ORIGINAL ARTICLE

Reliability of the ELUI Upper Extremity Functionality Test

Valéria Meirelles Carril Elui[1], Daniela Nakandakari Goia[2], Flávia Pessoni Faleiros Macêdo Ricci[3], Marisa de Cássia Registro Fonseca[4]

ABSTRACT

Manual dexterity is a key skill for the performance of everyday activities. Measurements of muscle strength, range of motion, and sensitivity alone may not reflect the functional status in assessing physical and functional conditions. It is also important to use self-applied assessments and specific functional tests to assess overall performance and test aspects such as dexterity, coordination and grasp quality, but these may differ in terms of standardization and psychometric properties. From this need we have developed the Elui Upper Extremity Functionality Test, with the intent to provide a national measuring instrument of the upper extremity and reference to be used in clinical practice, but its psychometric properties have not been yet defined. **Objective:** The aim of this study was to assess the inter-examiner reliability and test retest of the Elui Upper Extremity Functionality Test. **Methods:** Healthy volunteers (50) of both genders, with an average age of 32.62 years and no impairment or symptoms in the upper limbs were submitted to the test by two examiners and after 30 days by one examiner. The application of this test requires simple materials present in our everyday life, divided into 10 sub-items: Simulated writing, Turning a Key, Grasping small objects, Simulated feeding, Pouring water, Opening containers, Cutting with a knife, Simulated dressing, Grasping large and light objects, and Grasping large and heavy objects. Each volunteer evaluated should perform each item test with both hands or with the dominant hand, depending on the sub-item analyzed, and if needed, they adapted the laterality. **Results:** A statistical analysis was carried out to compare the differences in time measurements of each sub-item of the test in seconds. The analysis of the inter-examiner reliability and test-retest used the Interclass Correlation Coefficient (ICC) with a confidence interval of 95% and $p < 0.05$. The local Research Ethics Committee approved this study and all volunteers signed an informed consent form. With the exception of the Grasping small objects task, which had an unacceptable ICC (0.65), the results showed that all the other nine items had excellent inter-examiner reliability: between 0.95 and 0.99 and Cronbach's alpha between 0.97 and 0.99. For the test-retest, the tasks with excellent reliability were Pouring water ICC 0.98 and simulated writing with ICC 0.91, good reliability for the tasks Grasping large and heavy objects ICC 0.85, Cutting with a knife ICC 0.85 and Simulated feeding ICC 0.80; acceptable reliability for the items Turning a key ICC 0.74 and Simulated dressing ICC 0.76; with Cronbach's alpha of all tasks between 0.79 and 0.99. **Conclusion:** The Elui test showed excellent repeatability between examiners as well as with repeated measurements over time by the same examiner in most sub-items, being considered reliable for the studied sample using the third measurement.

Keywords: Hand, Motor Skills, Test Taking Skills

[1] Occupational Therapist, Ph.D., University of São Paulo School of Medicine, Ribeirão Preto.
[2] Occupational Therapist, Hospital das Clínicas, Ribeirão Preto.
[3] Physiotherapist, Master's candidate in the Post-graduation program in Rehabilitation and Functional Performance at the University of São Paulo, School of Medicine, Ribeirão Preto.
[4] Physiotherapist, Ph.D., University of São Paulo, School of Medicine, Ribeirão Preto.

Mailing address:
Universidade de São Paulo - Faculdade de Medicina de Ribeirão Preto
Valéria Meirelles Carril Elui
Avenida Bandeirantes, 3900
Ribeirão Preto - SP
CEP 14049-900
E-mail: velui@fmrp.usp.br

Financial Support:
Hospital das Clínicas, University of São Paulo School of Medicine Foundation of Support to Teaching, Research, and Assistance - FAEPA, Ribeirão Preto.

Received on September 24, 2014.
Accepted on October 23, 2014.

DOI: 10.5935/0104-7795.20140021

INTRODUCTION

The hand has great functional importance due to its discriminating sensory capacity as well as to the complex and delicate movements that it is able to execute through various types of pinching and prehension. Manual dexterity, which is the capacity to handle, position, and use objects, is a fundamental skill in performing daily life activities and occupational tasks.[1]

The injured or traumatized hand frequently generates functional disabilities for an individual.[2] In order to define appropriate proposals for the rehabilitation of these functional changes, a physical-functional evaluation is necessary to help the therapist to identify the disabilities of each dysfunction. This evaluation must be conducted so as to encompass all the aspects referring to function, muscle strength, joint amplitude, sensitivity, coordination, dexterity, and functional capacity.[3-6]

Objective measurements such as muscle strength, range of motion, and sensitivity are extremely important in determining the physical condition of an individual, however, separately they do not reflect the functional reality. In addition, movements of isolated muscles are rare, so when conditions related to the hand are examined, it is necessary to consider the upper extremity as a whole and its integration with the rest of the body.[7] Thus, the importance of specific functional tests that evaluate performance and that can test aspects such as dexterity, coordination, and types of prehension are clearly important.

The functional evaluation can be made through questionnaires or performance tests, to obtain precise data to provide a plan for the rehabilitation of the hand, based on standardized and reliable instruments that measure strength, sensitivity, and the ability to perform daily activities. Functional performance tests can vary in terms of standardization and psychometric properties.[8-10]

Functional tests evaluate a wide spectrum of motor function of the hand and of the upper extremity, including motor ability for gross and fine motor skills, manual dexterity, the performance of daily life activities (DLAs), practical life activities (PLAs), and work activities, and uni- and bi-manual activities, among other things. There are various categories among the standardized performance tests that vary with the objectives of the evaluation, either simulations of work situations or of daily life activities.[9-14]

The so-called work simulators are tests used to obtain quantitative measurements of the individual's skill in performing tasks related to work, such as the Valpar Work Sample® and the Baltimore Therapeutic Equipment Work Simulator (BTEWS)®.[14,15] Some tests evaluate the skill to handle specific tools, such as the Crawford Small Parts Dexterity Test® and the O'Connor Peg Board Test®.[14] To evaluate fine motor coordination there are tests like the Purdue Pegboard Test® that uses small parts such as pins, washers, and collars to be executed.[9] Other tests evaluate activities that demand daily life or work activities such as the Minnesota Rate of Manipulation Test®[14] and the Jebsen Taylor Hand Function Test®.[16]

The Jebsen Taylor Hand Function Test®[16] is a low-cost test that is easy to apply and record data. It consists of seven tasks that evaluate the skill of the subject to write, turn cards, handle small objects, use cutlery, handle small disks, and grasp empty (lightweight) and full (heavyweight) cans. Its norms are categorized according to the maximum time used to perform the tasks, the dominance, age, and gender of the subject. However, this test does not evaluate bilateral integration, the quality of fine prehension, or hand function patterns.[16-18]

In order to be applied in the clinical practice, the evaluation methods must present appropriate coefficients of validity, reliability, and precision, with well-defined standardizations, taking into consideration the various factors that may alter the measurements, such as previous learning that may help in dexterity and agility in the performance of functional tests. Criteria to grade the results must also be presented, in addition to these instruments being calibrated to prevent systemic errors.[5]

As with the self-applied assessment, the performance tests must be adapted to different populations. However, there is a scarcity of standardized Brazilian tests that evaluate the functions of the hand and of the upper extremity, as well as their most common prehensions in daily life, instrumental, work, and leisure activities. Based on that need, the Elui Upper Extremity Functionality Test[19] was developed as a Brazilian instrument to measure performance and as a reference to be used in clinical practice, standardized in its execution and recording of data from the test's items, and facilitating the measurement of motor learning and of agility in the execution of daily activities. From its development its psychometric measurement properties must be defined.

OBJECTIVE

The objective of this study was to analyze the inter-rater reliability and test retest of the Elui Upper Extremity Functionality Test.

METHOD

This study had the participation of 50 healthy volunteers of each gender and in the age bracket between 18 and 80 years of age, who did not show any dysfunction or symptomology in the upper extremities. Two trained examiners collected the data in a tranquil location furnished with a desk and chairs.

In order to apply the test, some simple materials commonly found in daily life are needed, such as: pencils; paper printed with figures; clipboard; one lock with a 1.5mm key; two threaded bottle caps; two 5-cent (Real/BRL) coins; two paper clips No. 18; one empty 500g plastic butter tub; one empty 500g plastic mayonnaise jar with threaded cap; six empty 500g metal cans with plastic tops for powdered food; one 90g tube of toothpaste; one tennis shoe with laces; one shirt with small buttons; one dessert spoon, one plate, one butter knife and play dough; seven dry white beans; one plastic and one metal jar to put water in, and a 50cm-high Styrofoam box with a lid. A wooden board measuring 60cm x 30cm x 3cm was set up with ink markings: a horizontal line all the way across it, at every 10cm a long vertical line, and at every 5cm a 2.5cm vertical line. Ten centimeters above that horizontal line there was a groove 1.5cm deep and 0.4cm thick to seat a wooden strip 60cm x 6.5cm x 0.4cm, forming an upright barrier. The development of this adaptation was necessary to provide parameters to place the items integral to some tasks.

The wooden board was placed at 10cm of the edge of a table where the test was applied. The volunteer needed to be seated, with the abdomen at a distance of 10 to 15cm from the edge of the table and with the hand being tested on the table.

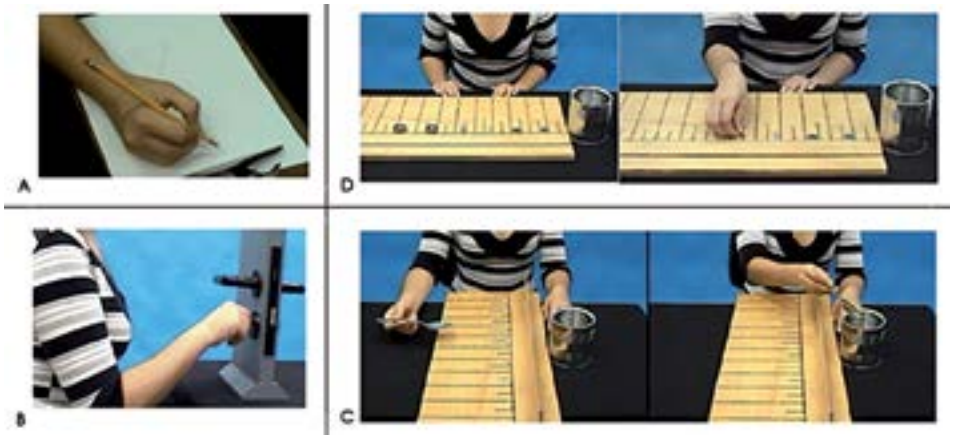
The measuring was made in two ways: by noting the time in seconds to perform each item and by observing the way in which the item was performed. A digital chronometer was used and the total time in seconds for the execution of each item was recorded. Each volunteer performed each item of the test four times as fast and naturally as possible, with intervals of 30 minutes between the two raters (inter-rater reliability) to avoid fatigue.

Five volunteers performed the test after 30 days with a rater (test retest).

The Elui Upper Extremity Functionality Test consists of the following sub-items: Simulated writing, Turning a key, Grasping small objects, Simulated feeding (Figure 1), Pouring water (Figure 2), Opening containers, Cutting with a knife, Simulated dressing (Figure 3), Grasping large light objects, and Grasping large heavy objects (Figure 4). Each individual evaluated should perform each item of the test either with both hands or with the dominant hand, depending on the sub-item analyzed. Before the test, the procedure for each task was explained verbally and demonstrated and any questions were clarified before the beginning. When necessary, the subjects could use glasses. To begin each sub-item test with the dominant hand, with the laterality adapted when needed, the command word "now" was given. An explanatory/demonstrative video to train the examiner of the Elui Upper Extremity Functionality Test was prepared to facilitate the application of the test, and to guarantee a standard of the technique employed in the uni- and bi-manual tasks.

The statistical analysis was made using the R® software, version 2.6.2, to compare the differences between the four measurements of each sub-item of the test in seconds and through the SPSS, version 20®, to analyze of repeatability of the measurements through an inter-rater reliability analysis, the test retest by the Intraclass Correlation Coefficient - ICC), and the internal consistency between items through the calculation of Cronbach's alpha, with a confidence interval of 95%. In order to verify the correlation coefficient, the ICC values classified according to Wahlund et al.[20] were adopted: 1) excellent reliability for ICC values greater than 0.90; 2) good reliability for the ICC values between 0.80 and 0.89; acceptable reliability for the ICC values between 0.70 and 0.79; and unacceptable reliability for ICC values less than 0.70.

The present study was approved by the Research Ethics Committee in of the Hospital das Clínicas, School of Medicine of Ribeirão Preto - USP (process 3725/2006) and all the volunteers signed a Free and Informed Consent form. The ethical principles contained in the Helsinki Declaration (2000) were fulfilled in addition to the pertinent Brazilian legislation.



A- Simulated writing (sheet of paper with geometric shapes drawn); B - Turning a key (wood support with a lock); C - Picking up small objects (Initial position to perform the test and position performing the test, using a paper clip, a bottle, and a 5-cent coin); D - Simulated eating (Initial position and performance of the item)

Figure 1. Sub-items of the Elui Test

Figure 2. Sub-items of the Elui Test - Pouring water (Initial position and the performing phases of the item)

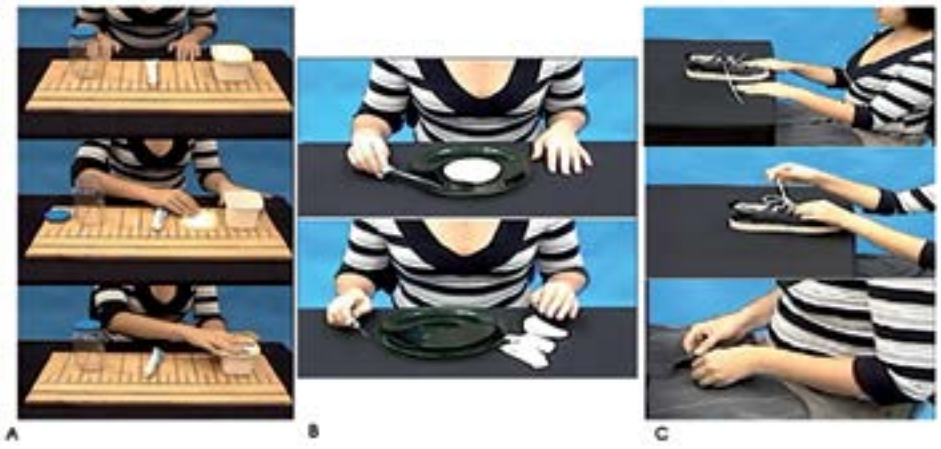


Figure 3. Sub-items of the Elui Test

(Initial performance phase of the items: Picking up large object, either light or heavy, with the initial phase of placing the object into the styrofoam box. Final performance phase of the items. Picking up large object, either light or heavy, and returning the object to the chair.)

Figure 4. Sub-items of the Elui Test - Grasping large and light objects and Grasping large and heavy objects

RESULTS

The sample consisted of healthy individuals with a mean age of 32.62 years (19-71), 36% were males (18), and 64% females (32).

The average times in seconds measured by the 2 examiners in the performance of each item was the shortest for the task Grasping Small Objects, 6.66s for examiner 1 and 6.84s for examiner 2, and the task with the longest time to perform was Turning a Key, which resulted in the average time of 16.30s and 16.26s, respectively (Table 1).

The results observed in the application of the test were similar for measurements 2 and 3 and for measurements 3 and 4, which happened in all the items ($p < 0.05$). This is why the third measurement was used as a reference.

Table 2 shows the values for the inter-examiner Intraclass Coefficient Correlation (ICC), and Cronbach's alpha with Confidence Interval of 95%. Except for the task Grasping Small Objects, with unacceptable ICC of 0.65 (CI 0.28 to 0.85) and Cronbach's alpha of 0.79, all the other nine items showed excellent inter-examiner reliability from 0.95 to 0.99 (CI 0.88 to 0.99) and Cronbach's alpha from 0.97 to 0.99.

For the test retest, the tasks with excellent reliability were Pouring Water, ICC 0.98 (CI 0.75-0.99), Grasping Small Objects ICC 0.93 (CI 0.31-0.99) and Simulated Writing ICC 0.91 (CI 0.18-0.99); good reliability for the tasks Grasping Large and Heavy Objects ICC 0.85 (CI 0.87-0.99), Cutting with a knife ICC 0.85 (CI 0.90-0.99), and Simulated Feeding ICC 0.80 (CI 0.23-0.98); acceptable reliability for the items Turning a Key ICC 0.74 (CI 0.39-0.98) and Simulated Dressing ICC 0.76 (CI 0.33-0.98), and unacceptable for Grasping Large and Light Objects ICC 0.66 (CI 0.51-0.97) and for Opening Containers ICC 0.66 (CI 0.50-0.97); with Cronbach's alpha of all tasks between 0.79 and 0.99 (Table 3).

DISCUSSION

The Elui test showed psychometric characteristics of excellent inter-examiner reliability for most sub-items of the test analyzed, demonstrating high measurement agreement, except for the task Grasping Small Objects. In the test retest, the tasks showed a reliability between excellent and acceptable, showing excellence for a good repeatability of measurements.

The items Turning a Key and Simulated Dressing had acceptable reliability and Grasping Large and Light Objects and Opening Containers had unacceptable reliability.

The Elui test is composed of sub-items that use the dominant side for uni-manual tasks: Simulated Writing; Grasping Small Objects; Simulated Feeding; Pouring Water; Grasping Large Light Objects; Grasping Large Heavy Objects. The other sub-items are bi-manual: Opening/Closing Containers; Simulated Dressing; and Cutting with a Knife. Functional evaluation allows the identification of deficits in the motor functions of the items examined and these items are simulations of the most used movements in the daily life of the Brazilian population.

During the application of the test, greater slowness was detected in performing the items for the first time, thus showing the process of motor learning stemming from the repetitions performed for each item of the test. The volunteers acquired greater agility with the repetitions of the items, and that was an influencing factor in the test's sub-items. In some items like Turning a Key, Pouring Water, Cutting with a Knife, Simulated Dressing, Grasping Large Light/Large Heavy Objects, it was possible to mark up to the second repetition, for there were no significant differences in execution time between the second and third measurements, however, the remaining items such as Simulated Writing, Grasping Small Objects, Simulated Feeding, and Opening Containers only obtained constant markings from the third repetition, which justified its being used as the reference. The prehension components are dependent on the aspects of strength, individual perception, and previous experiences and learnings, as well as recognition of the activity's target-objective. One's reach and prehension are related to the synchronized movements of the muscles of the eye, head, and hands, and have a physiological mechanism that works in parallel. Strength is determined by the individual perception of the object to be apprehended, thus obtaining a previous programming of the movements to be performed.[21]

The Jebsen-Taylor Hand Function Test®[16] is very simple and does not need fine motor coordination of the extremity to be performed. It is composed of seven sub-tests that evaluate various abilities. Its norms are categorized according to the maximum time spent on the tasks and the dominance, age, and gender of the subject. However, this test does not evaluate bi-lateral integration, fine prehension, nor the hand function patterns[5] The psychometric properties of this test were evaluated and described by Poole[22] in a review about performance tests made with rheumatoid arthritis patients. Its inter-examiner reliability was determined by the ICC (which ranged from 0.82 - 1.00) and was calculated by two examiners timing five patients at the same time. In addition, a high correlation was described with other existing performance tests,[22] as well as with the Elui Test sub-items, which also obtained excellent ICC values.

The importance of this study, however, is in the standardization of the way to mark and record the time spent in the execution of the test's items. The Elui Test was created in search

Table 1. Times in seconds for the performance of the 10 tasks from the Elui Test for the two examiners (Minimum, average, and standard deviation)

Task		Measurement/ examiner	Min.	Max.	Average Time in seconds	Standard deviation
1.	Simulated writing	M3E1	4.14	21.93	11.62	4.22
		M3E2	4.82	19.56	10.18	4.67
2.	Turning a key	M3E1	11.92	27.43	16.30	3.91
		M3E2	12.62	24.21	16.26	3.31
3.	Grasping small objects	M3E1	4.42	12.57	6.66	1.58
		M3E2	5.03	12.03	6.84	1.60
4.	Simulated feeding	M3E1	6.97	13.83	10.48	1.75
		M3E2	7.25	12.32	9.81	1.38
5.	Pouring water	M3E1	5.28	11.23	7.00	1.50
		M3E2	5.34	9.24	6.99	1.27
6.	Grasping large and light objects	M3E1	4.65	12.17	7.69	1.24
		M3E2	4.79	10.91	7.78	1.25
7.	Grasping large and heavy objects	M3E1	5.67	13.54	8.44	1.35
		M3E2	5.70	11.53	8.58	1.20
8.	Opening containers	M3E1	6.69	19.27	12.30	2.37
		M3E2	8.61	16.83	12.23	2.17
9.	Cutting with a knife	M3E1	3.81	12.80	7.27	2.49
		M3E2	4.37	13.00	7.26	2.37
10.	Simulated dressing	M3E1	5.22	27.00	13.96	3.31
		M3E2	5.31	23.54	14.11	3.76

M3E1 = measurement 3, examiner 1; M3E2 = measurement 3, examiner 2

Table 2. Inter-examiner Intraclass Coefficient Correlation (ICC) and Cronbach's alpha, (CI 95%)

Task			ICC	IC (95%)	Cronbach Alpha
1.	Simulated writing	M3E1 M3E2	0.99	0.994-0.999	0.99**
2.	Turning a key	M3E1 M3E2	0.99	0.992-0.999	0.99**
3.	Grasping small objects	M3E1 M3E2	0.65	0.280-0.854	0.79**
4.	Simulated feeding	M3E1 M3E2	0.96	0.901-0.986	0.98**
5.	Pouring water	M3E1 M3E2	0.98	0.962-0.995	0.99**
6.	Grasping large and light objects	M3E1 M3E2	0.99	0.981-0.997	0.99**
7.	Grasping large and heavy objects	M3E1 M3E2	0.97	0.928-0.990	0.98**
8.	Opening containers	M3E1 M3E2	0.95	0.880-0.982	0.97**
9.	Cutting with a knife	M3E1 M3E2	0.99	0.996-0.999	0.99**
10.	Simulated dressing	M3E1 M3E2	0.99	0.994-0.999	0.99**

M3E1: measurement 3, examiner 1; M3E2: measurement 3, examiner 2; * $p < 0.05$; ** $p < 0.01$

of a test that evaluated the use of the most common prehensions in daily life, which were easy to apply, financially accessible, and which allowed testing individuals afflicted by various musculoskeletal dysfunctions of the hand and upper extremity. It was developed based on the standardized tests by Jebsen-modified[16] and Carazatto.[23]

The present study was made only with individuals without functional limitations, but with a broad inclusion of adults from 19 to 71 years of age, including three elderly individuals, which can be seen as a factor in the time variation to perform a few sub-items in the test.

Future validation studies for different populations of patients with functional limitations stemming from musculoskeletal and neurofunctional dysfunctions are necessary.

CONCLUSION

The standardization of the scoring style and timing of all the 10 sub-items of the Elui Upper Extremity Functionality Test, considering motor learning, was the use of the third measurement.

The Elui test showed excellent repeatability between examiners as well as in measurements repeated over time by the same examiner in most sub-items, and was considered reliable for the sample studied.

REFERENCES

1. Sartorio F, Bravini E, Vercelli S, Ferriero G, Plebani G, Foti C et al. The Functional Dexterity Test: test-retest reliability analysis and up-to date reference norms. J Hand Ther. 2013;26(1):62-7. DOI: http://dx.doi.org/10.1016/j.jht.2012.08.001
2. Fonseca MCR, Mazzer N, Barbieri CH, Elui, VMC. Traumas da mão: estudo retrospectivo. Rev Bras Ortop. 2006; 41(5):181-6.
3. McPhee SD. Functional Hand Evaluations: A Review. The American Journal of Occupational Therapy. Am J Occup Ther. 1987;41(3):158-63. DOI: http://dx.doi.org/10.5014/ajot.41.3.158
4. Teixeira E, Sauron FN, Santos LSB, Oliveira MC. Terapia ocupacional na reabilitação física. São Paulo: Roca; 2003.
5. Araújo PMP. Avaliação funcional. In: Freitas PP. Reabilitação da mão. São Paulo: Atheneu; 2006. p.35-54.
6. Seftchick JL, Detullio LM, Fedorczyk JM, et al. Clinical examination of the hand. In: Skirven TM, Osterman L, Fedorczyk J, Amadio PC. Rehabilitation of the hand and upper extremity. Philadelphia: Elsevier Mosby; 2011. p 55–71.

Table 3. Test retest Intraclass Coefficient Correlation (ICC) after 30 days and Cronbach's alpha, (CI 95%)

Task		ICC		Cronbach's Alpha
1.	Simulated writing	0.91	0.18-0.99	0.95**
2.	Turning a key	0.74	0.39-0.98	0.85
3.	Grasping small objects	0.93	0.31-0.99	0.96*
4.	Simulated feeding	0.80	0.23-0.98	0.89*
5.	Pouring water	0.98	0.75-0.99	0.99**
6.	Grasping large and light objects	0.66	0.51-0.97	0.79
7.	Grasping large and heavy objects	0.85	0.87-0.99	0.92*
8.	Opening containers	0.66	0.50-0.97	0.80
9.	Cutting with a knife	0.85	0.90-0.99	0.92*
10.	Simulated dressing	0.76	0.33-0.98	0.86*

* $p < 0.05$; ** $p < 0.01$

7. MacDonald EM. Terapia ocupacional em reabilitação. 4 ed. São Paulo: Santos; 1998.
8. Beattie P. Measurement of health outcomes in the clinical setting: applications to physiotherapy. Physiother Theory Pract. 2001;17(3):173-85. DOI: http://dx.doi.org/10.1080/095939801317077632
9. Fess EE. Functional tests. In: Skirven TM, Osterman LA, Fedorczyk JM, Amadio PC. Rehabilitation of the hand and upper extremity. Philadelphia: Elsevier Mosby; 2011. p. 152-62.
10. Macdermid JC. Outcomes measurement in upper extremity practice. In: Skirven TM, Osterman LA, Fedorczyk JM, Amadio PC. Rehabilitation of the hand and upper extremity. Philadelphia: Elsevier Mosby; 2011. p. 194-205.
11. Elui VMC, Fonseca MCR. Destreza. In: Recomendações para avaliação do membro superior. 2 ed. São Paulo: Sociedade Brasileira de Terapeutas da Mão e Membro Superior; 2005. p. 98-110.
12. Rallon CR, Chen CC. Relationship between performance-based and self-reported assessment of hand function. Am J Occup Ther. 2008;62(5):574-9. DOI: http://dx.doi.org/10.5014/ajot.62.5.574
13. Yancosek KE, Howell D.A narrative review of dexterity assessments. J Hand Ther. 2009;22(3):258-69. DOI: http://dx.doi.org/10.1016/j.jht.2008.11.004
14. Skirven TM, Osterman AL. Clinical examination of the wrist. In: Skirven TM, Osterman LA, Fedorczyk JM, Amadio PC. Rehabilitation of the hand and upper extremity. Philadelphia: Elsevier Mosby; 2011. p. 72-84.
15. Coleman EF, Renfro RR, Cetinok EM, Fess EE, Shaar CJ, Dunipace KR. Reliability of the manual dynamic mode of the Baltimore Therapeutic Equipment Work Simulator. J Hand Ther. 1996;9(3):223-37. DOI: http://dx.doi.org/10.1016/S0894-1130(96)80086-X
16. Jebsen RH, Taylor N, Trieschmann RB, Trotter MJ, Howard LA. An objective and standardized test of hand function. Arch Phys Med Rehabil. 1969;50(6):311-9.
17. Rayan GM, Brentlinger A, Purnell D, Garcia-Moral CA. Functional assessment of bilateral wrist arthrodeses. J Hand Surg Am. 1987;12(6):1020-4. DOI: http://dx.doi.org/10.1016/S0363-5023(87)80102-8
18. Weiss AC, Wiedeman G Jr, Quenzer D, Hanington KR, Hastings H 2nd, Strickland JW. Upper extremity function after wrist arthrodesis. J Hand Surg Am. 1995;20(5):813-7. DOI: http://dx.doi.org/10.1016/S0363-5023(05)80437-X
19. Elui VMC. Comparação da função de duas órteses na reabilitação da mão em garra móvel de hansenianos [Tese]. Ribeirão Preto: Universidade de São Paulo; 2001.
20. Wahlund K, List T, Dworkin SF. Temporomandibular disorders in children and adolescentes: reability of a questionary, clinical examination, and diagnosis. J Orofacial Pain. 1998; 12(1):42-51.
21. Shumway-Cook A, Woollacott MH. Controle motor: teoria e aplicações práticas. 2 ed. Barueri: Manole; 2002.
22. Poole JL. Measures of hand function: Arthritis Hand Function Test (AHFT), Australian Canadian Osteoarthritis Hand Index (AUSCAN), Cochin Hand Function Scale, Functional Index for Hand Osteoarthritis (FIHOA), Grip Ability Test (GAT), Jebsen Hand Function Test (JHFT), and Michigan Hand Outcomes Questionnaire (MHQ). Arthritis Care Res (Hoboken). 2011;63 Suppl 11:S189-99. DOI: http://dx.doi.org/10.1002/acr.20631
23. Carazzato JG. Teste de função motora da mão pesquisa em 200 pessoas normais [Dissertação]. São Paulo: Universidade de São Paulo; 1978.