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To establish normative data using the Jebsen Taylor hand function test (JHFT) for normal, ethnically diverse South Africans aged between 20 and 59 years

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CHAPTER 2
REVIEW OF THE LITERATURE

The review of the literature will consider the importance of standardised tests in measuring occupational therapy outcomes, the JHFT, and an evaluation of its clinical value using the instrument evaluation framework of Rudman and Hannah[6]. The use of the JHFT in research and factors affecting hand function which may have an effect on the norms established for a standardised hand function test, will also be included.

2.1 IMPORTANCE OF STANDARDISED TESTS OF HAND FUNCTION

The importance of using standardised measurement techniques has been well documented in various publications [1, 3, and 5]. The use of standardised assessments promotes the objective recording of base line data and further readings to indicate progress made by the patient in therapy. The use of standardised tests is essential for accurate objective reports and quality control [6].

Standardised assessments that are norm referenced allow a comparison between the patient and the wider, normal population. The repeated use of a standardised measure enables change in a patient's performance to be measured, thus the effectiveness of an intervention can be evaluated. Information obtained can also be valuable in providing feedback in a consistent and objective manner to the clinician regarding whether the treatment needs to be adapted to promote positive results [30]. Another important aspect to consider in using a standardised assessment in clinical practice is the ease with which the assessment can be administered and interpreted. Manuals often include instructions for administration, which enables effective and efficient use of the assessments by both less experienced as well as the more experienced clinician.

Teamwork can be enhanced as standardised assessments can assist in the development of treatment protocols, if common impairments are associated with a

specific type of diagnosis. Patients can be stratified into appropriate treatment groups based on the level of impairment, and appropriate intervention can be provided [6].

In research, standardised assessments are essential in providing a basis for consistent and accurate compilation of data in the data collection process. Accuracy of findings and documentation is critical to the analysis and conclusions drawn [30].

Some disadvantages however are that standardised assessments do not consider contextual and individual differences like language, pre-morbid differences and cultural relevance. In addition, repeated use may suggest improvement but this could be due to knowledge of the assessment and practice effect, as opposed to true improvement in performance [30].

In any physical rehabilitation setting, a hand function outcome evaluation is an important part of the assessment process [10]. Kimmerle et al [31] believe that there are a number of reasons for including this outcome measure. These include the severity of the dysfunction, establishing a baseline of measurement, screening for return to work or comparing right and left hand function. They state that functional assessment is critical, irrespective of the context and reason for assessment.

A number of authors have identified and reviewed the criteria which should be included in a standardised test of hand function, including the measurement properties [8] and the psychometric criteria[9]. Other important attributes are the inclusion of ADL activities, evaluation of the patient's status and progress, the subtests types, quality of the standardisation, speed and reliability of administration and ease of fabrication [10].

The JHFT, although developed and standardised in 1969[1], meets these criteria to varying degrees. The JHFT was developed for use by health care professionals working with patients with hand dysfunction. It is used in both clinical practice and research internationally [16, 22, 32, and 33].

The test looks at a variety of hand functions commonly used in ADL and includes a range of weighted, non-weighted and fine hand function activities. The non- dominant hand is tested first, then the dominant hand, providing a timed score for each hand [(34)].

The JHFT comprises seven timed items viz.:

1. Writing by copying a 24-letter sentence of 3rd grade reading difficulty. Patients are asked not to use printed writing and are asked to write with the non-dominant hand and then the dominant hand. There is a choice of four sentences for the writing subtest so that a different sentence can be used in a re-test situation with the same patient.
2. Turning over three by five inch cards (simulating page turning) No accuracy of placement after turning is necessary as the cards are turned.
3. Picking up small common objects such as a paper clip, bottle cap and coin that are placed in an empty coffee can.
4. Simulated feeding using a teaspoon and five kidney beans that are placed on a board five centimetres apart and placed in an empty coffee can with the teaspoon.
5. Stacking draughts (checkers) requires the placement of four standard sized wooden draughts on top of each other on the board described in the specifications.
6. Picking up large, light objects. Five empty baked beans cans spaced five centimetres apart with the open end facing down are moved one by one to the board.
7. Picking up large, heavy objects. Five full baked beans cans spaced five centimetres apart are moved one by one to the board [(1)].

The test takes 15 to 20 minutes to administer and therefore can be used efficiently in clinical practice as well as research. No specific training is required and specific instructions for use have been published in the original paper produced by Jebsen et

al [1] in 1969. It is an objective; norm referenced measure and can be used with all patients over the age of 20 with a range of diagnoses.

2.2 EVALUATION OF THE JEBSEN-TAYLOR HAND FUNCTION TEST

Rudman and Hannah [6] described an instrument evaluation framework outlining the process for selecting measurement instruments. This framework was considered the most useful method in evaluating the JHFT for the purposes of this study as it includes most of the criteria described in the first paragraph on p 2.
The framework includes five categories viz.

- clinical utility,
- standardisation,
- purpose,
- psychometric properties and
- The client's perspective.

2.2.1 CLINICAL UTILITY

Clinical utility refers to the ease with which an assessment can be used in clinical practice. According to Rudman and Hannah [6], clinical utility, centres around the factors of applicability, specificity, availability, time demands and acceptability to clients.

2.2.1.1 Clinical Applicability

The JHFT was developed to provide a comparison of hand function to norm references. Although it was not originally designed to measure change in hand function of the individual over a period of time, it is often used for this purpose [6].

The JHFT assesses a broad range of hand functions that are essential for activities of daily living (ADL). It includes seven unilateral subtests that involve the use and manipulation of tools (Appendix A). Performance on subtests is timed so the results

can be accurately reported in a standard way and scores can be compared to norms or to the patients' previous performance.

2.2.1.2 Specificity

The JHFT is considered to be suitably specific in that it was not designed to be used with one patient group (specificity of an instrument refers to the population used when testing, developing and applying the instrument) [6].

The JHFT has been used with clients with various diagnoses like rheumatoid arthritis[26,35], traumatic hand injuries[28,29], head injuries[36], and stroke[12,13,25]. Rudman and Hannah [6] reported in 1998, that the JHFT was one of the hand tests most cited in allied health professionals' literature.

Another condition with which the JHFT has been used in research is Duchene Muscular Dystrophy. In a research study conducted using 23 subjects, the JHFT was found to be a more sensitive assessment of changes in hand function over time than the Brooke Scale for this population [37]. The JHFT has proved useful in the assessment of the hand in stroke patients[25,38,39] as well as in burn injury[40]and with children[41,42] including those with cerebral palsy[14,43].The test has been used with older adults as well[44].

2.2.1.3 Availability

For a test to be used in clinical practice, it has to be readily available for use. Both clinicians and researchers can purchase commercial versions of the JHFT easily through companies that supply such products. It is available online. Prices for the test in 2007 were approximately £250.00 the United Kingdom [45] and $ 290.00 in the USA [46] from up to seven different suppliers.

The original article by Jebsen et al [1] also describes construction specifications**.** Clinicians are therefore able to construct the test themselves if required. This may represent a more cost effective alternative, as this is often a necessary consideration.

The wooden draughts needed for the self-constructed tests are also available commercially at approximately $12.00 from the companies that supply the test [46]. These are a requirement for self-constructed tests, as Rider and Linden showed that plastic draughts affect the reliability of the test [47].

2.2.1.4 Time Demands

The JHFT is a very simple test that is easy to administer. The test can be completed within 15 to 20 minutes. It may take longer for some patients who have specific problems like longer information processing time and significant upper limb impairment. The simplicity of use as well as the relatively short administration time ensures that the tool is appropriate for use in clinical practice and in research [1].

2.2.1.5 Acceptability to clients

To promote client participation and motivation, it is important for patients to accept the test being used and to be able to understand the relevance of performing the test. In terms of acceptability to patients, the test is available in English only, which can be problematic in the ethnically diverse context in which South African therapists work. It has also been argued that certain cultures may not be familiar with the spoon used during the feeding assessment [6]. Lack of familiarity with the test material may affect performance on the subtest. The standardised version of the JHFT requires an individual to be able to read an entire sentence in English [1]. The use of the non dominant hand in skilled activities like writing and feeding also means that tasks will be unfamiliar and may not be of interest or relevance to the patient group are being assessed[7].

2.2.2 STANDARDISATION OF THE JEBSEN-TAYLOR HAND FUNCTION TEST

Fess [48] states that a standardised test must come with instructions for administration, scoring, interpretation and criteria for equipment setup. In terms of standardisation, a manual is available with the JHFT. This outlines all the procedures and interpretation and documents criteria for the equipment and how it should be set up [1]. The protocol for the administration of the JHFT and scoring is standardised. Decreased hand

function is associated with the increased length of time required to complete the subtest. Rudman and Hannah[6] indicated that the prefabricated nature of the test further promotes standardisation of equipment used in the test, but that the equipment setup instructions for the JHFT are not as precise as other tests. The test must be administered following the standardised instructions.

The test was originally standardised on 300 subjects aged between 20 and 94 years of age. There were 30 males and 30 females in age groups 20-29, 30-39, 40 – 49, 50 – 59 and 60 – 94 years. Subjects were excluded only if they had clinical abnormalities of their upper limbs. The test was checked for test-retest reliability on 26 patients with various disabilities, including discriminative ability on 12 patients with hemiplegia [1].

2.2.3 PURPOSE OF THE TEST

Poole describes the purpose of the JHFT as the assessment of

> *'broad aspects of hand function commonly used in activities of daily living using standardized(sic) tasks*."[16] (pS62)

Jebsen et al [1] who developed the test state that this is a

> "test of hand function that will:
>
> (1). Provide *objective* measurements of *standardised* tasks with *norms* against which patient performance can be compared,
>
> (2). Assess broad aspects of hand function *commonly used* in activities of daily living.
>
> (3). Be able to document a continuum of ability within each category of hand function tested.
>
> (4). Be easily administered in a short period of time
>
> (5). Utilise test materials and equipment that are easily available" [1]. (p 311)

Jebsen et al [1] emphasise that the test was not designed to measure all aspects of hand function but should "*be thought of as providing a standardized(sic) and objective evaluation of several major aspects of hand function*" [1] (p 318).

The purpose of the JHFT is further described by van Tuijl et al [49] as an assessment to objectively assess the improvement in hand function gained in treatment. They reviewed the test specifically for use with spinal cord injured patients.

2.2.4 PSYCHOMETRIC PROPERTIES

Psychometric properties of a test include item construction, reliability, validity and norms. These aspects have been investigated for the JHFT by a number of researchers and are described below.

2.2.4.1 Item Construction

According to Rudman and Hannah [6], a descriptive hand function assessment should include a broad range of items to differentiate between persons with and without hand injuries. Jebsen et al[1] specifically chose subtests that are suitable for a descriptive hand function test and provide a broad sample of hand function. This met the criteria of co-ordination, dexterity and various types of prehension that were identified as important by Desrosiers et al [11] as essential in upper extremity tests. The test does not, however, address the full range of movement of the joints of the entire upper extremity.

2.2.4.2 Reliability

Strong test retest reliability has been shown by Jebsen et al [1] and Stern [50] and has been confirmed more recently by Hill et al [51]. Along with Rudman and Hannah, they also support the inter-rater reliability of the test [6, 51]. Hackel et al [5] provide further evidence of interrater as well as intrarater reliability. Stern also demonstrated strong test stability across three sessions except for the subtests of writing and simulated feeding in normal subjects. She suggested that the time differences found might be due to practice in using a tool [50]. Van Tuijl et al [49] concurred and reported that non-dominant hand feeding had the lowest test retest reliability.

2.2.4.3 Validity

According to Hill et al[51] and Rudman and Hannah[6] preliminary studies showed initial support for construct validity of the JHFT. This is because scores correlated

positively with the patients' ability to do ADL and their actual physical status. The ability of the test in distinguishing between different groups of patients further adds to the validity. However, Linch and Bridle [52] have indicated that the lack of bilateral tasks limit the validity of the test, in relation to the ability to do ADL.

Mathiowetz [7] questioned the JHFT's content validity. He argued that the subtests do not necessarily represent everyday tasks like page turning and eating, especially writing with the non-dominant hand and stacking draughts. Jebsen et al [1] themselves indicate that stacking draughts is not a very functional subtest but they included it to provide another fine coordination measure.

Criterion validity of the test was not addressed by the developers [6]. The JHFT has been used to evaluate the criterion validity of other tests developed since then, like the Musculoskeletal Function Assessment Instrument [53] and the Hong Kong Edition of the Patient-rated Wrist Evaluation Questionnaire (Chinese Version) [22].

Convergent validity with other tests has been researched. The JHFT has been shown to correlate well with other tests of activities of daily living like the Paediatric Evaluation of Disability Inventory (PEDI) ($p<0.05$), Wee Functional Independence Measure for Children (WeeFIM) ($p<0.05$) and Physical Ability Test ($p<0.05$). It is thus useful in the assessment of ADL in cerebral palsy children [54].

2.2.4.4 Norms

The original norms for the JHFT were published in 1969[1] but according to Hackel et al [5], these should not be used clinically because of errors made in the grouping of data. They conducted a study that showed hand function, as measured by the JHFT, declined with age in subjects over the age of 60 years. The study looked at 121 subjects and results indicate that when used with the elderly, measurements on the JHFT should be compared to normative values obtained from similarly aged subjects. The Hackel et al [5] study grouped individuals into the following age categories: 60-

69 years, 70-79 years, 80-89 years, and revised norms are now available based on their work for persons 60 years and older.
Max [55] in his study in 1994 sought to establish normative values for the JHFT on an ethnically diverse older population aged 65-98 year old, and the relationship between performance on the JHFT and ADL status. The author found that older adults tended to perform more slowly on some of the subtests, and that 60 year olds tended to be slower than 70 year olds. The author suggested that this discrepancy could be because of variables such as ADL status, educational level and ethnicity. There was no significant difference in terms of gender in this population.

Normative values for the JHFT using a random sample of 120 adults from 20-59 years old were established by Gosciak [23]. The new norms were compared with the original norms and the author looked for differences between genders. Results indicate that there are statistical differences between the original and new norms as well as between genders when using the dominant hand. The scores of healthy 70-79 year old people were compared with established norms in a study by Miller [44] . This author also confirmed significant differences between the old and new norms for all but a few specific subtests.

2.2.5 THE PATIENT'S PERSPECTIVE

The patient's perspective is an important area for consideration as there may be a discrepancy between what the patient thinks they are able to do and what they can actually do. In order to facilitate a successful partnership between therapist and patient, the therapist needs to assess what other factors may affect the patient's performance e.g. self perception of injury and expectation from therapist
The JHFT, however, does not address the patient's perspective [6] . Though addressing this area is important to ensure the needs of the patient are accounted for in a client centred manner, many standardised assessments are not able meet all of the recommended individual criteria. Shortcomings can often be overcome by using more than one assessment tool to complement assessment findings.

2.3 LIMITATIONS OF THE JEBSEN-TAYLOR HAND FUNCTION TEST

Limitations of the JHFT, other than those indicated above in the availability, reliability and validity review are listed by Jarus and Poremba [10]. One other limitation is a lack of analysis of the quality of the movement and the static prehension used. Desrosiers et al [11] concur and point out that although speed in execution of a task is an effective indicator of upper extremity ability, it provides no data on the difficulty experienced or the method used. Thus, a speed test like the JHFT must be backed up by other types of measurements and observations.

A criticism of the use of the JHFT in research is that some studies reported the use of a limited number of subtests and not the entire test to assess specific aspects of hand function. Since each subtest has its own time norms it is possible to compare the results of these subtests with other outcome measures, but this may affect the overall validity and reliability of the test.

A case in point is the modified version of the JHFT called the Modified Jebsen Test of Hand Function (MJT), which was developed to be used with stroke patients. The MJT has however been proved reliable and valid by Bovend'Eerdtet al [33]. The MJT used only three of the original subtests (turning over three inch by five inch cards, picking up large light objects and simulated feeding) to assess gross functional dexterity. Since the MJT was used with the hand affected by the stroke, the fine dexterity tests were not applicable.

2.4 VALUE OF THE TEST AS AN OUTCOME MEASURE IN RESEARCH

The JHFT is an important tool when it comes to research, as it has the ability to discriminate between the hand function in the normal population and those with various diagnoses, including patients with Rheumatoid Arthritis [26, 27]. Sharma et al [56] compared JHFT scores to the norms for age, ability to perform activities of daily living, pain and levels of deformity. These authors were able to detect differences between the patients and controls on all subtests excluding writing. Results also showed a correlation with performance on activities of daily living and the patient's deformity.

There was no significant correlation with the level of pain. Kim et al [57] working in Korea found similar results except that the scores correlated well with both pain and joint deformity.

Another condition, with which the JHFT has been used in research, is stroke. It has also been useful in determining hand function. Patients with stroke demonstrated significantly slower performance on the JHFT with both the affected and unaffected hand. Performance with the unaffected hand was significantly different between patients with left and right hemiplegia only on the writing subtest that could not be explained by hand dominance or hemispheric specialisation [58].

The JHFT continues to be used in research and has been used recently to establish the outcome of surgical procedures in the hands of patients with rheumatoid arthritis as well as with patients with incomplete cervical spinal cord lesions [59]. It has also proved useful in establishing the improvement in hand function of patients with cerebral palsy [43, 60] and those being treated for osteoarthritis [26, 61-63]. The effect of home programmes on stroke patients[27,64], non invasive brain stimulation[13] and telerehabilitation, where constraint therapy is provided by a remote control computer and teleconferencing equipment[38], have all been assessed using the JHFT.

The JHFT has also has been used as an outcome measure in studies on finger tracking combined with electrical stimulation in stroke[12,13,25]and burn injury[40].

Outcomes of hand function, when considering the ability to carry out everyday tasks by people with no disability, is of interest to occupational therapists. In the elderly, the JHFT was found to be useful in assessing the ability to care for dentures. Subjects with poor hand function according to the JHFT also had significantly more denture plaque after adjustment for age, cognitive status and gender [65].

The test has also been use to evaluate the outcomes of procedures used in hand therapy like the immobilisation of the wrist in splinting and the wearing of prescribed

pressure garments. Carlson and Trombly [66] using 18 normal subjects established the effect of wrist immobilisation. The increased time to complete all subtests was noted when the wrist was immobilised.

The impact of custom made pressure gloves and the commercially available New York Presbyterian glove (NYPDG) was completed by O'Brien et al [40] where patients wore the gloves over 7 to 10 days as they completed activities of daily living. The JHFT was one of the assessment tools used in this study that showed that the NYPDG allowed faster movement and correlated positively with the patient's preference.

A comparison of a scaphoid and colles cast to immobilise fractures using the JHFT found that both slowed hand function, with the patients in a scaphoid cast taking significantly longer to complete the test [28].

The JHFT has been used in the correlation of hand function with other internal performance components like sensation, when predicting hand function recovery. To compare light touch sensation tested by Semmes Weinstein monofilaments (SWM) with hand function, 27 participants with leprosy and 31 controls were assessed with the JHFT and the Functional Dexterity Test (FDT). Correlations between the sensory thresholds and the JHFT scores were significant, especially for tasks entailing manipulation of small objects. The SWM test must however be supplemented with other hand function tests as a predictor of hand function [67]. The JHFT has also been used to demonstrate the effect of posture on hand function [14].

More recently with the introduction of the ICF [4] there has been a shift in the focus from the biomechanical and internal performance component assessments to functional outcome measures like the JHFT. These are being used more frequently to evaluate the effects of surgery and treatment in rheumatoid arthritis [68] and osteoarthritis [63]. Although studies, evaluating the outcome of carpal tunnel syndrome, used measures reflecting body functions like pain, the importance of

aspects like self care and fine hand use, have been recognised[69]. Thus, norm-referenced tests like the JHFT remain useful as outcome measures in research that consider hand function.

2.5 FACTORS AFFECTING HAND FUNCTION

Various factors like age, gender, dominance and culture, in people without disability, can also affect dexterity in the performance of functional tasks. Jebsen et al [1] however only considered the factors of age and gender when standardising their test.

2.5.1 Genetic factors

Andersen-Ranberg et al [70] suggested that hand grip strength may be affected by both genetic and biologically determined factors. They found grip strength in people 50 years and over, were lower in the southern European countries than in people in northern European and continental European countries. In the Malaysian population grip strength can be as much as five times less than in western populations [71]. According to Annet [72], the presence of the right-shift gene causing right-handedness is present in up to 88% of the world's population, which results in genetically determined rates of right- and left-handedness. There is a universal prevalence of between 4%-12% for left hand dominance.

2.5.2 Dominance

The "strength" of the dominance of a persons hand also needs to be considered [72]. There is a difference between people who show strong ability to do dexterous activities much better with one hand than the other and those who have a "weak" dominance and can do activities almost equally as well with both hands. Many studies define right- and left-handers according to the observation of only one manual activity item that has led to inaccuracies. Dominance and preferred hand for activity may not be the same. Forced use of the non-dominant hand may result in the preferred hand being the genetically determined non-dominant hand [73].

2.5.3 Culture and hand preference

A number of cultural differences in the use of the dominant and non-dominant hand in activities of daily living like the ones used in the JHFT also exist in the ethnic groups around the world, as well as in South Africa. Cultures around the world have different expectations about hand use for tasks such as eating and writing.
Bril et al [74] have shown that eating with the right hand alone from an early age without the use of cutlery leads to a strong hand preference. They emphasise the possible influence of learning on hand preference. The possible transfer of this early hand preference to other activities is not clear.

When eating many cultural communities enforce a strict use of the right hand only and prevent the use of the left hand, because the left hand is generally used for ablution [74]. De Agostini et al [73] demonstrated discrepancies in left hand use, particularly among young adults in the Ivory Coast. These findings are in agreement with the traditional Malawian philosophy, that the left hand should not be used for eating, and that left-handers should be forced to change hand preference [75]. Eating with the left hand, the use of the left hand for greeting, writing with the left hand and holding a knife or a spoon with the left hand are all considered undesirable [73]. The trend toward a low prevalence of non-right-handedness has also been shown in Asian populations [76] where, especially amongst Muslims, one is not allowed to use the left hand to eat in public. This stresses the importance of cultural differences between the populations with regard to hand preference for various tasks.

2.5.4 Gender and Age

The effects of both gender and age on hand function using a test battery consisting of six tests for both hands and feet by Kuaranen and Vanharanta [77] showed that speed of movement in each age group was faster for men than women. There were also significant gender differences when completing the Finger Tapping Test. In this test woman were substantially slower than men. In a Grooved Pegboard Test, however, women were substantially faster than men were. This supports the need to take care

when applying normative data during assessments, if gender differences in hand function is not taken into account [78].

It is important therefore not only to establish norms on standardised tests like the JHFT for populations in different counties and contexts, but also to understand the factors that may affect the results found on the test.

Age, culture, gender, hand dominance and hand preference are key factors identified in the literature that may influence performance on hand function tests. Issues around gender and culture will be further explored as part of this study. Occupation was not considered in this study as no research directly linking occupation and hand function in the normal hand was found, only that reflecting hand and grip strength in various occupations [79].