# Hand Anthropometry of Indonesian Young Adult Females

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## ABSTRACT

An anthropometric survey measuring 24 hand dimensions was conducted in 202 Indonesian young adult females. The samples consisted of three different ethnic groups in Indonesia, including Bataknese, Javanese, and Sundanese. The results of the measurements were presented using means, standard deviations, and percentile values which were summarized in tables. Comparisons of the collected data among ethnic groups were performed. Also, comparisons between the collected data and other nationalities such as Jordanian, Bangladeshis, Vietnamese, Hong Kong Chinese, Nigerian, and UK Resident were performed. The results showed many significant differences among ethnic groups. The Sundanese tended to have narrower and thinner hands than the Bataknese and Javanese. Also, many differences on hand dimensions existed among the Indonesian young adult females and other nationalities. However, a general conclusion on the differences was difficult to be reached. The results of this study should be considered in the design or selection of the hand-operated products that are used by Indonesian young adult females.

**Keywords:** hand anthropometry, Indonesian young adult females, hand-operated products

## 1. Introduction

Due to their flexibility, numerous products are operated using human hands. The products vary from simple woodworking tools like a saw to high-tech devices such as controls of the airplane cockpit. However, in several circumstances, the operation of hand-operated products can induce upper extremity musculoskeletal disorders such as carpal tunnel syndrome and tendonitis [1]. To minimize the musculoskeletal disorders and the other adverse health effects in hand, the products should be compatible with the physical characteristics of the users [2], [3]. One of the physical characteristics that should be considered during product design process of the hand-operated products is the anthropometry. The anthropometry is essential to be utilized in determining many dimensions of the products. Thus, the products are comfortable, healthy, safe, and efficient when they are used by users [4].

On the other hand, women dominate the labor force of industry in developing countries [5]. Also, women reported more symptoms of musculoskeletal disorders than men in the upper extremities such as wrists, and hands though they performed the same types of task [6]. The high prevalence of disorders may partly be attributed because women use hand-operated tools and devices which have been primarily designed for men [7], [8]. In addition to the domination of the female workers in the industry, in terms of the age group, the labor force is still dominated by young adults [9]. According to these facts, the hand anthropometry data of the young adult females should be important in minimizing the adverse health effects on the female workers due to the operation of the hand-operated products in the industry.

Various hand anthropometric data of several countries such as Bangladesh [2], Hong Kong [10], Jordan [3], Nigeria [11], and Vietnam [12] are already available. They provide the measurement results of many hand dimensions, which relevant to the design of hand-operated tools and other manual devices. Also, several studies consider the young adult females as the part of their samples. Although the hand anthropometric data for the young adult females are widely available, the data might be not applicable to be utilized in the design or selection of the hand-operated products that are used by other populations. It occurs because anthropometry is influenced by many factors such as gender, age, ethnicity, and occupation [13]. Therefore, hand anthropometric data for the other populations such as for the Indonesian young adult females should be collected.

Moreover, the hand anthropometry of Indonesian, as one of the developing countries, is still limited. The present hand anthropometric data only describe less than ten hand dimensions such as hand length, hand breadth, and finger lengths [14], [15]. More dimensions are required for designing the hand-operated products. Also, many studies have been proven that ethnic group might influence to the anthropometric differences [16]–[18]. Since Indonesia is a country that has numerous ethnic groups, the anthropometric study of Indonesia population should consider this factor. According to this gap, this study was conducted. The main purpose of this study was to gather hand anthropometric data of Indonesian young adult females by considering the ethnic group differences. Comparisons among ethnic groups were performed. Also, comparisons between the hand anthropometric data of this study to the corresponding dimensions of other populations were also conducted.

## 2. Methods

***Participants***

The samples in this study consisted of 202 young adult females, which were conveniently sampled from a university in Yogyakarta, Indonesia. The participants consisted of three ethnic groups in Indonesia, including Bataknese, Javanese, and Sundanese. These ethnic groups were the first, second and third largest population in Indonesia. According to the census results in 2010, Javanese held 40.22% of the Indonesia population, and Sundanese held 15.5%, while Bataknese held 3.58% [19]. These percentages were utilized to determine the number of samples since this study applied quota sampling. The participants were voluntarily participated and selected according to their availability. All participants were right-handed and did not have any hand injury or disability at the time of the study (self-reported). Summary of the weight, stature, and age of the participants is given in Table 1.

**Table 1.** Participant characteristics

| | Bataknese (n=13) | | | Javanese (n=136) | | | Sundanese (n=53) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Range | Mean | SD | Range | Mean | SD | Range |
| Weight (kg) | 55.15 | 7.86 | 42 - 69 | 52.25 | 6.58 | 38 - 80 | 54.03 | 6.36 | 42 - 70 |
| Stature (cm) | 158.92 | 5.12 | 151 - 168 | 157.53 | 5.33 | 145 - 170 | 156.64 | 4.52 | 145 - 167 |
| Age (years) | 20.58 | 1.34 | 18.84 – 22.38 | 21.52 | 1.79 | 17.75 – 27.45 | 20.98 | 1.86 | 17.51 – 24.16 |

***Apparatus and Measurement***

The measurements conducted on 24 hand dimensions using a 20 cm electronic digital caliper with an accuracy of 0.01 mm, a 40 cm caliper with an accuracy 0.05 mm, and a measuring tape with an accuracy of 0.1 mm. The measured dimensions and the definition of each dimension were taken from previous research papers by Davies et al. [20], Courtney [10], and Imrhan et al. [12] which are compiled by Mandahawi et al. [3]. The definitions of the measured hand dimensions are summarized in Table 2. All measurements were performed by two trained experimenters, which had shown accurate and consistent measurement results.

**Table 2.** Hand dimension definitions

| | Hand dimension | Definition |
|---|---|---|
| 1 | Fingertip to root digit 5 | Hand is extended and the palm is facing up. The distance along vertical the axis of digit 5, from the midpoint of the tip of this digit to the root of the hand |
| 2 | Fingertip to root digit 3 | Hand is extended and the palm is facing up; the distance along the vertical axis of digit 3, from the tip of digit 3 to the root of the hand |
| 3 | First joint to root digit 5 | Hand is extended and the palm is facing up; the distance along the vertical axis of digit 5, from the midpoint of the first joint of digit 5 to the root of the hand |
| 4 | First joint to root digit 3 | Hand is extended and the palm is facing up; the distance along the vertical axis of digit 3, from the midpoint of the first joint of digit 3 to the root of the hand |
| 5 | Second joint to root digit 5 | Hand is extended and palm is facing up; the distance along the vertical axis of digit 5 from the midpoint of the joint of digit 5 to the root of the hand |
| 6 | Second joint to root digit 3 | Hand is extended and palm is facing up; the distance along the vertical axis of digit 3 from the midpoint of the joint of digit 3 to the root of the hand |
| 7 | Breadth at tip digit 5 | Hand is extended and palm is facing down; the breadth at the tip of digit 5 |
| 8 | Breadth at tip digit 3 | Hand is extended and palm is facing down, the breadth at the tip of digit 3 |
| 9 | Breadth at 1st joint of digit 5 | Hand is extended and palm is facing down; the maximum breadth of the first joint of digit 5 |
| 10 | Breadth at 1st joint of digit 3 | Hand is extended and palm is facing down; the maximum breadth of the first joint of digit 3 |
| 11 | Breadth at 2nd joint of digit 5 | Hand is extended and palm is facing down; the maximum breadth of the second joint of digit 5 |
| 12 | Breadth at 2nd joint of digit 3 | Hand is extended and palm is facing down; the maximum breadth of the second joint of digit 3 |
| 13 | Depth at tip digit 5 | Hand is extended and palm is facing down; the depth at the tip of digit 5 |
| 14 | Depth at tip digit 3 | Hand is extended and palm is facing down; the depth at the tip of digit 3 |
| 15 | Depth at 1st joint digit 5 | Hand is extended and palm facing is down; the maximum depth of the first joint of digit 5 |
| 16 | Depth at 1st joint digit 3 | Hand is extended and palm is facing down; the maximum depth of the first joint of digit 3 |
| 17 | Depth at 2nd joint digit 5 | Hand is extended and palm is facing down; the maximum depth of the second joint of digit 5 |
| 18 | Depth at 2nd joint digit 3 | Hand is extended and palm is facing down; the maximum depth of the second joint of digit 3 |
| 19 | Maximum breadth of the hand | Hand is extended and palm is facing down; fingers are together while the thumb is held loosely against the hand. This dimension is measured horizontally at the widest section of the hand |
| 20 | Breadth at the knuckles | Hand is extended and palm is facing down. This dimension is measured across the palm of the hand at the junction between the palm and the fingers, not including the thumb. The hand and fingers must be held flat, palm uppermost |
| 21 | Length of hand | Hand is extended and palm is facing up. This dimension is measured from the wrist crease directly below the pad of muscle at the base of the thumb to the tip of the middle finger. The hand and fingers should be held straight and flat, palm uppermost |

| | Hand dimension | Definition |
|---|---|---|
| 22 | 3rd digit to base of the thumb | Hand is extended and palm is facing up; thumb is held away from the side of the hand with its axis about 45° to the long axis of the hand. The measurement is taken along the long axis of the hand from crotch 1 to dactylion |
| 23 | Depth at knuckles | Hand is extended; thumb held away from the hand but the other fingers close together. This measurement is taken as the depth of the hand at the distal ends of the metacarpals of digits 2–5 |
| 24 | Maximum depth of the hand | Hand is extended with palm facing down; fingers are close together with the thumb held against the side of the hand. This measurement is the maximum depth from the volar side of the thenar pad to the dorsal surface of the hand |

***Data Analysis***

The descriptive statistics were summarized in terms of mean, standard deviation (SD), and percentile values. T-tests or Mann-Whitney test were performed to compare the hand anthropometry between ethnic groups on all 24 measured dimensions. The similar statistical procedure was also performed to compare the hand anthropometric data of this study and those of other populations. The level of statistical significance was reported as 5%.

## 3. Results and Discussion

**Comparison among ethnic groups**

Table 3 and 4 present the summary data for all measurements, which were stratified according to the ethnic group. Table 5 presents the tabulated results of percentage differences and t-test results between ethnic groups. As seen in Table 5, the Bataknese and Javanese had the smallest numbers of hand dimensions that were significantly different compared to the Bataknese and Sundanese, as well as the Javanese and Sundanese. Seven hand dimensions of the Bataknese and Javanese were found to be significantly different. Twelve hand dimensions which were dominated by breadth and depth dimensions such as breadth at 1st joint of digit 5 and index finger breadth of the Sundanese were significantly different compared to the Bataknese. Slightly similar, fifteen hand dimensions such as length of hand, maximum breadth of the hand, and thumb thickness of the Javanese were significantly different to those of the Sundanese.

According to the results, it can be inferred that the hand anthropometry between the Bataknese and Javanese were quite similar. On the other hand, the Bataknese females had wider and thicker hands than the Sundanese. Also, the comparison shows that the Javanese females tended to have longer, wider, and thicker hands than the Sundanese.

The results of this study show that there were significant differences of the hand anthropometry among ethnic groups in Indonesia. Similar trends also explained by Widyanti et al. [15]. They found that most mean dimensions and all of the bodily proportions between three ethnic groups in Indonesia: Javanese, Sundanese, and Minangkabau have significant differences. Moreover, the differences among ethnic groups might be caused by the differences in the dietary pattern. Compared to other ethnic groups, the Sundanese have a greater fruit and vegetable intake [21]. This dietary pattern might affect their hand dimensions, particularly on the depth dimensions of the hands such as depth at the finger joint.

**Table 3.** Means and standard deviations for all measurements by ethnic group of the Indonesian young adult females (in mm)

| Hand dimension | Bataknese | | Javanese | | Sundanese | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Fingertip to root digit 5 | 54.96 | 1.19 | 53.81 | 2.59 | 53.82 | 2.72 |
| Fingertip to root digit 3 | 71.94 | 1.93 | 74.13 | 3.50 | 72.35 | 3.89 |
| First joint to root digit 5 | 33.78 | 2.58 | 33.57 | 2.06 | 33.90 | 1.70 |
| First joint to root digit 3 | 48.19 | 1.80 | 51.04 | 2.91 | 49.24 | 2.97 |
| Second joint to root digit 5 | 18.49 | 2.57 | 18.08 | 1.69 | 18.33 | 1.39 |
| Second joint to root digit 3 | 24.88 | 1.29 | 26.09 | 1.95 | 26.25 | 1.43 |
| Breadth at tip digit 5 | 10.56 | 0.84 | 10.21 | 0.58 | 10.50 | 0.40 |
| Breadth at tip digit 3 | 12.90 | 0.87 | 12.60 | 0.52 | 12.54 | 0.47 |
| Breadth at 1st joint of digit 5 | 11.60 | 0.72 | 11.25 | 0.53 | 10.99 | 0.57 |
| Breadth at 1st joint of digit 3 | 13.85 | 0.76 | 13.62 | 0.52 | 13.61 | 0.43 |
| Breadth at 2nd joint of digit 5 | 13.49 | 0.51 | 13.27 | 0.57 | 12.89 | 0.56 |
| Breadth at 2nd joint of digit 3 | 16.48 | 1.01 | 16.24 | 0.56 | 15.97 | 0.58 |
| Depth at tip digit 5 | 10.19 | 0.74 | 9.57 | 0.64 | 9.41 | 0.39 |
| Depth at tip digit 3 | 11.82 | 0.76 | 11.53 | 0.57 | 11.18 | 0.45 |
| Depth at 1st joint digit 5 | 9.58 | 0.38 | 9.54 | 0.48 | 9.29 | 0.35 |
| Depth at 1st joint digit 3 | 11.60 | 0.88 | 11.50 | 0.45 | 11.15 | 0.41 |
| Depth at 2nd joint digit 5 | 12.11 | 0.49 | 11.93 | 0.62 | 11.73 | 0.40 |
| Depth at 2nd joint digit 3 | 14.93 | 0.80 | 14.91 | 0.96 | 14.47 | 0.59 |
| Maximum breadth of the hand | 85.68 | 1.43 | 86.12 | 3.33 | 84.41 | 2.68 |
| Breadth at the knuckles | 73.02 | 2.24 | 72.55 | 2.25 | 71.96 | 3.10 |
| Length of hand | 169.08 | 6.92 | 171.29 | 4.94 | 169.60 | 5.38 |
| 3rd digit to base of the thumb | 115.23 | 3.41 | 120.84 | 4.46 | 118.84 | 5.32 |
| Depth at knuckles | 25.62 | 1.02 | 25.87 | 1.35 | 25.02 | 1.32 |
| Maximum depth of the hand | 37.27 | 2.99 | 36.85 | 2.23 | 36.54 | 2.24 |

**Table 4.** Percentile values for all measurements by ethnic group of the Indonesian young adult females (in mm)

| Hand dimension | Bataknese | | | Javanese | | | Sundanese | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5th | 50th | 95th | 5th | 50th | 95th | 5th | 50th | 95th |
| Fingertip to root digit 5 | 53,40 | 55,07 | 56,48 | 48,75 | 53,93 | 57,71 | 49,90 | 53,46 | 58,59 |
| Fingertip to root digit 3 | 68,97 | 71,91 | 74,38 | 68,44 | 74,21 | 80,27 | 66,05 | 72,17 | 79,25 |
| First joint to root digit 5 | 29,72 | 33,78 | 37,31 | 30,27 | 33,43 | 37,24 | 30,53 | 33,96 | 36,61 |
| First joint to root digit 3 | 45,40 | 49,26 | 49,69 | 46,42 | 51,14 | 55,26 | 44,21 | 49,64 | 53,93 |
| Second joint to root digit 5 | 14,85 | 19,19 | 21,65 | 15,68 | 18,03 | 21,07 | 16,21 | 18,16 | 20,83 |
| Second joint to root digit 3 | 23,12 | 25,27 | 26,47 | 22,94 | 26,09 | 29,09 | 23,96 | 26,84 | 28,43 |
| Breadth at tip digit 5 | 9,37 | 10,43 | 11,54 | 9,29 | 10,23 | 11,11 | 9,94 | 10,47 | 11,25 |
| Breadth at tip digit 3 | 11,30 | 13,24 | 13,73 | 11,80 | 12,62 | 13,38 | 11,82 | 12,51 | 13,27 |
| Breadth at 1st joint of digit 5 | 10,70 | 11,61 | 12,61 | 10,33 | 11,24 | 12,12 | 9,92 | 10,91 | 11,83 |
| Breadth at 1st joint of digit 3 | 12,79 | 13,85 | 14,75 | 12,80 | 13,64 | 14,50 | 12,92 | 13,57 | 14,38 |
| Breadth at 2nd joint of digit 5 | 12,83 | 13,49 | 14,24 | 12,33 | 13,26 | 14,20 | 12,01 | 12,94 | 13,69 |
| Breadth at 2nd joint of digit 3 | 15,29 | 16,22 | 18,06 | 15,39 | 16,30 | 17,21 | 15,11 | 15,95 | 17,00 |
| Depth at tip digit 5 | 9,05 | 10,42 | 11,10 | 8,50 | 9,56 | 10,71 | 8,81 | 9,40 | 10,13 |
| Depth at tip digit 3 | 10,35 | 11,92 | 12,57 | 10,67 | 11,49 | 12,56 | 10,37 | 11,23 | 11,88 |
| Depth at 1st joint digit 5 | 9,06 | 9,57 | 10,15 | 8,73 | 9,57 | 10,28 | 8,73 | 9,24 | 9,86 |
| Depth at 1st joint digit 3 | 10,15 | 11,86 | 12,74 | 10,73 | 11,45 | 12,27 | 10,52 | 11,18 | 11,87 |
| Depth at 2nd joint digit 5 | 11,36 | 12,32 | 12,67 | 11,09 | 11,87 | 13,12 | 11,03 | 11,69 | 12,36 |
| Depth at 2nd joint digit 3 | 13,84 | 15,15 | 15,98 | 13,29 | 14,90 | 16,48 | 13,55 | 14,50 | 15,48 |
| Maximum breadth of the hand | 83,56 | 85,66 | 87,42 | 80,61 | 86,30 | 91,01 | 79,72 | 84,71 | 88,87 |
| Breadth at the knuckles | 70,10 | 72,77 | 76,17 | 68,71 | 72,71 | 76,31 | 67,64 | 71,65 | 77,37 |
| Length of hand | 158,84 | 169,60 | 178,96 | 162,08 | 171,60 | 178,98 | 161,73 | 169,53 | 179,77 |
| 3rd digit to base of the thumb | 110,65 | 116,43 | 119,54 | 113,28 | 120,88 | 127,91 | 110,34 | 119,33 | 126,08 |
| Depth at knuckles | 24,47 | 25,49 | 27,34 | 23,76 | 25,90 | 28,10 | 23,29 | 24,69 | 27,50 |
| Maximum depth of the hand | 33,99 | 36,50 | 41,77 | 33,36 | 37,12 | 40,59 | 33,18 | 36,99 | 39,45 |

**Table 5.** Tabulated results of significance test between the data for the Indonesian females from the different ethnic group

| Hand dimension | Bataknese vs Javanese | | | Bataknese vs Sundanese | | | Javanese vs Sundanese | | |
|---|---|---|---|---|---|---|---|---|---|
| | %Diff. | p-value | | %Diff. | p-value | | %Diff. | p-value | |
| Fingertip to root digit 5 | -2.13 | 0.216 | | -2.12 | 0.249 | | -0.01 | 0.988 | |
| Fingertip to root digit 3 | 2.96 | 0.052 | | 0.57 | 0.745 | | 2.405 | 0.003 | * |
| First joint to root digit 5 | -0.65 | 0.742 | | 0.35 | 0.851 | | -1 | 0.312 | |
| First joint to root digit 3 | 5.58 | 0.002 | * | 2.13 | 0.168 | | 3.522 | <0.001 | * |
| Second joint to root digit 5 | -2.30 | 0.423 | | -0.90 | 0.751 | | -1.38 | 0.341 | |
| Second joint to root digit 3 | 4.62 | 0.038 | * | 5.21 | 0.004 | * | -0.62 | 0.589 | |
| Breadth at tip digit 5 | -3.41 | 0.049 | * | -0.57 | 0.715 | | -2.82 | 0.002 | * |
| Breadth at tip digit 3 | -2.43 | 0.045 | * | -2.88 | 0.032 | * | 0.435 | 0.509 | |
| Breadth at 1st joint of digit 5 | -3.10 | 0.031 | * | -5.55 | 0.002 | * | 2.328 | 0.003 | * |
| Breadth at 1st joint of digit 3 | -1.69 | 0.149 | | -1.82 | 0.129 | | 0.129 | 0.834 | |
| Breadth at 2nd joint of digit 5 | -1.72 | 0.202 | | -4.70 | 0.002 | * | 2.85 | <0.001 | * |
| Breadth at 2nd joint of digit 3 | -1.46 | 0.193 | | -3.17 | 0.023 | * | 1.653 | 0.004 | * |
| Depth at tip digit 5 | -6.42 | 0.002 | * | -8.24 | <0.001 | * | 1.674 | 0.092 | |
| Depth at tip digit 3 | -2.49 | 0.057 | | -5.71 | <0.001 | * | 3.046 | <0.001 | * |
| Depth at 1st joint digit 5 | -0.36 | 0.825 | | -3.06 | 0.024 | * | 2.618 | <0.001 | * |
| Depth at 1st joint digit 3 | -0.87 | 0.496 | | -4.01 | 0.009 | * | 3.016 | <0.001 | * |
| Depth at 2nd joint digit 5 | -1.50 | 0.333 | | -3.30 | 0.005 | * | 1.737 | 0.027 | * |
| Depth at 2nd joint digit 3 | -0.13 | 0.944 | | -3.21 | 0.022 | * | 2.981 | 0.002 | * |
| Maximum breadth of the hand | 0.52 | 0.675 | | -1.50 | 0.154 | | 1.986 | <0.001 | * |
| Breadth at the knuckles | -0.64 | 0.493 | | -1.48 | 0.266 | | 0.826 | 0.146 | |
| Length of hand | 1.29 | 0.139 | | 0.31 | 0.77 | | 0.988 | 0.047 | * |
| 3rd digit to base of the thumb | 4.64 | <0.001 | * | 3.04 | 0.035 | * | 1.653 | 0.010 | * |
| Depth at knuckles | 0.95 | 0.554 | | -2.42 | 0.156 | | 3.292 | <0.001 | * |
| Maximum depth of the hand | -1.13 | 0.535 | | -2.00 | 0.329 | | 0.854 | 0.387 | |

*significant ($p$<0.05)

**Comparison with other populations**

The hand dimension data of this study were compared with those of other populations. The other population characteristics are shown in Table 6, while summary data are presented in Table 7. Table 8 gives the tabulated results of percentage differences and t-statistics between the Indonesian females and the other nations. As seen in Table 8, the differences in 19 hand dimensions were found to be significant between Indonesian females and the Jordanian females. Twenty-three hand dimensions of the Bangladeshis females was significantly different to those of Indonesian females. There were 21 hand dimensions of the Vietnamese which were significantly different to those of Indonesian females. All hand dimensions of the Hong Kong Chinese females were significantly different to those of Indonesian females. Fourteen hand dimensions of the Nigerian significantly different to those of Indonesian females. Twenty-one hand dimensions of the Indonesian females were significantly different to the UK resident females.

According to the above comparisons, Indonesian females have longer hands than Vietnamese and Bangladeshis females. They were indicated by the significant differences in hand dimensions such as length of hand and first joint to root digit 5. However, Indonesian females had shorter hands than the Hong Kong Chinese, Jordanian, Nigerian, and UK Resident females, which were indicated by the significant differences in hand dimensions such as fingertip to root digit 5. Indonesian females also had thicker hands than Hong Kong Chinese and Nigerian females, but thinner than the Bangladeshis, Vietnamese, Jordanian, and UK Resident females. Although many differences on hand dimensions were found, conclusion on the differences was difficult to be reached.

Slightly similar to the cause of the hand anthropometric differences among ethnic groups in Indonesia, the differences between Indonesian and other population might be caused by nutrition intake. Most Indonesian, particularly the Javanese, rely on the soybean products such as tempeh and tofu as the main source of protein [22]. On the other hand, other population such as Jordanian consumed more animal origin products such as meat, egg, and milk [23]. The difference in the dietary pattern might affect the hand dimensions, particularly on the dimensions which are related to thickness of the hand.

**Table 6.** Characteristics of comparison samples from other published studies

| Nationality | Sample size | Number of hand dimensions | Year of data collection | Mean age or age range (years) | Mean weight | Mean height (cm) | Occupations |
|---|---|---|---|---|---|---|---|
| Indonesia (this study) | 202 | 24 | 2015 | 21.34 | 52.9 kg | 157.8 | College students |
| Bangladeshis [2] | 50 | 24 | 2005 | N/A | N/A | N/A | Industrial/manufacturing workers, clerical workers, home makers, and college students |
| Hong Kong Chinese [10] | 100 | 22 | 1984 | 15-33 | N/A | N/A | Clothing industry workers |
| Jordanian [3] | 120 | 24 | 2006 | 28.03 | 63.51 kg | 162.19 | Various type of jobs, including carpenters, drivers, technician, police, engineers, nurses, and students |
| Nigerian [11] | 37 | 28 | 2000 | 33.51 | 516.07 N | 157.22 | Farmers |
| UK Resident [20] | 92 | 22 | 1980 | N/A | N/A | | Industrial workers |
| Vietnamese [12] | 30 | 24 | 1993 | 24.8 | 476.8 N | 155.9 | Industrial workers, home makers, and college students. |

**Table 7.** Summary data of hand dimensions (in mm) of Indonesian young adult females and other populations

| (a) | Indonesian | | Jordanian | | Bangladeshis | | Vietnamese | |
|---|---|---|---|---|---|---|---|---|
| Hand dimension | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Fingertip to root digit 5 | 53.86 | 2.58 | 51.9 | 4.1 | 55.7 | 3.88 | 56.63 | 3.4 |
| Fingertip to root digit 3 | 73.52 | 3.64 | 73.3 | 3.3 | 77.49 | 3.7 | 75.15 | 3.62 |
| First joint to root digit 5 | 33.66 | 2.00 | 30.4 | 3.3 | 35.47 | 3.5 | 34.16 | 2.97 |
| First joint to root digit 3 | 50.41 | 3.02 | 45.8 | 4.2 | 54.76 | 3.21 | 50.74 | 3.95 |
| Second joint to root digit 5 | 18.17 | 1.69 | 16.4 | 2.3 | 18.7 | 2.79 | 18.34 | 1.79 |
| Second joint to root digit 3 | 26.06 | 1.81 | 23.5 | 3.3 | 27.36 | 2.6 | 26.11 | 2.57 |
| Breadth at tip digit 5 | 10.30 | 0.58 | 10.6 | 1.1 | 10.83 | 0.95 | 10.53 | 0.87 |
| Breadth at tip digit 3 | 12.60 | 0.54 | 13.4 | 1.1 | 13.38 | 0.87 | 13.64 | 1 |
| Breadth at 1st joint of digit 5 | 11.20 | 0.58 | 12.7 | 0.9 | 12.63 | 0.88 | 13.54 | 0.96 |
| Breadth at 1st joint of digit 3 | 13.64 | 0.52 | 15.5 | 1.2 | 14.88 | 0.83 | 15.83 | 0.99 |
| Breadth at 2nd joint of digit 5 | 13.18 | 0.59 | 15.4 | 1.3 | 14.51 | 0.9 | 15.3 | 1.05 |
| Breadth at 2nd joint of digit 3 | 16.19 | 0.61 | 18.2 | 2.1 | 17.38 | 0.97 | 18.11 | 1.1 |
| Depth at tip digit 5 | 9.57 | 0.61 | 9.08 | 1.1 | 8.27 | 0.71 | 10.92 | 0.94 |
| Depth at tip digit 3 | 11.45 | 0.58 | 10.5 | 1.4 | 9.46 | 0.92 | 12.92 | 1.02 |
| Depth at 1st joint digit 5 | 9.48 | 0.45 | 10.1 | 1.4 | 10.49 | 0.81 | 11.46 | 1.12 |
| Depth at 1st joint digi 3 | 11.41 | 0.50 | 12.2 | 1.5 | 12.15 | 0.82 | 13.22 | 0.96 |
| Depth at 2nd joint digit 5 | 11.89 | 0.57 | 12.8 | 1.3 | 12.98 | 0.92 | 13.94 | 1.17 |
| Depth at 2nd joint digit 3 | 14.79 | 0.88 | 15.5 | 1.7 | 15.73 | 0.84 | 16.37 | 1.24 |
| Maximum breadth of the hand | 85.66 | 3.18 | 88.6 | 5.4 | 91.48 | 4.5 | 93.99 | 5.63 |
| Breadth at the knuckles | 72.43 | 2.51 | 73.9 | 4.2 | | | 77.82 | 3.92 |
| Length of hand | 170.72 | 5.24 | 167 | 10 | | | 171.27 | 7.44 |
| 3rd digit to base of the thumb | 120.00 | 4.85 | 128 | 7.6 | 115.78 | 5.39 | 124.49 | 6.48 |
| Depth at knuckles | 25.62 | 1.37 | 27.4 | 4 | 24.37 | 1.47 | 28.36 | 2.26 |
| Maximum depth of the hand | 36.79 | 2.28 | 41.6 | 2.8 | 29.73 | 2.82 | 40.35 | 4.26 |

| (b) Hand dimension | Hong Kong Chinese | | Nigerian | | UK Resident | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Fingertip to root digit 5 | 54.21 | 4.93 | 77.8 | 5.3 | 54.5 | 4.5 |
| Fingertip to root digit 3 | 74.2 | 5.49 | 33.9 | 3.6 | 72.3 | 4.6 |
| First joint to root digit 5 | 31.46 | 3.87 | 51.5 | 5.2 | 32 | 3.3 |
| First joint to root digit 3 | 48.62 | 4.62 | 17.6 | 2.2 | 47.9 | 6.1 |
| Second joint to root digit 5 | 15.45 | 3.15 | 27.9 | 3.6 | 19.2 | 3.4 |
| Second joint to root digit 3 | 22.45 | 2.83 | 10.6 | 1.1 | 25.2 | 2.7 |
| Breadth at tip digit 5 | | | 13.3 | 1.1 | 11.9 | 2.5 |
| Breadth at tip digit 3 | | | 12.5 | 1.1 | 14.6 | 2.7 |
| Breadth at 1st joint of digit 5 | 13.19 | 1.71 | 15.1 | 1.2 | 13.3 | 2.3 |
| Breadth at 1st joint of digit 3 | 14.84 | 2.05 | 13.7 | 1.3 | 15.9 | 2.5 |
| Breadth at 2nd joint of digit 5 | 14.5 | 1.77 | 17.6 | 1.3 | 14.9 | 2.4 |
| Breadth at 2nd joint of digit 3 | 17.89 | 1.95 | 9 | 1.1 | 17.9 | 2.5 |
| Depth at tip digit 5 | 11.11 | 1.45 | 10.4 | 1.1 | 8.6 | 2.6 |
| Depth at tip digit 3 | 12.67 | 1.42 | 10.4 | 1.1 | 10.3 | 2.6 |
| Depth at 1st joint digit 5 | | | 12.6 | 1.1 | 8.5 | 3 |
| Depth at 1st joint digi 3 | | | 13.7 | 1.3 | 10.7 | 2.5 |
| Depth at 2nd joint digit 5 | | | 16.8 | 1.3 | 11.5 | 2.4 |
| Depth at 2nd joint digit 3 | | | 94.1 | 5.6 | 13.9 | 2.3 |
| Maximum breadth of the hand | 87.94 | 4.99 | | | 86.8 | 6.1 |
| Breadth at the knuckles | 75.75 | 5.17 | | | 71 | 4.3 |
| Length of hand | 175.05 | 11.07 | 125.9 | 8.8 | 165 | 9 |
| 3rd digit to base of the thumb | | | 26.4 | 2.9 | 110.7 | 9.1 |
| Depth at knuckles | 22.71 | 2.85 | 40.5 | 4.9 | 23.5 | 4 |
| Maximum depth of the hand | | | 56.9 | 4.4 | 40.9 | 4.9 |

**Table 8.** Comparison of hand dimensions between Indonesian and other nationalities

| (a) Hand dimension | Indonesian vs Jordanian | | | Indonesian vs Bangladeshis | | | Indonesian vs Vietnamese | | |
|---|---|---|---|---|---|---|---|---|---|
| | %diff | t-statistics | | %diff | t-statistics | | %diff | t-statistics | |
| Fingertip to root digit 5 | -5,14 | -8,25 | * | 3,64 | 3,93 | * | -1,19 | -1,13 | |
| Fingertip to root digit 3 | -2,22 | -3,89 | * | 0,30 | 0,35 | | 1,66 | 1,65 | |
| First joint to root digit 5 | -1,48 | -1,8 | | 9,69 | 8,33 | * | 4,94 | 3,84 | * |
| First joint to root digit 3 | -0,65 | -0,84 | | 9,15 | 8,22 | * | 4,98 | 3,61 | * |
| Second joint to root digit 5 | -0,94 | -0,85 | | 9,74 | 5,67 | * | -5,68 | -2,65 | * |
| Second joint to root digit 3 | -0,20 | -0,2 | | 9,81 | 6,96 | * | 3,29 | 2,26 | * |
| Breadth at tip digit 5 | -2,23 | -2,84 | * | -2,91 | -2,51 | * | -15,53 | -7,86 | * |
| Breadth at tip digit 3 | -8,25 | -12,11 | * | -6,34 | -6,96 | * | -15,86 | -9,43 | * |
| Breadth at 1st joint of digit 5 | -20,85 | -27,28 | * | -13,36 | -13,5 | * | -18,71 | -10,95 | * |
| Breadth at 1st joint of digit 3 | -16,10 | -25,99 | * | -13,68 | -15,8 | * | -16,61 | -11,41 | * |
| Breadth at 2nd joint of digit 5 | -16,11 | -23,2 | * | -16,87 | -17,1 | * | -13,07 | -8,66 | * |
| Breadth at 2nd joint of digit 3 | -11,88 | -20,15 | * | -12,44 | -11,5 | * | -10,58 | -8,28 | * |
| Depth at tip digit 5 | -14,11 | -15,62 | * | 5,12 | 3,97 | * | 10,13 | 4,57 | * |
| Depth at tip digit 3 | -12,80 | -16,49 | * | 8,33 | 7,09 | * | 10,08 | 5,49 | * |
| Depth at 1st joint digit 5 | -20,94 | -22,3 | * | -6,59 | -5,13 | * | 10,30 | 4,37 | * |
| Depth at 1st joint digit 3 | -15,82 | -22,21 | * | -6,88 | -6,02 | * | 6,26 | 14,82 | * |
| Depth at 2nd joint digit 5 | -17,24 | -21,06 | * | -7,65 | -7,11 | * | 3,28 | 1,98 | * |
| Depth at 2nd joint digit 3 | -10,66 | -13,33 | * | -4,78 | -3,88 | * | 6,04 | 3,92 | * |
| Maximum breadth of the hand | -9,72 | -16,97 | * | -3,43 | -4,67 | * | -1,33 | -1,58 | |
| Breadth at the knuckles | -7,45 | -15,04 | * | -2,03 | -2,98 | * | 1,97 | 2,61 | * |
| Length of hand | -0,32 | -0,78 | | 2,18 | 3,43 | * | 3,35 | 5 | * |
| 3rd digit to base of the thumb | -3,75 | -7,07 | * | -6,67 | -8,57 | * | 7,75 | 8,54 | * |
| Depth at knuckles | -10,68 | -13,55 | * | -6,94 | -5,04 | * | 8,28 | 5,67 | * |
| Maximum depth of the hand | -9,67 | -9,76 | * | -13,06 | -11,7 | * | -11,16 | -7,63 | * |

| (b) Hand dimension | Indonesian vs Hong Kong Chinese | | | Indonesian vs Nigerian | | | Indonesian vs UK Resident | | |
|---|---|---|---|---|---|---|---|---|---|
| | %diff | t-statistics | | %diff | t-statistics | | %diff | t-statistics | |
| Fingertip to root digit 5 | -3,42 | -4,9 | * | -0,65 | -0,64 | | -5,65 | -7,42 | * |
| Fingertip to root digit 3 | -5,40 | -8,87 | * | -0,92 | -0,96 | | -5,82 | -8,05 | * |
| First joint to root digit 5 | -5,37 | -5,71 | * | 6,54 | 5,17 | * | -0,70 | -0,73 | |
| First joint to root digit 3 | -8,63 | -11,54 | * | 3,55 | 3,02 | * | -2,16 | -2,26 | * |
| Second joint to root digit 5 | -2,92 | -2,05 | * | 14,96 | 7,67 | * | 3,13 | 2,43 | * |
| Second joint to root digit 3 | -5,00 | -5,05 | * | 13,84 | 10,1 | * | -7,07 | -5,83 | * |
| Breadth at tip digit 5 | -5,14 | -5,99 | * | | | | -2,91 | -3,06 | * |
| Breadth at tip digit 3 | -6,18 | -9,56 | * | | | | -5,55 | -7,32 | * |
| Breadth at 1st joint of digit 5 | -12,73 | -16,86 | * | -17,73 | -13 | * | -11,57 | -13,25 | * |
| Breadth at 1st joint of digit 3 | -9,13 | -15,87 | * | -8,84 | -7,2 | * | -10,74 | -14,57 | * |
| Breadth at 2nd joint of digit 5 | -10,11 | -15,37 | * | -10,04 | -8,41 | * | -3,97 | -4,72 | * |
| Breadth at 2nd joint of digit 3 | -7,37 | -13,01 | * | -10,52 | -10,1 | * | -8,73 | -12,67 | * |
| Depth at tip digit 5 | 13,58 | 16,49 | * | -16,10 | -10,8 | * | 5,95 | 5,69 | * |
| Depth at tip digit 3 | 17,41 | 22,91 | * | -10,61 | -8,87 | * | 9,20 | 10,7 | * |

| (b) Hand dimension | Indonesian vs Hong Kong Chinese | | | Indonesian vs Nigerian | | | Indonesian vs UK Resident | | |
|---|---|---|---|---|---|---|---|---|---|
| | %diff | t-statistics | | %diff | t-statistics | | %diff | t-statistics | |
| Depth at 1st joint digit 5 | -10,70 | -13,92 | * | | | | -9,75 | -10,18 | * |
| Depth at 1st joint digi 3 | -6,45 | -9,7 | * | | | | -10,39 | -12,77 | * |
| Depth at 2nd joint digit 5 | -9,17 | -12,65 | * | | | | -15,22 | -16,61 | * |
| Depth at 2nd joint digit 3 | -6,33 | -8,87 | * | | | | -13,56 | 15,52 | * |
| Maximum breadth of the hand | -6,79 | -12,98 | * | -2,66 | -3,63 | * | -9,85 | -16,4 | * |
| Breadth at the knuckles | | | | -4,59 | -6,05 | * | | | |
| Length of hand | | | | -2,53 | -3,74 | * | | | |
| 3rd digit to base of the thumb | 3,51 | 6,86 | * | | | | -4,92 | -7,39 | * |
| Depth at knuckles | 4,89 | 7,28 | * | 11,37 | 9,68 | * | -3,03 | -3,14 | * |
| Maximum depth of the hand | 19,20 | 23,36 | * | | | | -10,07 | -8,87 | * |

*significant ($p$<0.05)

## Conclusion

This study provided new hand anthropometric data that may be useful for the design and selection of the hand-operated products for Indonesian young adult females. Furthermore, the hand anthropometric data of this study showed that the Javanese females had longer, wider, and thicker hands than the Sundanese, which was indicated by the significant differences in hand dimensions such as length of hand, maximum breadth of the hand, and thumb thickness. Slightly similar, the Bataknese females had wider and thicker hands than the Sundanese that were indicated by the significant differences in dimensions such as breadth at 1st joint of digit 5 and index finger breadth. On the other hand, the Javanese females appeared to have quite a similar hand anthropometry to the Bataknese. Only nine hand dimensions of the Javanese and Bataknese that were significantly different

Moreover, compared to the hand dimensions of other nationalities, the Indonesian young adult females appeared to have longer hands than Vietnamese and Bangladeshis females. However, they had shorter hands than the Hong Kong Chinese, Jordanian, Nigerian, and UK Resident females. Indonesian females also had thicker hands than Hong Kong Chinese and Nigerian females, but thinner than Bangladeshis, Vietnamese, Jordanian, and UK Resident females. Although many differences on hand dimensions existed among the Indonesian young adult females and other nationalities, a general conclusion on the differences was difficult to be reached. However, the differences of the hand anthropometry should be still considered in the design process or selection of hand-operated products for the Indonesian young adult females market.

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