain the homogeneity of the respondents based on the inclusion criteria set by the researcher

Instrumentation and Validation

The researcher used three (3) parts of validated researcher-made questionnaires. This researcher-made questionnaire answered the statement of the problem of this study, such as the Current instrument used by occupational and physical therapists in assessing handgrip strength, the usability of the Samar Dynamometer in the practice of occupational and physical therapists, and the level of satisfaction of patients in using Samar Dynamometer. Part I (Instruments used by occupational and physical therapists in assessing handgrip strength) was a researcher-made questionnaire based on the instrument used in assessing handgrip strength. This researcher-made questionnaire was used to identify the current instrument used in assessing handgrip strength and the problems encountered in using the instrument by the occupational and physical therapists. The researcher-made questionnaire consisted of the following questions: (1) Profession, (2) What is the current instrument being used in assessing handgrip strength? (3) Have you encountered problems using the current instrument to assess handgrip strength? and (4) If yes, what are the problems you encountered? Part II (Usability of Samar Dynamometer in Practice of Occupational and Physical Therapists) was a researcher-made questionnaire based on Technology Acceptance Model Questionnaire. This researcher-made questionnaire determined the level of usability of the Samar Dynamometer in assessing handgrip strength in the practice of occupational and physical therapists. The researcher-made questionnaire consisted of two categories with five questions in each category. The category was based on the perceived usefulness of the Samar Dynamometer. It has six questions which were (1) Using the Samar Dynamometer enables therapists' to assess handgrip strength more quickly, (2) Using the Samar Dynamometer would improve therapists' skill in assessing handgrip strength, (3) Using the Samar Dynamometer to assess handgrip strength would increase therapists' productivity so it can do another task, (4) Using the Samar Dynamometer would enhance therapists' effectiveness in assessing handgrip strength, (5) Using the Samar Dynamometer, and (6) Therapists' find the Samar Dynamometer useful in assessing handgrip strength and would make it easier to assess handgrip strength.

Part III (Level of Satisfaction of the patients using the Samar Dynamometer) was a researcher-made questionnaire based on the patients' level of satisfaction using the Samar Dynamometer in assessing handgrip strength. This researcher-made questionnaire determined the patients' level of satisfaction in using the Samar Dynamometer. The questionnaire consisted of five questions which were (1) Physical Design, (2) Weight, (3) Material used, (4) Comfortability, and (5) Innovation. Also, all the questions were translated into Tagalog. The researcher-made questionnaire was validated through a pilot study with five occupational therapists, five physical therapists, and five patients diagnosed with cerebrovascular accident (CVA) with at least stage 4 motor recovery who were not included in the sample population during the implementation phase. All of the researcher-made questionnaires were understandable and acceptable to the intended samples. Also, the researcher used Cronbach Alpha for the reliability of the questionnaires. The results of Cronbach Alpha in the researcher-made questionnaire part II was 0.817 and in part III was 0.963, which indicated good reliability and internal consistency.

Evaluation and Scoring

To determine the level of usability of the Samar Dynamometer in occupational and physical therapists' practice, the following measures were used:

Assigned Points	Numerical Ranges	Categorical Responses	Verbal Interpretation
5	4.2 - 5	Strongly Agree	Highly Usable
4	3.4 - 4.2	Agree	Usable
3	2.6 - 3.4	Neither agree nor disagree	Neutral
2	1.8 - 2.6	Disagree	Unusable
1	1 - <1.8	Strongly Disagree	Highly Unusable

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To determine the level of satisfaction of patients with cerebrovascular accident (CVA) with hand dysfunction in using the Samar Dynamometer in assessing handgrip strength, the following measures were used:

Assigned Points	Numerical Ranges	Categorical Responses	Verbal Interpretation
5	4.2 - 5	Very Satisfied	Highly Satisfied
4	3.4 - 4.2	Satisfied	Satisfied
3	2.6 - 3.4	Neither satisfied nor dissatisfied	Neutral
2	1.8 - 2.6	Dissatisfied	Dissatisfied
1	1 - <1.8	Very Dissatisfied	Highly Dissatisfied

Data Gathering Procedure

Data gathering procedure was commenced upon securing a consent letter countersigned by the thesis adviser to permit the researcher to conduct the study and administer the questionnaire. The researcher conducted a visit to the intended hospitals and clinics within Laguna and sought the approval of the Head of the Rehabilitation Medicine Department of the hospital to assure them that patients will not be harmed and secured the confidentiality of patients' information. The confidentiality of the respondents was maintained during the implementation by using a control code, in which only the researcher had a copy of the respondents' details. After the head of the Rehabilitation Department agreed and signed the consent letter. A pilot testing was conducted with five occupational therapists, five physical therapists, and five patients diagnosed with cerebrovascular accident (CVA) patients with hand dysfunction who were not included in the sample population during the implementation phase. All respondents agreed that all researcher-made questionnaires were understandable and acceptable to the intended respondents.

After the researcher-made questionnaire was validated. The researcher distributed letters of consent among the respondents to be a part of the study. The respondents were given three (3) days to read and acknowledge the consent letter. If the respondents did not respond to the letter of consent after three (3) days, the researcher reminded the respondents regarding the consent letter using mobile text or phone calls. And if the respondents were not able to respond to the questionnaire within the allotted days, the respondents were automatically excluded from the study. Among the respondents, ten (10) respondents were excluded from the study by the reason that they were not able to reply to the letter. The number of respondents who agreed and signed the consent letter consisted of twenty-five (25) physical therapists, five (5) occupational therapists, and thirty (30) patients diagnosed with Cerebrovascular Accidents (CVA) with at Brunnstrom stage 4 motor recovery. After the respondent agreed and signed the consent letter, the researcher gave the schedule for the orientation and description regarding the conduct of the study. The implementation of the study was divided into three (3) phases. Phase 1, A validated researcher-made questionnaire form regarding current instruments used and problems encountered in handgrip strength assessment was distributed among Occupational and Physical therapists. The survey questionnaire was given online (google form) or in hard copy.

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Phase 2, the researcher had developed a prototype of the intended instrument, and based on the answer of the occupational and physical therapists regarding the problems they had encountered on the current instrument they have used in assessing handgrip strength. The said prototype has been upgraded and modified.

Phase 3, The researcher began to discuss the testing protocol which was based on the standard protocol set by the American Society of Hand Therapist (ASHT) and the presentation of the developed instrument that can be used in assessing handgrip strength which was named after the researcher, Samar Dynamometer. The respondents were instructed on how to use the Samar Dynamometer in assessing handgrip strength for them to be familiarized. The researcher deemed that with Jamar Dynamometer there's no need for instructions on how to use the instrument considering that the respondents were familiar with the instrument. The following testing protocol was followed in the utilization of Jamar and Samar Dynamometer: The respondents were seated comfortably, shoulder adducted, 90 degrees elbow flexion, slightly wrist extended, and slightly ulnar deviated (ASHT). Three (3) trials of three (3) seconds of maximal grip and thirty (30) seconds of rest between maximal grip on each hand were performed by the respondents on each instrument. Jamar Dynamometer was the first instrument to use in the dominant hand and then in the non-dominant hand. The respondents were given three (3) minutes of rest to prevent fatigue before proceeding with handgrip strength assessment using Samar Dynamometer with the same procedure and protocol used in the first handgrip assessment.

All the results were recorded in a spreadsheet by the researcher. After the respondent had tested both of the instruments, a modified Technology Acceptance Model-based questionnaire was distributed to occupational and physical therapists to determine the level of usability of the Samar Dynamometer in the practice of occupational and physical therapists. Additionally, a validated researcher-made questionnaire was also distributed among the patients to determine the level of satisfaction in using the Samar Dynamometer as an instrument for assessing handgrip strength. The gathered data was compiled in an excel spreadsheet and sent to a statistician for computation.

Statistical Treatment Data

For the analysis of data gathered, the following statistical tools were utilized:

1. Frequency and Percentage distribution were used to determine the current instrument used in assessing handgrip strength
2. Analysis of Variance (ANOVA) was used to determine the difference between the three trials using Samar Dynamometer.
3. T-test was used to determine the average handgrip strength in using Jamar Dynamometer and Samar Dynamometer
4. Weighted Mean was used to determine the level of usability of the Samar Dynamometer in the practice of Occupational and Physical Therapists and the patient's level of satisfaction in using the Samar Dynamometer

RESULTS

The Current Instruments Used by The Occupational and Physical Therapists in Assessing Handgrip Strength

Current instrument	Frequency	Percentage
Camry digital dynamometer	4	13.33

Modified sphygmomanometer	3	10.00
Jamar dynamometer	18	60.00
Two Finger Test	5	16.67
Total	30	100.00

Out of 30 respondents, 18 or 60 percent used Jamar Dynamometer in assessing handgrip strength while 5 or 16.67 percent used the Two Finger test. Meanwhile, 4 or 13.33 percent used the Camry digital dynamometer and 3 or 10 percent used the modified sphygmomanometer.

Problems Encountered by Occupational and Physical Therapists in Using Current Instruments

Problem Encountered	Frequency	Percentage
Inaccuracy	4	13.33
Difficult to Calibrate	6	20
No numerical value	2	6.67
Total	12	40.00

Out of thirty (30) respondents, twelve (12) or 40 percent of the respondents encountered problems in using an instrument. Out of 12 respondents, 6 or 20 percent encountered "Difficult to Calibrate" of the instrument. While 4 with 13.33 percent encountered "Inaccuracy" and 2 or 6.67 percent encountered ``No numerical value".

Difference in The Grip Strength When Measured Repeatedly for Three Trials Using Samar Dynamometer

Trial	Patients right		Patients left	
	Mean	Test statistic	Mean	Test statistic
1	12.10	F=0.135 p=0.874	11.37	F=0.161 p=0.851
2	11.83		10.83	
3	11.30		10.53	
Trial	Professionals right		Professionals left	
	Mean	Test statistic	Mean	Test statistic
1	19.03	F=0.318 p=0.729	16.17	F=0.086 p=0.918
2	12.67		15.60	
3	17.57		15.47	
Significance level @ 0.05				

As shown, in the patient's right hand, the value of F=0.135 was less than the value of p=0.874 which was greater than the significant level of 0.05, therefore, there was no difference between the three trials using Samar Dynamometer on the patient's right hand. In the patient's left hand, the value of F=0.161 was less than the value p=0.851 which was greater than the significant level of 0.05; therefore, there was no difference between the three trials using Samar Dynamometer on the patient's left hand. In the professional's right hand, the value of F=0. 318 was less than the value of p=0.729 which was greater than the significant level of 0.05; therefore, there was no difference between the three trials using the Samar Dynamometer on the professional's right hand. In the professional's left hand, the value of F=0.086 was less than the value of p=0.918 which was greater than the significant level of 0.05; therefore, there was no difference between the three trials using Samar Dynamometer on the professional's left hand. Overall, there was no significant difference between the three trials on both hands of patients and professionals.

Difference Between the Mean Grip Strength Measurements Using Samar Dynamometer and Jamar Dynamometer

Dynamometer	Patients right		Patients left	
	Mean	Test statistic	Mean	Test statistic
Samar	11.63	t=2.175 p=0.038*	10.93	t=2.721 p=0.011*
Jamar	10.51		9.61	
Dynamometer	Professionals right		Professionals left	
	Mean	Test statistic	Mean	Test statistic
Samar	18.27	t=1.482 p=0.149	15.70	t=1.174 p=0.250
Jamar	17.61		15.21	
*Significant @ 0.05				

As shown, the patient's right-hand used Samar Dynamometer had a mean of 11.63 and the Jamar Dynamometer had a mean of 10.51 with test statistics of t=2.175 and p=0.038*, which was less than the significant level of 0.05; therefore, there was a significant difference between Samar and Jamar Dynamometer average result. The patient's left-hand used Samar Dynamometer had a mean of 10.93, and Jamar Dynamometer had a mean of 9.61 with test statistics of t=2.72 and p=0.011*, which was less than the significant level of 0.05; therefore, there was a significant difference between Samar and Jamar Dynamometer average result. On the professional's right-hand used Samar Dynamometer had a mean of 18.27 and the Jamar Dynamometer had a mean of 17.61 with test statistics of t=1.482 and p=0.149 which was greater than the significant level of 0.05; therefore, there was no significant difference between Samar and Jamar Dynamometer average result. On the professional's left-hand used Samar Dynamometer had a mean of 15.70, and the Jamar Dynamometer had a mean of 15.21 with test statistics of t=1.174 and p=0.250, which was greater than the significant level of 0.05; therefore, there was no significant difference between Samar and Jamar Dynamometer average result. Overall, the Samar Dynamometer and Jamar Dynamometer had a significant difference in average results when tested both instruments in the patient's hands; however, there was no significant difference in the average results when tested both instruments in the professional's hands.

Level of Usability of the Samar Dynamometer in The Practice of Occupational and Physical Therapists

Indicators	Weighted Mean	Verbal Interpretation	Rank
1. Using the Samar Dynamometer enables the therapist to assess handgrip strength more quickly	4.87	Highly Usable	1.5
2. Using the Samar Dynamometer would improve the therapist's skill in assessing handgrip strength	4.83	Highly Usable	3
3. Using the Samar Dynamometer to assess handgrip strength increases the therapist's work productivity	4.70	Highly Usable	5

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4.Using the Samar Dynamometer to assess handgrip strength would have a better or more accurate result	4.63	Highly Usable	6
5. Using the Samar Dynamometer would make it easier to assess handgrip strength	4.80	Highly Usable	4
6.The therapist finds the Samar Dynamometer useful in assessing handgrip strength	4.87	Highly Usable	1.5
Average	4.78	Highly Usable	

The highest indicator with a weighted mean of 4.87 and ranked 1.5 was “The therapist finds the Samar Dynamometer useful in assessing handgrip strength” and “Using the Samar Dynamometer enables the therapist to assess handgrip strength more quickly”. The lowest indicator was “Using the Samar Dynamometer to assess handgrip strength would have a better or more accurate result” with a weighted mean of 4.63 and ranked 6 of all the indicators. The average mean of all six (6) indicators was 4.78 with a verbal interpretation of “Highly Usable”. With these findings, it revealed that Samar Dynamometer was highly usable in the practice of occupational and physical therapists in assessing handgrip strength.

DISCUSSION

The findings support the study made by Torralvo et al., 2017 which stated that Jamar Dynamometer was commonly used in clinical practice. It also reflects that the majority of occupational and physical therapists use Jamar Dynamometer as an instrument used in assessing handgrip strength (American Society of Hand Therapists). The findings do not support the study of Ha et al., 2018, which stated that the most commonly used instrument in the Asia is Smedley type which contradicts the findings. Several studies confirmed that there is a problem in using several instruments for assessing handgrip strength. The Baseline® Pneumatic Squeeze Bulb Dynamometer encountered with measurement accuracy due to a lack of guidance or instructions on how to use the instrument (Maher, et al., 2018). Additionally, Jamar Dynamometer encountered inaccurate results in assessing elderly with arthritis (de Dobbeleer et al., 2018) and patient with leprosy (Scapinelli et al., 2019).

The results of the study were related to the findings that tested the reliability of other instruments used in assessing handgrip strength such as the Bulb Dynamometer (Maher et al., 2018), and Jamar Plus Dynamometer (Gasior et al., 2020), and Smedley Dynamometer (Kim &Shinkai, 2017) which had the same finding with the present study that there is no significant difference between three trials. However, these instruments are tested in different populations and employ different statistical treatment data. In the study of Ortmann et al., 2020, the researcher tested the reliability and validity of the new instrument “Manovo Power robot-assisted device” on stroke patients and it was compared with “Biometrics E-LINK EP9,” which was already a valid and reliable instrument in assessing handgrip strength.The following instruments compared with Jamar Dynamometer were the Body Grip Dynamometer (Guerra, R.S. et al. 2017) and K-Force Grip (Nikodelis, 2021) which subsequently gave an outcome of no significant difference. However, in the study conducted by Amaral et al., 2017, wherein they compare an instrument with Jamar Dynamometer the results were there was a significant difference. According to Douze et al, 2021, usability is addressed mostly through questionnaires that assess the medical device's perceived usability rather than its usability per se which was parallel to the study. Also, usability testing was necessary in developing a new medical device (Parreira et al., 2020). In the study by Laver et al., 2021, the researcher identified the usability of a new portable rehabilitation system (mRehab) which was useful as a remote home program. The results of the previous study presented have similar findings with the present study. Nonetheless, the respondents included in the study to determine the usability and those who answered the questionnaire were not the same. Furthermore, a new develop mobile application "Home Maddirs" was also tested for its usability which gathered a good preliminary result in terms of its usability in occupational therapy.

The majority of the patients were "Highly Satisfied" in terms of the characteristics of the instruments such as physical design, weight, material, comfortability, and technology. These findings can be correlated to the study by Maher et al. 2018 which confirmed that Bulb Dynamometer was an alternative instrument that can be used in assessing handgrip strength among adults and young adults, and can be used with less pain and more comfortable (Mendonca et al., 2020) compared to Jamar Dynamometer wherein the measurement can be difficult or inaccurate when administered on patients with weak handgrip strength including elderly patients with arthritis (de Dobbeleer et al., 2018) and leprosy (Scapinelli et al., 2019). Moreover, according to the study of Munoz & Millan 2019, it was better to use Camry electronic devices in a population with an age group between 40 and 59 year old.

CONCLUSION

Based on the results of the study, the following conclusions were drawn:

1. The instrument being used by occupational and physical therapists in assessing handgrip strength was the Jamar Dynamometer since it was the gold standard device used for assessing grip strength.
2. More than half of occupational and physical therapists' respondents did not encounter any problem with the instrument being used to assess handgrip strength. However, some occupational and physical therapists encountered problems such as "difficult to calibrate," "inaccurate," and "no numerical value" with the current instrument they used in assessing handgrip strength.
3. Samar Dynamometer is a reliable instrument for assessing handgrip strength among individuals with or without hand dysfunction. Samar Dynamometer was able to assess handgrip strength with or without hand dysfunction, and it has a higher probability of having consistent results between three trials.
4. Samar Dynamometer was a valid instrument among the respondents without hand dysfunction, Nevertheless, the instrument was not valid when used on CVA patients with hand dysfunction. The following were factors to consider as to the significant difference in results between the Samar Dynamometer and Jamar Dynamometer: (1) The Jamar Dynamometer was heavy and requires more effort to position the hand in full grip compared to the Samar Dynamometer which is lightweight and less effort was needed during the whole assessment, and (2) the Samar Dynamometer make use of a sensitive load cell sensor that can detect minimal force in contrast with Jamar Dynamometer that employs a hydraulic mechanism which cannot detect minimal force.
5. Samar Dynamometer has a high level of usability in the practice of Occupational and Physical Therapists during handgrip strength assessment. Samar Dynamometer uses its own instrument and "android" application and it uses Bluetooth to transfer and received data. The Samar Dynamometer is highly usable due to its features. The following features are: (1) The instrument is accessible due to its size and weight, (2) Frequent calibration is not needed (3) The information such as name, diagnosis, testing hand, age, sex, date, and time can be recorded in the application. (4) The application has a timer that can be seen by the tester

during the assessment. (5) All three trials are recorded using kilograms and pounds, and also it has the automatic computation of average results.
6. Samar Dynamometer has a high level of satisfaction among patients owing to its physical characteristics being lightweight, and comfortable to use and it is supported with android application technology wherein the patient can view immediately the measurement reading after the assessment.

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