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# Jebsen Taylor Hand Function test: Gender, dominance, and age differences in healthy Egyptian population

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**Background**
The Jebsen–Taylor Hand Function Test (JTHFT) was established to provide a standardized and objective evaluation of fine and gross motor hand function using simulated activities of daily living.
**Aim**
The aims of this study were to establish normative data for hand function using JTHFT and to investigate the effect of age, sex and dominance differences on hand function in healthy Egyptian individuals.
**Participants and methods**
One shot cross-sectional descriptive design was used. One hundred and fifty normal Egyptians were equally stratified into three age groups: 20–29, 30–39, and 40–50. JTHFT subtests were introduced to all participants, which included writing, turning over 3 by 5-inch cards, picking up small common objects, simulated feeding, stacking checkers, picking up large objects, and picking up a large heavy object. Speed on completing each JTHFT subtest was calculated in seconds, and the total score was computed.
**Results**
Statistically significant differences were found between sex, age and dominance ($P<0.0001$).
**Conclusion**
This study presents normative data of JTHFT among middle-aged Egyptians. Our results provide evidence that handedness and age may affect hand function, especially high-level fine dexterity activities. Moreover, no significant relationship was found between sex and hand function in individuals who were 20–50 years of age in the Egyptian population.

**Keywords:**
dominance, sex, Jebsen–Taylor Hand Function Test, population

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## Introduction

The hand represents an excellent model in complex motor control that contributes to 90% of upper limb function. This complex structure is used both to grasp objects of all shapes and sizes through the coupled action of all digits as well as to perform the skilled, individuated finger movements, such as handwriting and painting [1]. The evaluation of the hand function is a crucial element of physical rehabilitation, in order to define the limitations and functional capacities, in an attempt to construct a proper treatment plan and to test its effectiveness [2]. While hand functional abilities depend on anatomical integrity, muscle strength, sensation, and dexterity [3], these abilities can be influenced by age, sex, and handedness [4]. In clinical literature, there are multiple tests for the evaluation of hand function [5–7]. In spite of their specificity in particular patient populations, the assessments of activities of daily living (ADL), such as fundamental self-care, remain too general and focus on the global functions rather than the specific hand function. Moreover, standard performance, such as normative data for comparison of limited hand function, is absent [2]. The hand function test of interest, Jebsen–Taylor Hand Function Test (JTHFT), was chosen, as it provides objective measurements of standardized tasks relative to norms [3]. In addition, it evaluates common aspects of hand functions commonly used in ADL. Moreover, it can be used in many local clinical settings and can be administered in a short time by using readily available materials [8].

The JTHFT consists of seven subtests: writing, simulated page turning, lifting small objects, simulated feeding, stacking, and lifting large, lightweight, and heavy objects. To evaluate hand function, each subset is timed and can be compared with the established norms [3]. The JTHFT has been widely used in the clinical and research setting as well as

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in different patient populations such as those with spinal cord injury, stroke, cerebral palsy, multiple sclerosis, hand and wrist fractures, osteoarthritis, and rheumatoid arthritis [9–16].

Results from numerous studies showed that the JTHFT is a valid assessment tool for the measurement of hand dysfunction from a variety of patient populations [11,13,17,18]. Test–retest reliability was established from the original JTHFT, wherein results were found to be fairly to moderately consistent over time. In addition, no significant learning effect was found between the two sessions [3]. This was also verified by Stern [19] with 20 normal participants. Several studies also demonstrated that the JHFT had moderate to high test–retest reliability and excellent intrarater reliability ($r$=0.84 and 0.85, $P$<0.05) with absent practice effect ($P$<0.05) [20–24].

Various factors such as age, sex, dominance and culture, in people without disability, can affect hand performance in functional tasks. However, Jebsen *et al.* [3] only considered age and sex when standardizing their test on the American community. Hackel *et al.* [20] found that hand function, as measured by the JTHFT, declined with age in participants over the age of 60 years. Jeune *et al.* [25] suggested that hand grip strength may be affected by both genetic and biologically determined factors. They found lower grip strength in individuals above 50 years in the southern European countries than in people in northern European and continental European countries. A number of cultural differences in the use of the dominant and nondominant hand in ADL, such as the ones used in the JTHFT also exist in the ethnic groups around the world, as well as in Egypt. De Agostini *et al.* [26] demonstrated discrepancies in left-hand use, particularly among young adults in the Ivory Coast. The trend toward a lower prevalence of non-right-handedness has also been shown in Asian populations [27]. Different world races and cultures established norms using JTHFT including Chinese [21], Portuguese [28], Australian [29], Asian [26], Italian [2], and Indian [30]. Hence, the purpose of this study was to establish normative data for hand function using JTHFT and to investigate the effect of age, sex and dominance differences on hand function in healthy Egyptian individuals.

## Participants and methods

### Study design and participants

One shot cross-sectional descriptive design was used in this study. One hundred and fifty healthy individuals (age: 20–50 years) were recruited by convenience sampling to undergo the JTHFT, from February 2017 to December 2017. Participants were visitors to the in-patient and out-patient departments of Kaser El-Einy hospital, and outpatient department of School of Physical Therapy Cairo University. Inclusion criteria included the following: (a) normal upper extremity function (assessed through Barthel ADL scale); (b) full range of movement of shoulder, elbow, wrist and finger joints (assessed through goniometer); (c) adequate muscular strength in the upper extremity (grade 5 manual muscle testing); (d) intact sensation (assessed through sensation tests; temperature, pain, touch, vibration and pressure); (e) intact co-ordination (by finger to nose test); (f) minimal level of primary education with a good to perfect command of English in terms of speaking, reading, listening and writing the English language (assessed through personal communication, ability to speak, and reading and writing a grade 3 comprehension). Participants were excluded if they had the following: (a) history of upper extremity injury or deformity with motor or sensory impairment; (b) neurological disorders affecting the hand (e.g. stroke, parkinsonism and neurodegenerative disorders); (c) acute illness or hospitalization within the past month; (d) a Barthel Index score of less than 90; and (e) poor command of the English language. Thereafter, the participants were stratified into three equal age groups: 20–29 (25 men and 25 women), 30–39 (25 men and 25 women), 40–50 (25 men and 25 women) with 50 participants in each group.

The Board Council of Higher Education of the School of Physical Therapy, the Institutional Review Board of Higher Education and Research of Cairo University, and the Supreme Council of Universities at Egypt reviewed and approved this study. The study is prospectively registered with the Pan African Clinical Trial Registry (PACTR201802003028136). All participants gave written informed consent before data collection began.

### Instrumentation

The JTHFT includes a series of seven subtests: (a) printing a 24-letter, third-grade reading difficulty sentence; (b) turning over 7.6×12.7 cm (3×5-inch) cards (simulated page turning); (c) picking up small, common objects (e.g. pennies, paper clips, bottle caps) and placing them in a container; (d) stacking checkers (test of eye-hand co-ordination); (e) simulated feeding; (f) moving large empty cans; and (g) moving large weighted [0.45 kg (1 lb)] cans. The subtests are scored by recording the number of seconds required to complete each test.

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### Procedure

The test was directed by one physical therapist (5 years of experience) who was trained in the administration of the JTHFT. A stopwatch was used to time the completion of each test. Basic demographic information and a brief medical history were recorded from each of the participants. With the participants in a seated position in front of an adjustable table, the test was administered according to the standardized procedures of the JTHFT [3].

The test consists of seven successive subtests, representing fine motor, nonweighted and weighted hand function in ADL, including writing, turning over 3-by-5-inch cards (simulated page turning), picking up small common objects, simulated feeding, stacking checkers, picking up empty large cans, and picking up weighted large cans. The subtests were presented in the same sequence, starting with the nondominant hand and followed by the dominant hand. Verbal standardized instructions were given in all subtests, followed by specific questions to ensure test familiarity. Measurement outcome included duration of time (in s) required to complete each subtest; the maximum time allocated per subtest was 120 s. The total duration was then computed for all the seven subtests to yield the total score. Lower scores indicated greater levels of hand function.

### Sample size

The sample size calculations were performed using the G*Power software (version 3.0.10) (Department of Psychology, Heinrich Heine University, Düsseldorf, Germany). *F*-test model analysis of variance (MANOVA) with global effects was selected. It was calculated from a pilot study with 15 participants in the three age groups, with five in each age group. Partial $\eta^2$ effect size of the overall dependent variable was calculated [$f^2(V)=8$]. Considering a power of 0.95, an $\alpha$ level of 0.05, three groups and response variables of 3, and a generated sample size of at least 48 participants per group would be required. Allowing for a 20% dropout rate, it was necessary to reach a total sample level of a minimum of 50 participants.

### Data analysis

Statistical analysis was computed using SPSS for Windows, version 20 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics was used to describe the means and SD of the participants' characteristics. Before data analysis, the Shapiro–Wilk test was used to test data normality, and Levene's test was used to test the equality of variances. A 3×7 mixed MANOVA was used to compare differences in the three age groups. Moreover, the Bonferroni correction test was used to compare between the groups. The *P*-value was set at 0.05.

## Results

Table 1 lists the age, sex and handedness distribution of the 150 participants in our study. There was no significant difference in the mean values of sex and handedness among the three groups, as revealed by the one-way analysis of variance and $\chi^2$-tests, with a *P* value of more than 0.05. A total of 300 hands were evaluated for function using JTHFT. Table 2 represents the normative mean values for JTHFT subtests (in s) within age groups for both the right (dominant) and left (nondominant) hands in the Egyptian population.

A 3×7 mixed design MANOVA indicated that there was no significant interaction effect of age, sex and handedness, with values of $F=1.4$ and *P* value of more than 0.14. Furthermore, there were significant main effects of age, sex and handedness on JTHFT scores with values of $F=39.26$, 2.18 and 164.64, respectively, and *P* value of less than 0.0001.

### Effect of age on hand function

Among group comparison and the Bonferroni correction test revealed that there was a significant

**Table 1 General characteristics of the participants**

| | Age groups | | | $\chi^2$ | *P* value |
|---|---|---|---|---|---|
| | 20–29 | 30–39 | 40–50 | | |
| Age | | | | | |
| Male | 24.32±2.68 | 34.84±2.73 | 45.36±3.2 | | |
| Female | 25.04±2.31 | 36.04±2.87 | 46.64±2.72 | | |
| Handedness | | | | | |
| Right | 48 (96) | 49 (98) | 47 (94) | 1.04 | 0.59 (NS) |
| Left | 2 (4) | 1 (2) | 3(6) | | |
| Sex | | | | | |
| Female | 30 (60) | 22 (44) | 23 (46) | 0.805 | 0.848 (NS) |
| Male | 20 (40) | 28 (56) | 27 (54) | | |

Data are expressed as mean (SD) or *n* (%). $P>0.05$, NS.

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**Table 2 Mean (SD) values for Jebsen–Taylor Hand Function Test subtests (in s) within age groups**

| JTHFT subtests time (s) | Age groups | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20–29 | | | | 30–39 | | | | 40–50 | | | |
| Sex | Female | | Male | | Female | | Male | | Female | | Male | |
| Handedness | Dom (Rt) | Nondom (Lt) | Dom (Rt) | Nondom (Lt) | Dom (Rt) | Nondom (Lt) | Dom (Rt) | Nondom (Lt) | Dom (Rt) | Nondom (Lt) | Dom (Rt) | Nondom (Lt) |
| Writing | 10.65 ±1.32 | 29.81 ±5.05 | 11.11 ±1.21 | 27.88 ±5.95 | 12.46 ±3.45 | 26.46 ±6.02 | 11.71 ±2.8 | 30.78 ±5.27 | 24.62 ±4.24 | 36.42 ±3.93 | 23.77 ±3.4 | 38.35 ±5.09 |
| Simulated page turning | 4.32 ±0.84 | 4.82 ±0.97 | 3.91 ±0.77 | 4.69 ±0.98 | 5.15 ±1.15 | 5.17±1.4 | 4.13 ±1.08 | 4.33 ±1.06 | 6.14 ±1.48 | 6.57 ±1.51 | 6.22 ±1.5 | 6.74 ±1.61 |
| Picking up small common objects | 4.54 ±0.69 | 5.33 ±1.19 | 4.89 ±0.99 | 5.15 ±0.95 | 5.42 ±1.08 | 5.47 ±1.38 | 4.79 ±1.18 | 4.98 ±1.15 | 6.69 ±1.51 | 7.16 ±1.57 | 6.93 ±1.49 | 6.71 ±1.66 |
| Simulated feeding | 7.61 ±1.05 | 9.11±1.9 | 7.84 ±1.15 | 9.17 ±1.84 | 7.63 ±1.16 | 11.5 ±2.64 | 7.87 ±1.67 | 12.03 ±1.82 | 9.21 ±1.62 | 10.18 ±1.65 | 8.67 ±1.54 | 9.87 ±1.83 |
| Stacking checkers (draughts) | 4.3 ±0.87 | 5.25 ±0.98 | 4.29 ±0.82 | 5.08 ±0.88 | 5.02 ±1.26 | 5.18 ±1.47 | 4.54 ±1.07 | 5.05 ±1.24 | 6.19 ±1.48 | 6.98 ±1.56 | 6.28 ±1.56 | 6.76 ±1.46 |
| Picking up large light objects | 3.39 ±0.81 | 3.68 ±0.74 | 3.37 ±0.77 | 3.68 ±0.71 | 3.93 ±1.11 | 3.97 ±1.36 | 3.65 ±0.91 | 3.78 ±0.86 | 5.73 ±1.62 | 5.6±1.51 | 5.91 ±1.44 | 5.33 ±1.49 |
| Picking up large heavy objects | 3.4 ±0.76 | 3.66 ±0.77 | 3.42 ±0.72 | 3.49±0.7 | 4.37 ±1.21 | 4.24 ±1.36 | 3.76 ±1.01 | 3.98 ±1.03 | 5.35 ±1.49 | 5.2±1.48 | 5.72 ±1.46 | 5.24 ±1.49 |

Data are expressed as mean (SD). Dom Rt, dominant right; JTHFT, Jebsen–Taylor hand function test; Nondom Lt, nondominant left.

**Table 3 Between groups comparison of age decades on Jebsen–Taylor Hand Function Test scores in female individuals**

| Handedness | Dominant hand (Rt) | | | Nondominant hand (Lt) | | |
|---|---|---|---|---|---|---|
| Female individuals | 20–29 vs. 30–39 | 20–29 vs. 40–50 | 30–39 vs. 40–50 | 20–29 vs. 30–39 | 20–29 vs. 40–50 | 30–39 vs. 40–50 |
| Writing | | | | | | |
| Mean difference (90% CI) | −1.81 (−3.61 to 0.01) | −13.96 (−15.76 to 12.16) | −12.16 (−13.95 to 10.35) | 3.35 (0.15–6.55) | −6.61 (−9.8 to 3.4) | −9.96 (−13.15 to 6.75) |
| *P* value | 0.09 (S) | 0.0001 (S) | 0.0001 (S) | 0.07(S) | 0.0001 (S) | 0.0001 (S) |
| Simulated page turning | | | | | | |
| Mean difference (90% CI) | −0.83 (−1.54 to 0.11) | −1.82 (−2.53 to 1.1) | −0.99 (−1.7 to 0.27) | −0.35 (−1.12 to 0.43) | −1.75 (−2.52 to 0.96) | −1.4 (−2.18 to 0.62) |
| *P* value | 0.04 (S) | 0.0001 (S) | 0.01 (S) | 1 (NS) | 0.0001 (S) | 0.001 (S) |
| Picking up small common objects | | | | | | |
| Mean difference (90% CI) | −0.88 (−1.6 to 0.15) | −2.15 (−2.87 to 1.41) | −1.27 (−1.99 to 0.53) | −0.14 (−0.95 to 0.67) | −1.83 (−2.64 to 1.01) | −1.69 (−2.51 to 0.87) |
| *P* value | 0.03 (S) | 0.0001 (S) | 0.001 (S) | 1 (NS) | 0.0001 (S) | 0.0001 (S) |
| Simulated feeding | | | | | | |
| Mean difference (90% CI) | −0.02 (−0.86 to 0.83) | −1.6 (−2.44 to 0.75) | −1.58 (−2.42 to 0.73) | −2.39 (−3.59 to 1.19) | −1.07 (−2.26 to 0.13) | 1.32 (0.12–2.52) |
| *P* value | 1 (NS) | 0.0001 (S) | 0.0001 (S) | 0.0001 (S) | 0.17 (NS) | 0.057 (S) |
| Stacking checkers (draughts) | | | | | | |
| Mean difference (90% CI) | −0.72 (−1.45 to 0.01) | −1.89 (−2.63 to 1.15) | −1.17 (−1.91 to 0.43) | 0.07 (−0.71 to 0.86) | −1.73 (−2.51 to 0.93) | −1.8 (−2.58 to 1.01) |
| *P* value | 0.11 (NS) | 0.0001 (S) | 0.002 (S) | 0.1 (NS) | 0.0001 (NS) | 0.0001 (NS) |
| Picking up large light objects | | | | | | |
| Mean difference (90% CI) | −0.54 (−1.24 to 0.16) | −2.34 (−3.04 to 1.63) | −1.8 (−2.5 to 1.09) | −0.29 (−0.99 to 0.42) | −1.92 (−2.62 to 1.2) | −1.63 (−2.33 to 0.91) |
| *P* value | 0.31 (NS) | 0.0001 (S) | 0.0001 (S) | 1 (NS) | 0.0001 (S) | 0.0001 (S) |
| Picking up large heavy objects | | | | | | |
| Mean difference (90% CI) | −0.97 (−1.6 to 0.27) | −1.95 (−2.65 to 1.25) | −0.98 (−1.68 to 0.28) | −0.58 (−1.29 to 0.14) | −1.54 (−2.26 to 0.81) | −0.96 (−1.68 to 0.24) |
| *P* value | 0.01 (S) | 0.0001 (S) | 0.009 (S) | 0.26 (NS) | 0.0001 (S) | 0.01 (S) |

Data are expressed as mean difference and 90% confidence interval (CI). Lt, left; Rt, right. $P>0.05$, NS. $P<0.05$, significant (S).

difference between age groups 20–29 and 40–50 as well as between 30–39 and 40–50 in almost all JTHFT subset scores, using the dominant and the nondominant hands for female ($P<0.0001$; Table 3) and male individuals ($P<0.0001$; Table 4). However, no significant difference was found in almost all

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**Table 4 Between groups comparison of age decades on Jebsen–Taylor Hand Function Test scores in male individuals**

| Handedness | Dominant hand (Rt) | | | Nondominant hand (Lt) | | |
|---|---|---|---|---|---|---|
| Male individuals | 20–29 vs. 30–39 | 20–29 vs. 40–50 | 30–39 vs. 40–50 | 20–29 vs. 30–39 | 20–29 vs. 40–50 | 30–39 vs. 40–50 |
| Writing | | | | | | |
| Mean difference | −0.6 (−2.4 to 1.19) | −12.66 (−14.46 to 10.86) | −12.06 (−13.85 to 10.25) | −2.9 (−6.1 to 0.3) | −10.47 (−13.66 to 7.26) | −7.57 (−10.77 to 4.36) |
| *P* value | 1 (NS) | 0.0001 (S) | 0.0001 (S) | 0.16 (NS) | 0.0001 (S) | 0.0001 (S) |
| Simulated page turning | | | | | | |
| Mean difference | −0.22 (−0.93 to 0.49) | −2.31 (−3.02 to 1.59) | −2.09 (−2.8 to 1.37) | 0.36 (−0.42 to 1.14) | −2.05 (−2.82 to 1.26) | −2.41 (−3.18 to 1.62) |
| *P* value | 1 (NS) | 0.0001 (S) | 0.0001 (S) | 0.97 (NS) | 0.0001 (S) | 0.0001 (S) |
| Picking up small common objects | | | | | | |
| Mean difference | 0.1 (−0.63 to 0.82) | −2.04 (−2.77 to 1.31) | −2.14 (−2.86 to 1.41) | 0.17 (−0.64 to 0.98) | −1.56 (−2.38 to 0.74) | −1.73 (−2.54 to 0.91) |
| *P* value | 1 (NS) | 0.0001 (S) | 0.0001 (S) | 1 (NS) | 0.0001 (S) | 0.0001 (S) |
| Simulated feeding | | | | | | |
| Mean difference | −0.03 (−0.88 to 0.8) | −0.83 (−1.67 to 0.01) | −0.8 (−1.64 to 0.05) | −2.86 (−4.06 to 1.65) | −0.7 (−1.9 to 0.5) | 2.16 (0.95–3.36) |
| *P* value | 1 (NS) | 0.11 (NS) | 0.13 (NS) | 0.0001 (S) | 0.63 (NS) | 0.001 (NS) |
| Stacking checkers (draughts) | | | | | | |
| Mean difference | −0.25 (−0.9 to 0.49) | −1.99 (−2.72 to 1.25) | −1.74 (−2.47 to 1) | 0.03 (−0.76 to 0.81) | −1.68 (−2.47 to 0.89) | −1.71 (−2.49 to 0.92) |
| *P* value | 1 (NS) | 0.0001 (S) | 0.0001 (S) | 1 (NS) | 0.0001 (S) | 0.0001 (S) |
| Picking up large light objects | | | | | | |
| Mean difference | −0.28 (−0.98 to 0.42) | −2.54 (−3.23 to 1.82) | −2.26 (−2.95 to 1.54) | −0.1 (−0.81 to 0.6) | −1.65 (−2.36 to 0.94) | −1.55 (−2.25 to 0.83) |
| *P* value | 1 (NS) | 0.0001 (S) | 0.0001 (S) | 1 (NS) | 0.0001 (S) | 0.0001 (S) |
| Picking up large heavy objects | | | | | | |
| Mean difference | −0.34 (−1.03 to 0.36) | −2.3 (−3 to 1.6) | −1.96 (−2.66 to 1.26) | −0.49 (−1.21 to 0.23) | −1.75 (−2.47 to 1.02) | −1.26 (−1.98 to 0.54) |
| *P* value | 0.91 (NS) | 0.0001 (S) | 0.0001 (S) | 0.44 (NS) | 0.0001 (S) | 0.001 (S) |

Data are expressed as mean difference and 90% confidence interval (CI). Lt, left; Rt, right. $P>0.05$, NS. $P<0.05$, significant (S).

JTHFT subtests when comparing 20–29 versus 30–39 age groups, using both the dominant and nondominant hands in both sexes ($P>0.05$).

### Effect of sex on hand function

With regard to the effect of sex on JTHFT scores, the Bonferroni correction test revealed that there was a significant difference found between female and male individuals only in the 30–39 age group, in writing with the nondominant hand and in simulated page turning with both dominant and nondominant hands. In addition, no significant difference was found between male and female individuals in the age groups of 20–29 and 40–50 years for all JTHFT subtest scores ($P>0.05$; Table 5).

### Effect of dominance on hand function

Moreover, among group comparison of the effect of handedness on JTHFT scores, Bonferroni correction test revealed that there was a significant difference between using the dominant and nondominant hands in both sexes, in all the three age groups, in writing, stacking checkers, simulated page turning and feeding subtests. However, no significant difference was found when picking up light and heavy objects as well as picking up small common objects with both hands in almost all age groups in both sexes ($P>0.05$; Table 6).

## Discussion

The present study aimed to tackle the lack of standardized hand function norms in Egypt, by developing normative data using JTHFT in healthy Egyptians less than 51 years of age. The values obtained represent normal ranges and did not consider factors that may have influenced hand function and strength, such as body weight and height, occupation, and leisure activities. In addition, this study aimed to investigate the effects of age, sex, and dominance differences on hand function.

In our study, hand function significantly declined with increasing age. Among group comparison revealed that, while using the dominant hand, female individuals in the 40–50 age groups were slower in completing all JTHFT subtests than those in the 20–29 and 30–39 age groups ($P<0.0001$). In addition, while using the nondominant hand, female individuals were found to be slower in completing most test items, except for simulated feeding

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**Table 5 Between groups comparison of sex difference on Jebsen–Taylor Hand Function Test scores.**

| Handedness | Dominant hand (Rt) | | | Nondominant hand (Lt) | | |
|---|---|---|---|---|---|---|
| Female vs. male individuals across age groups | 20–29 | 30–39 | 40–50 | 20–29 | 30–39 | 40–50 |
| Writing | | | | | | |
| Mean difference | −0.46 (−1.84 to 0.92) | 0.75 (−0.63 to 2.14) | 0.85 (−0.53 to 2.23) | 1.93 (−0.53 to 4.39) | −4.32 (−6.78 to 1.85) | −1.93 (−0.53 to 4.39) |
| *P* value | 0.58 (NS) | 0.37 (NS) | 0.31 (NS) | 0.19 (NS) | 0.004 (S) | 0.19 (NS) |
| Simulated page turning | | | | | | |
| Mean difference | 0.41 (−0.14 to 0.95) | 1.02 (0.47–1.57) | −0.08 (−0.62 to 0.47) | 0.13 (−0.47 to 0.73) | 0.84 (0.22–1.43) | −0.17 (−0.77 to 0.43) |
| *P* value | 0.22 (NS) | 0.003 (S) | 0.81 (NS) | 0.72 (NS) | 0.02 (S) | 0.64 (NS) |
| Picking up small common objects | | | | | | |
| Mean difference | −0.35 (−0.9 to 0.21) | 0.63 (0.06–1.18) | −0.24 (−0.8 to 0.31) | 0.18 (−0.44 to 0.81) | 0.49 (−0.13 to 1.11) | 0.45 (−0.17 to 1.08) |
| *P* value | 0.3 (NS) | 0.06 (S) | 0.46 (NS) | 0.62 (NS) | 0.19 (NS) | 0.23 (NS) |
| Simulated feeding | | | | | | |
| Mean difference | −0.23 (−0.87 to 042) | −0.24 (−0.89 to 0.4) | 0.54 (−0.11 to 0.19) | −0.06 (−0.98 to 0.86) | −0.53 (−1.45 to 0.39) | 0.31 (−0.62 to 1.23) |
| *P* value | 0.57 (NS) | 0.53 (NS) | 0.16 (NS) | 0.91 (NS) | 0.34 (NS) | 0.58 (NS) |
| Stacking checkers (draughts) | | | | | | |
| Mean difference | 0.01 (−0.56 to 0.57) | 0.48 (−0.09 to 1.04) | −0.09 (−0.65 to 0.48) | 0.17 (−0.43 to 0.78) | 0.13 (−0.48 to 0.73) | 0.22 (−0.39 to 0.82) |
| *P* value | 0.98 (NS) | 0.16 (NS) | 0.79 (NS) | 0.63 (NS) | 0.73 (NS) | 0.55 (NS) |
| Picking up large light objects | | | | | | |
| Mean difference | 0.02 (0.53–0.55) | 0.28 (−0.27 to 0.81) | −0.18 (−0.72 to 0.36) | −0.005 (−0.54 to 0.55) | 0.19 (−0.36 to 0.73) | 0.27 (−0.27 to 0.81) |
| *P* value | 0.96 (NS) | 0.41 (NS) | 0.58 (NS) | 98 (NS) | 0.57 (NS) | 0.41 (NS) |
| Picking up large heavy objects | | | | | | |
| Mean difference | −0.02 (−0.56 to 0.51) | 0.61 (0.07–1.15) | −0.37 (−0.9 to 0.17) | 0.17 (−0.38 to 0.72) | 0.26 (−0.29 to 0.81) | −0.04 (−0.59 to 0.51) |
| *P* value | 0.94 (NS) | 0.06 (S) | 0.26 (NS) | 0.6 (NS) | 0.44 (NS) | 0.91 (NS) |

Data are expressed as mean difference and 90% confidence interval (CI). Lt, left; Rt, right. $P>0.05$, NS. $P<0.05$, significant (S).

and stacking checkers. As for the male individuals in the 40–50 age group, among group comparison revealed that they were slower in completing almost all test items, except for simulated feeding, than those in the 20–29 and 30–39 age groups, regardless of using the dominant or nondominant hands.

In addition, when comparing female individuals in the age groups 20–29 and 30–39, the younger group was faster while using the dominant hand in writing, page turning, and picking small objects and large heavy objects, but both groups were similar in simulated feeding, stacking checkers and picking light large objects. However, while using the nondominant hand, no significant difference was found in most test items (except for writing and feeding) in female individuals of both the 20–29 and 30–39 age groups. Furthermore, when comparing male individuals in the age groups 20–29 and 30–39, regardless of using the dominant or nondominant hand, no significant difference was found in the time needed to complete all test items, except for simulated feeding using the nondominant hand, which was slower in the older group.

These findings were consistent with previous studies [3,31–33]. Michimata *et al.* [31] found that hand dexterity started to decrease in the 40 s for the nondominant hand. Similarly, Kamarul *et al.* [32] found that the strongest hand grip strength in the right-hand-dominant group occurred in the age-group of 25–34 years in the Malaysian population. It seems logical that general age-related decline in hand performance and function, irrespective of sex and dominance, may occur due to changes in the nervous, muscular, skeletal, and sensory systems that may influence the functional abilities of the hands [33], as indicated in this study.

In terms of sex, the results of this study revealed that there was no significant difference between male and female individuals in the 20–29 and 40–50 age groups. However, female individuals in the 30–39 age group were faster in writing with the nondominant hand, while male individuals in the same age group were faster in picking small objects and large, heavy objects with the dominant hand, as well as in page turning with the dominant and nondominant hands. These results are somehow in line with the original study of Jebsen

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**Table 6 Between groups comparison of handedness on Jebsen–Taylor Hand Function Test scores**

| Handedness | Female | | | Male | | |
|---|---|---|---|---|---|---|
| Dominant vs. nondominant handedness across age groups | 20–29 | 30–39 | 40–50 | 20–29 | 30–39 | 40–50 |
| Writing | | | | | | |
| Mean difference | −19.16 (−21.1 to 17.23) | −14 (−15.94 to 12.06) | −11.8 (−13.73 to 9.86) | −16.77 (−18.71 to 14.84) | −19.07 (−21 to 17.13) | −14.58 (−16.51 to 12.64) |
| *P* value | 0.0001 (S) | 0.0001 (S) | 0.0001 (S) | 0.0001 (S) | 0.0001 (S) | 0.0001 (S) |
| Simulated page turning | | | | | | |
| Mean difference | −0.5 (−0.83 to 0.18) | −0.02 (−0.34 to 0.3) | −0.43 (−0.75 to 0.1) | −0.78 (−1.1 to 0.46) | −0.2 (−0.53 to 0.11) | −0.52 (−0.84 to 0.19) |
| *P* value | 0.01 (S) | 0.93 (NS) | 0.02 (S) | 0.0001 (S) | 0.28 (NS) | 0.008 (S) |
| Picking up small common objects | | | | | | |
| Mean difference | −0.79 (−1.15 to 0.42) | −0.05 (−0.41 to 0.31) | −0.47 (−0.84 to 0.11) | −0.26 (−0.62 to 0.1) | −0.19 (−0.55 to 0.17) | 0.22 (−0.14 to 0.58) |
| *P* value | 0.0001 (S) | 0.82 (NS) | 0.03 (S) | 0.24 (NS) | 0.39 (NS) | 0.31 (NS) |
| Simulated feeding | | | | | | |
| Mean difference | −1.5 (−2.13 to 0.85) | −3.87 (−4.51 to 3.22) | −0.97 (−1.6 to 0.31) | −1.33 (−1.97 to 0.68) | −4.16 (−4.79 to 3.51) | −1.2 (−1.84 to 0.55) |
| *P* value | 0.0001 (S) | 0.0001 (S) | 0.01 (S) | 0.001 (S) | 0.0001 (S) | 0.002 (NS) |
| Stacking checkers (draughts) | | | | | | |
| Mean difference | −0.95 (−1.29 to 0.61) | −0.16 (−0.5 to 0.18) | −0.79 (−1.12 to 0.44) | −0.79 (−1.12 to 0.44) | −0.51 (−0.85 to 0.17) | −0.48 (−0.82 to 0.13) |
| *P* value | 0.0001 (S) | 0.43 (NS) | 0.0001 (S) | 0.0001 (S) | 0.01 (NS) | 0.02 (S) |
| Picking up large light objects | | | | | | |
| Mean difference | −0.29 (−0.6 to 0.01) | −0.04 (−0.35 to 0.26) | 0.13 (−0.17 to 0.43) | −0.31 (−0.61 to 003) | −0.13 (−0.43 to 0.17) | 0.57 (0.27–0.88) |
| *P* value | 0.11 (NS) | 0.81 (NS) | 0.49 (NS) | 0.1 (NS) | 0.49 (NS) | 0.002 (NS) |
| Picking up large heavy objects | | | | | | |
| Mean difference | −0.26 (−0.56 to 0.03) | 0.13 (−0.16 to 0.43) | 0.15 (−0.15 to 0.45) | −0.07 (−0.37 to 0.22) | −0.22 (−0.52 to 0.07) | 0.48 (0.18–0.78) |
| *P* value | 0.14 (NS) | 0.47 (NS) | 0.4 (NS) | 0.69 (NS) | 0.21 (NS) | 0.009 (NS) |

Data are expressed as mean difference and 90% confidence interval (CI). $P>0.05$, NS. $P<0.05$, significant (S).

*et al.* [3]. They found that female individuals were faster in handwriting, as in our study, as well as for the picking up small objects subtest with both hands. However, in the Egyptian sample, male individuals were slightly faster using their dominant hands for this task than the female individuals. These findings appear to signify the Jebsen *et al.* [3] suggestion that differences found in their study between male and female individuals followed no pattern that could be generalized to the entire population. Moreover, Ruff and Parker [34] found women were substantially slower than men were when using both their dominant and nondominant hands during the Finger Tapping test, a hand–eye co-ordination measure. This may be due to the fact that women appear to be more cautious and tend to avoid errors, thereby resulting in a slower movement time.

With regard to hand dominance, the results of this study revealed that both female and male individuals wrote faster with the dominant hand than with the nondominant hand in all age groups. Furthermore, simulated feeding subtest for both sexes was faster while using the dominant hand in almost all age groups, except for male individuals in the 40–50 age group. This exception in the older male group may indicate that hand dominance may be affected during the normal aging process. These findings come in line with Mokashi [30]; they found significantly slower scores for feeding in the Indian population with the nondominant hand. They suggested that the intense pressure against left-hand eating that exists, particularly in Muslim communities, may have influenced the slower performance in the nondominant hand. This may be the same situation with Egyptians, with the majority being Muslims. In addition, as for the page turning and stacking checkers subtests, the dominant hand was faster than the nondominant hand for both sexes in almost all age groups, except in the 30–39 age group for both sexes. Moreover, no significant difference was found between hands for the picking light and heavy objects subtests for both sexes in all age groups, as well as picking small common objects for male individuals in all age groups. The advanced performance of the preferred hand more than the nonpreferred hand in most tasks has been documented extensively. In general, the preferred hand is faster and more precise than the nonpreferred one [35]. In addition, tasks that required a high level of fine dexterity (handle

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coins and pick up and move small objects), may need precision and time more than that of gross hand function, when performed by the nonpreferred hand.

### Limitations

Our study includes several limitations. First, a convenience sample was used, wherein participants were recruited from only two places, the School of Physical Therapy and XXXXX Hospital, XXXX University, which may not be representative of the whole country. Nonetheless, XXXX university medical hospital is a tertiary university for medical referral and education, where individuals originate from various parts of Egypt. Second, we combined the data of the left-hand-dominant individuals ($n$=6) with that of the right-hand-dominant group to form a study population with the aim to avoid a skewed distribution of data. Finally, factors that may influence hand function and strength, such as body weight and height, education, occupation, peculiarities of cultures and leisure activities were not considered. Future studies should include further information on the educational background, occupation, social status, culture and physical activities, in order to analyze the results more comprehensively on hand function in the Egyptian population. Furthermore, the older Egyptian (51–89 years) population needs to be investigated for hand function and compared with international norms.

## Conclusion

This study presents normative data on JTHFT among middle-aged Egyptians. Hand function appears to decline in both men and women with increasing age. In addition, our results provide evidence that handedness may affect hand function, especially high-level fine dexterity activities. Moreover, no significant difference was found between sex and hand function in individuals in the age range of 20–50 years in the Egyptian population.

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### Conflicts of interest

There are no conflicts of interest.

## References

1 Schieber M, Santello M. Hand function: peripheral and central constraints on performance. J Appl Physiol. 2004; 96:2293–2300.

2 Culicchia G, Nobilia M, Asturi M, Santilli V, Paoloni M, Santis R, Galeoto G. Cross-cultural adaptation and validation of the Jebsen-Taylor Hand Function Test in an Italian population. Rehabil Res Pract 2016; 2016:8970917.

3 Jebsen R, Taylor N, Trieschmann R, Trotter M, Howard L. An objective and standardized test of hand function. Arch Phys Med Rehabil 1969; 50:311–319.

4 Shiffman L. Effects of aging on adult hand function. Am J Occup Ther 1992; 46(9):785–792.

5 Sollerman C, Ejeskär A. Sollerman hand function test: a standardised method and its use in tetraplegic patients. Scand J Plast Reconstr Surg Hand Surg 1995; 29:167–176.

6 Carroll D. A quantitative test of upper extremity function. J Chronic Dis 1965; 18:479–491.

7 Kapadia N, Zivanovic V, Verrier M, Popovic M. Toronto Rehabilitation Institute-hand function test: assessment of gross motor function in individuals with spinal cord injury. Top Spinal Cord Inj Rehabil 2012; 18:167–186.

8 Sears E, Chung K. Validity and responsiveness of the Jebsen-Taylor Hand Function Test. J Hand Surg Am 2010; 35:30–37.

9 Beekhuizen S, Field-Fote C. Massed practice versus massed practice with stimulation: effects on upper extremity function and cortical plasticity in individuals with incomplete cervical spinal cord injury. Neurorehabil Neural Repair 2005; 19:33–45.

10 Alon G, Sunnerhagen S, Geurts H, Ohry A. A home-based, self-administered stimulation program to improve selected hand functions of chronic stroke. NeuroRehabilitation 2003; 18:215–225.

11 Bovend'Eerdt H, Dawes H, Johansen-Berg H, Wade T. Evaluation of the Modified Jebsen Test of Hand Function and the University of Maryland Arm Questionnaire for Stroke. Clin Rehabil 2004; 18:195–202.

12 Charles R, Wolf L, Schneider A, Gordon M. Efficacy of a child-friendly form of constraint-induced movement therapy in hemiplegic cerebral palsy: a randomized control trial. Dev Med Child Neurol 2006; 48:635–642.

13 Feys P, Duportail M, Kos D, van Asch P, Ketelaer P. Validity of the TEMPA for the measurement of upper limb function in multiple sclerosis. Clin Rehabil 2002; 16:166–173.

14 Kreder J, Agel J, McKee D, Schemitsch H, Stephen D, Hanel P. A randomized, controlled trial of distal radius fractures with metaphyseal displacement but without joint incongruity: closed reduction and casting versus closed reduction, spanning external fixation, and optional percutaneous K-wires. J Orthop Trauma 2006; 20:115–121.

15 Jones E, Hanly G, Mooney R, Rand L, Spurway M, Eastwood JI. Strength and function in the normal and rheumatoid hand. J Rheumatol 1991; 18:1313–1318.

16 Rettig A, Luca L, Murphy S. Silicone implant arthroplasty in patients with idiopathic osteoarthritis of the metacarpophalangeal joint. J Hand Surg Am 2005; 30:667–672.

17 Vliet Vieland TP, van der Wijk TP, Jolie IM, Zwinderman AH. Determinants of hand function in patients with rheumatoid arthritis. J Rheumatol 1996;23:835–840.

18 Sharma S, Schumacher HR, McLellan AT. Evaluation of the Jebsen Hand Function Test for use in patients with rheumatoid arthritis. Arthritis Care Res 1994; 7:16–19.

19 Stern B. Stability of the Jebsen-Taylor Hand Function Test across three test sessions. Ame J Occup Ther . 1992 46:647.

20 Hackel E, Wolfe A, Bang M. Changes in hand function in the aging adult as determined by the Jebsen Test of Hand Function. PhysTher. 1992; 72:373.

21 Li-Tsang C, Chan S, Chan SY, Soo A. The Hong Kong Chinese version of Jebsen hand function test: Inter-rater and test-retest reliabilities. Hong Kong J Occup Ther 2004; 14:12–20.

22 Backman C, Mackie H. Arthritis hand function test: inter-rater reliability among self-trained raters. Arthritis Care Res 1995; 8:10–15.

23 Jones E, Hanly G, Mooney R, Rand L, Spurway M, Eastwood J, Jones V. Strength and function in the normal and rheumatoid hand. J Rheumatol 1991; 18:1313–1318.

24 Vliet Vlieland P, van der Wijk P, Jolie M, Zwinderman H, Hazes M. Determinants of hand function in patients with rheumatoid arthritis. J Rheumatol 1996; 23:835–840.

25 Jeune B, Skytthe A, Cournil A, Greco V, Gampe J, Berardelli M, *et al.* Handgrip strength among nonagenarians and centenarians in three European regions. J Gerontol 2006; 61:707–712.

26 De Agostini M, Khamis H, Ahui M, Dellatolas G. Environmental influences in hand preference: an African point of view. Brain Cogn 1997; 35:151–167.

27 Lam N, Goh H, Kamaruzzaman S, Chin A, Poi P, Tan M. Normative data for hand grip strength and key pinch strength, stratified by age and gender for a multiethnic Asian population. Singapore Med J 2016; 57:578–584.

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**28** Ferreiro N, Santos D, Conforto B. Psychometric properties of the portuguese version of the Jebsen-Taylor test for adults with mild hemiparesis. Rev Bras Fisioter 2010; 14:377–382.

**29** Beagley S, Reedman S, Sakzewski L, Boyd R. Establishing Australian norms for the Jebsen-Taylor test of hand function in typically developing children aged five to 10 years: a pilot study. Phys Occup Ther Pediatr 2016; 36:88–109.

**30** Mokashi S. Jebsen Hand Function Test – How useful it is for Indian population? J Hand Ther 2010; 23:8–16.

**31** Michimata A, Kondo T, Suzukamo Y, Chiba M, Izumi S. The manual function test: norms for 20- to 90-year-olds and effects of age, gender, and hand dominance on dexterity. Tohoku J Exp Med 2008; 214:257–267.

**32** Kamarul T, Ahmad S, Loh Y. Hand grip strength in the adult Malaysian population. J Orthop Surg Res 2006; 14:172–177.

**33** Kalisch T, Wilimzig C, Kleibel N, Tegenthoff M, Dinse H. Age-related attenuation of dominant hand superiority. PLoS One 2006; 1:e90.

**34** Ruff R, Parker S. Gender- and age-specific changes in motor speed and eye-hand coordination in adults: normative values for the finger tapping and Grooved Pegboard Tests. Percept Mot Skills. 1993; 76:1219–1230.

**35** Ozcan A, Tulum Z, Pinar L, Baskurt F. Comparison of pressure pain threshold, grip strength, dexterity and touch pressure of dominant and non-dominant hands within and between right- and left-handed subjects. J Korean Med Sci 2004; 19:874–878.