

## NORMAL VALUES OF KEY PINCH STRENGTH IN A HEALTHY NIGERIAN POPULATION

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### ABSTRACT

**Background:** With the severity of machine hand injuries in our environment, the need to determine the normal values for key pinch strength with which to compare restorative surgeries was justified.

**Methods:** A cross sectional survey of participants who had no previous hand injuries limiting hand function. Data obtained included age, gender, body mass index, hand dominance and hand span. The Baseline Hydraulic Pinch Gauge was used to obtain key pinch strength. The influence of the above variables on measured pinch strength was analyzed using independent sample t-tests and Pearson's correlation.

**Results:** Of the 242 recruited participants, age range between 20 and 80 years, 163(67.4%) were male and 79 (32.6%) were female. Males had higher pinch strength (right- $8.3\pm 2.7$ kg, left- $7.6\pm 2.5$ kg) than females (right- $6.3\pm 1.5$ kg, left- $5.8\pm 1.5$ kg). Pinch strength varied with age peaking in the fifth decade in males and females. Interestingly, the left handed dominant female had higher right pinch strength than her right handed counterpart ( $p < 0.009$ ). Height, and hand span correlated with pinch strength in females.

**Conclusion:** Normal values for key pinch strength in this Nigerian population are lower than that of Caucasians.

**Keywords:** Key pinch, Nigerians, Normal values.

### BACKGROUND

Performances of the activities of daily living (ADL) are spontaneous with normal functioning hands. With hand injuries resulting in impairment of ADL, these seemingly innocuous tasks become arduous. The ADL tasks brought about by the key pinch include; insertion and removal of a key or the Automated Teller Machine (ATM) card, operating a clothes zipper, insertion or removal of a plug, stabbing food with the prongs of a fork, operating a remote control or holding a pen.<sup>1</sup> The key pinch strength has been demonstrated as a standard objective clinical test for evaluating the outcome of surgical procedures on the hand.<sup>2,3</sup> A statistically significant difference between the mean pinch strength of the donor finger and that of the contralateral finger in extended reverse dorsal metacarpal artery flaps was found by.<sup>3</sup>

The surgeon's primary goal is restoration of hand function as much as is possible. Post operative evaluation data are needed in clinical audit and therefore governance geared towards improving surgical practice. Normal data on key pinch strength in adult Caucasians in both the normal and pathological states

exist in the literature.<sup>4-8</sup> Increasingly, the need to exercise caution in generalization of normative data across regions is emphasized. Hand grip values in an African population have been found to be lower than that of the Caucasian population.<sup>9,10</sup> There is a dearth of data on key pinch strength in Africans in the literature. The objectives of the study were to have normal values of key pinch strength amongst a Nigerian population, to determine the influence of gender, age, handedness and body mass index on key pinch strength and to compare the values obtained with that reported in other populations.

### METHODS

The study was a community based cross sectional survey carried out over a one-year period on adults between the ages of 20 and 80 years in Ibadan, the capital City of Oyo State. A multi-staged sampling method was used to select the Local Government Areas (LGAs) for the study. Akinyele and Ibadan North local government areas were randomly selected from the eleven LGAs in Ibadan. In each of these selected LGAs, two streets were selected by

convenience sampling from where the subjects were recruited using a modified cluster sampling method.

Ethical approval was obtained from the Institutional Review Board. For each participant that met the terms of the inclusion criteria stated, an informed consent was obtained. Participants who were not conversant with English language were communicated with in the local dialect.

Participants who were of lucid consciousness, without any history or obvious mental illness, who were not on systemic drugs, were recruited. They also had no history of alcohol misuse and were able to display the activities of daily living such as eating, bathing, dressing, and work.

A structured questionnaire, which was in two parts, was used for obtaining data. The first part consisted of information such as age, sex, height, weight, drug use and the occurrence of previous hand trauma or surgery. The second part comprised of the required hand measurements; key pinch values and hand span. The key pinch (lateral pinch grip) was measured with the baseline hydraulic pinch gauge that had been pre-calibrated at the factory. The subjects were seated with their shoulder adducted and neutrally rotated, elbow flexed at 90° with the forearm and wrist in neutral position.<sup>11</sup> Three consecutive measurements in kilograms, after resetting to zero, were taken and the arithmetic mean computed.<sup>12</sup>

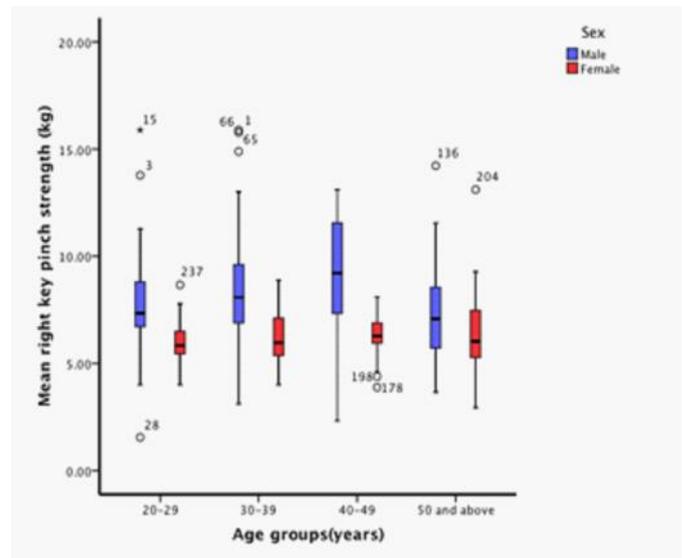
The hand span was measured by first instructing that the hand be opened as wide as possible and placed on a plain paper on a table. The outer lateral border of the distal phalanx of the little finger and thumb were marked as points on the paper. The distance between these two points, the hand span, was then measured and recorded to the nearest centimeter.

Descriptive statistics (mean, mode) were used to determine frequency of data subsets. Independent t test were used to compare key pinch with gender and hand dominance while Pearson's correlation was used to determine the relationship between key pinch and the measured constitutional variables. Statistical significance was defined by p values <0.05.

Previous data on key pinch values in which similar methodologies to this study were employed, were obtained from four studies on German<sup>5</sup>, Swiss<sup>13</sup>, Turkish<sup>14</sup> and Korean<sup>7</sup> populations and the values compared to those in this study.

## RESULTS

Key pinch strength was measured on the right and left hand of 242 adults aged between 20 and 80 years. Of the 242 participants, 163(67.4%) were male and 79 (32.6%) were female. The age and gender distribution



**Figure 1:** Box plot showing variation of age with mean right key pinch strength in males and females

of the patients are as shown in Table 1. Two hundred and nine (86.4%) of these participants were right hand dominant comprising 139(85.3%) male and 70(88.5%) female participants, while 31(12.4%) were left hand dominant comprising 23(14.1%) male and 8(10.1%) female participants.

**Table 1:** Age and gender distribution of participants

| Age groups | Male      | Female    | Total     |
|------------|-----------|-----------|-----------|
| 20-29      | 48(29.4%) | 21(26.6%) | 69(28.5%) |
| 30-39      | 68(41.7%) | 20(25.3%) | 88(36.4%) |
| 40-49      | 29(17.8%) | 22(27.8%) | 51(21.1%) |
| 50-59      | 11(6.7%)  | 12(15.2%) | 23(9.5%)  |
| 60-69      | 5(3.1%)   | 3(3.8%)   | 8(3.3%)   |
| 70-79      | 1(0.6%)   | -         | 2(0.8%)   |
| >80        | 1(0.6)    | -         | 1(0.4%)   |
| Total      | 163       | 79        | 242       |

**Table 2:** Independent sample t test comparison of right and left hand key pinch strengths between males and females.

| Hand  | Sex           | Mean key pinch strength (kg) | SD  | p      |
|-------|---------------|------------------------------|-----|--------|
| Right | Male (n=163)  | 8.27                         | 2.7 | 0.001* |
|       | Female (n=79) | 6.26                         | 1.5 |        |
| Left  | Male (n=163)  | 7.58                         | 2.5 | 0.001* |
|       | Female (n=79) | 5.78                         | 1.5 |        |

\*Significant at p<0.05

**Table 3:** Independent sample t test comparison of hand dominance on key pinch strength.

| Gender | Key pinch | Hand dominance | n   | Mean key pinch strength (kg) | SD  | p      |
|--------|-----------|----------------|-----|------------------------------|-----|--------|
| Male   | Right     | R              | 139 | 8.3                          | 2.7 | 0.57   |
|        |           | L              | 23  | 7.9                          | 1.8 |        |
|        | Left      | R              | 139 | 7.5                          | 2.5 |        |
|        |           | L              | 23  | 7.7                          | 2.3 |        |
| Female | Right     | R              | 70  | 6.2                          | 1.4 | 0.009* |
|        |           | L              | 8   | 7.6                          | 1.4 |        |
|        | Left      | R              | 68  | 5.7                          | 1.3 | 0.004* |
|        |           | L              | 8   | 7.2                          | 2.0 |        |

\*Significant at  $p < 0.05$

### Effect of gender on key pinch strength

Key pinch strengths on the right and left hand were significantly higher in males than in females ( $p < 0.01$ ,  $p < 0.01$ ) with a mean of 8.3kg (SD 2.7) on the right and 7.6kg (SD 2.5) on the left hand in males and a mean of 6.3kg (SD 1.5) on the right hand and 5.8kg (SD 1.5) on the left hand in females, Table 2. The strength of the left hand averaged 92% of the right hand irrespective of gender.

**Table 4:** Pearson's Correlation between key pinch strength and constitutional variables

| Variable        | Male  |      | Female |        |
|-----------------|-------|------|--------|--------|
|                 | Right | Left | Right  | Left   |
| Weight          | .122  | .073 | .093   | .163   |
| Height          | .073  | .026 | .349** | .270*  |
| Body Mass Index | .080  | .056 | -.082  | .040   |
| Hand span       | .201* | .132 | .437** | .303** |

\*\*Correlation is significant at 0.01 level

\*Correlation is significant at 0.05 level

### Effect of handedness on key pinch strength

The right key pinch strength is higher for the right hand dominant male than his left hand dominant counterpart ( $p > 0.05$ ), similarly, the left key pinch strength is higher for the left hand dominant male than his right hand dominant counterpart, ( $p > 0.05$ ). However for the females, the right key pinch strength is significantly higher for the left hand dominant female than the right hand dominant female, ( $p = 0.009$ ). The left key pinch strength is also significantly higher for the left hand dominant female than the right hand dominant female, ( $p = 0.004$ ), Table 3.

### Effect of age on key pinch strength

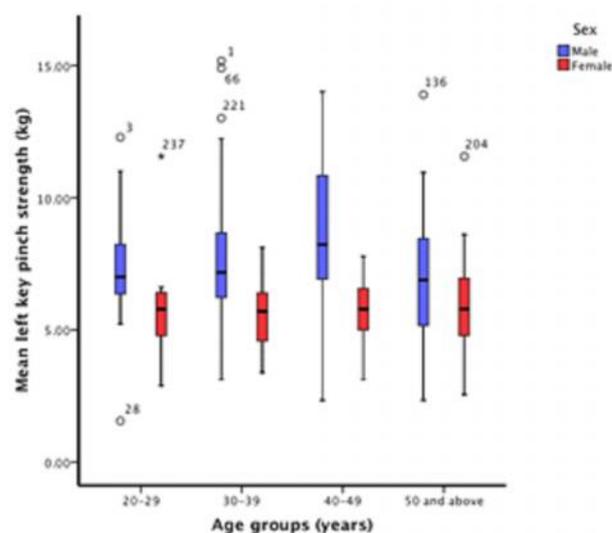
Figures 1 and 2 show the key pinch strength varied with age. The greatest strength was seen in the 40-49 year age group in both males and females.

### Relationship between anthropometric measures and key pinch strength

There was no correlation between the weight, height, body mass index, and the left and right key pinch strength tests in the male participants. There was a positive correlation between the right hand span and the right key pinch strength. However, this was not seen on the left. In the female participants the height and hand span correlated with the right and left key pinch strengths, Table 4.

### Comparison of data with different population groups

Key pinch values obtained in this study were lower when compared with data from four population groups; German, Swiss, Turkish and Korean, (table 5).



**Figure 2:** Box plot showing variation of age with mean left key pinch strength in males and females

**Table 5:** Comparison of key pinch values with other studies

| Study/population |              | Male pinch strength Kg (SD) | Percent of reported strengths | Female pinch strength Kg (SD) | Percent of reported strengths |
|------------------|--------------|-----------------------------|-------------------------------|-------------------------------|-------------------------------|
| Switzerland      | Dominant     | 10.4 (1.5)                  | 79.8                          | 7.2 (1.0)                     | 60.6                          |
|                  | Non-Dominant | 10.1 (1.6)                  | 75.2                          | 6.9 (1.0)                     | 84.0                          |
| Korean           | Right        | 9.3 (1.7)                   | 89.2                          | 6.5 (1.1)                     | 96.9                          |
|                  | Left         | 6.9 (1.5)                   | 110.1                         | 5.1 (1.2)                     | 113.7                         |
| This study       | Right        | 8.3 (2.7)                   |                               | 6.3 (1.5)                     |                               |
|                  | Left         | 7.6 (2.5)                   |                               | 5.8 (1.5)                     |                               |
| German           | Right        | 10.4 (2.2)                  | 79.8                          | 6.6 (1.6)                     | 95.4                          |
|                  | Left         | 9.7 (2.3)                   | 78.3                          | 6.1 (1.6)                     | 95                            |
| Turkish          | Dominant     | 11.5 (1.5)                  | 72.1                          | 8.7 (1.2)                     | 72.4                          |
|                  | Non-Dominant | 11.2 (1.6)                  | 67.9                          | 8.4 (1.2)                     | 69.0                          |

**Table 6:** Reference for male key pinch strength obtained in this study

| Age (yrs) | Right pinch strength (kg) |     |     |      | Left pinch strength(kg) |     |     |      |
|-----------|---------------------------|-----|-----|------|-------------------------|-----|-----|------|
|           | Mean                      | SD  | Min | Max  | Mean                    | SD  | Min | Max  |
| 20-29     | 7.8                       | 2.3 | 1.6 | 15.9 | 7.3                     | 1.8 | 1.6 | 12.3 |
| 30-39     | 8.6                       | 2.7 | 3.1 | 15.9 | 7.7                     | 2.6 | 3.1 | 15.2 |
| 40-49     | 9.0                       | 2.9 | 2.3 | 13.1 | 8.3                     | 3.0 | 2.3 | 14.0 |
| >50       | 7.3                       | 2.8 | 3.7 | 14.2 | 6.9                     | 3.0 | 2.3 | 13.9 |

**Table 7:** Reference values for female key pinch strength obtained in this study

| Age (yrs) | Right key pinch strength (kg) |     |     |      | Left key pinch strength (kg) |     |     |      |
|-----------|-------------------------------|-----|-----|------|------------------------------|-----|-----|------|
|           | Mean                          | SD  | Min | Max  | Mean                         | SD  | Min | Max  |
| 20-29     | 6.1                           | 1.2 | 4.0 | 8.7  | 5.8                          | 1.7 | 2.9 | 11.6 |
| 30-39     | 6.1                           | 1.2 | 4.0 | 8.9  | 5.7                          | 1.3 | 3.4 | 8.1  |
| 40-49     | 6.3                           | 1.1 | 3.9 | 8.1  | 5.7                          | 1.2 | 3.1 | 7.8  |
| >50       | 6.6                           | 2.4 | 2.9 | 13.1 | 6.1                          | 2.0 | 2.6 | 11.6 |

## DISCUSSION

This study confirms that amongst these African adults, the general assumption that strength tests, which includes the key pinch strength are greater in men than in women holds true. This gender-based difference has been reported by other studies.<sup>4,5,7</sup> The key pinch strength in females was found to be two thirds that of males. This study revealed a positive correlation of key pinch with height and hand span in females. Some studies have indicated strong predictors of hand strength as sex, age, body height and mid forearm circumference and weaker predictors being body weight and hand size measurements.<sup>15</sup> Another study reported that hand size influences optimal grip span in

women but not in men.<sup>16</sup> In this study the strength of the key pinch varied with age, peaking in the fifth decade in both males and females declining thereafter. This is similar to a previous report.<sup>5</sup> Some have reported a peak in key pinch strength at the fourth decade.<sup>4,7</sup> This decline in strength with age after achieving a peak has been attributed to decrease in muscle power as well as to asymptomatic joint degeneration.<sup>5</sup>

In general we found the key pinch of the right hand was about 8% stronger than that on the left. This finding was irrespective of hand dominance.<sup>5</sup> reported a seven percent stronger pinch strength on the right

than on the left hand. An interesting finding in this study not previously reported is the significantly higher grip strength on the right hand of left handed dominant females. This may be explained by the cultural tendency to insist on the use of the right hand irrespective of the left laterality of the individual. Larger studies are needed to confirm this finding.

The key pinch strength in this study is lower than in previous reports amongst the Caucasian population<sup>4,5</sup>. Peak key pinch strengths in the German and Swiss male population were 10.4 and 10.3 kilograms respectively compared with 8.3 and 9.3 kilograms obtained in this study and in a Korean population respectively<sup>7</sup>. Similar ratios are seen among the females. The interplay of genetic and socio-cultural influences on the key pinch strength across regions and population groups are hypothetical explanations for these differences and requires further exploration. The study limitations are; the subset of the elderly was too small from which to draw conclusions and the influence of occupation on the pinch strength was not evaluated. The values obtained in this study represent normal values. A larger population size may be required to present reference values.

## CONCLUSIONS

We have provided normal values, tables 6 and 7 in this Nigerian population. Reference to these values may be made when performing hand strength assessments. These values differ from reported figures. Generalization of reference values across populations should therefore be done with due caution.

## Competing interests

The authors declare that they have no competing interests.

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