

Hand Anthropometry of Thai Female Industrial Workers

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Abstract

The objectives of this study were to determine various hand dimensions for Thai female industrial workers and to compare the data obtained from this study with some other populations. One hundred and fifty female subjects who had normal hands were used in this study. The average values and standard deviations of age, height, and weight of the subjects were 25.1 (± 5.4) years, 155.3 (± 5.6) cm, and 51.9 (± 8.6) kg, respectively. The apparatus used to measure the dimensions was 3-Dimensional Digitizer, ISOTRAK II interfaced with a computer. The ISO 7250: 1996 (E) [1] was utilized in the measurements with some adaptations. Forty-six landmarks were identified and marked on the subjects' hands and arms, and then, digitized into a computer system. After that, forty-one dimensions were calculated from the coordinates obtained from the digitizing. The values of means, standard deviations, and 5th and 95th percentiles for all dimensions were tabulated. Then, the means of 18 dimensions obtained from this study were compared with the means of the same dimensions of Hong Kong, British, and Indian female populations utilizing two tailed t-test with the level of significant of 5%. The comparison results indicated that Thai females tended to have wider and thicker fingers but narrower knuckles than the females from Hong Kong, British, and India.

1. Introduction

Anthropometric data is very useful in designing functions concerning with human. Without such data,

the designs cannot fit people who are going to use them. Therefore, the information about human sizes is essential to be implemented in the design of various facilities.

Hand anthropometry is also very important to be used in designing projects dealing with human hands. The examples of such facilities are machine guards, hand tools, handles of luggage, and so on. Although this information is necessary, the complete set of hand anthropometry was not exist in Thailand. The objectives of this work were to measure hand sizes for Thai female workers who have been working in factories and also to compare the results of the present work with Hong Kong, British, and Indian populations.

2. Method

2.1 Subjects

One hundred and fifty Thai female industrial workers were used as subjects of this study. All of the subjects had normal hands. They have been working in various factories in central region of Thailand. The measurement was carried out in the subjects' workplaces.

2.2 Apparatus

A 3-dimensional digitizer, ISOTRAK II was used to obtain the three-dimensional coordinates of the landmarks specified on the subjects' hands and arms. This facility utilizes low-frequency electromagnetic field technology to determine positions and orientations of a remote objects in vectors. The electromagnetic

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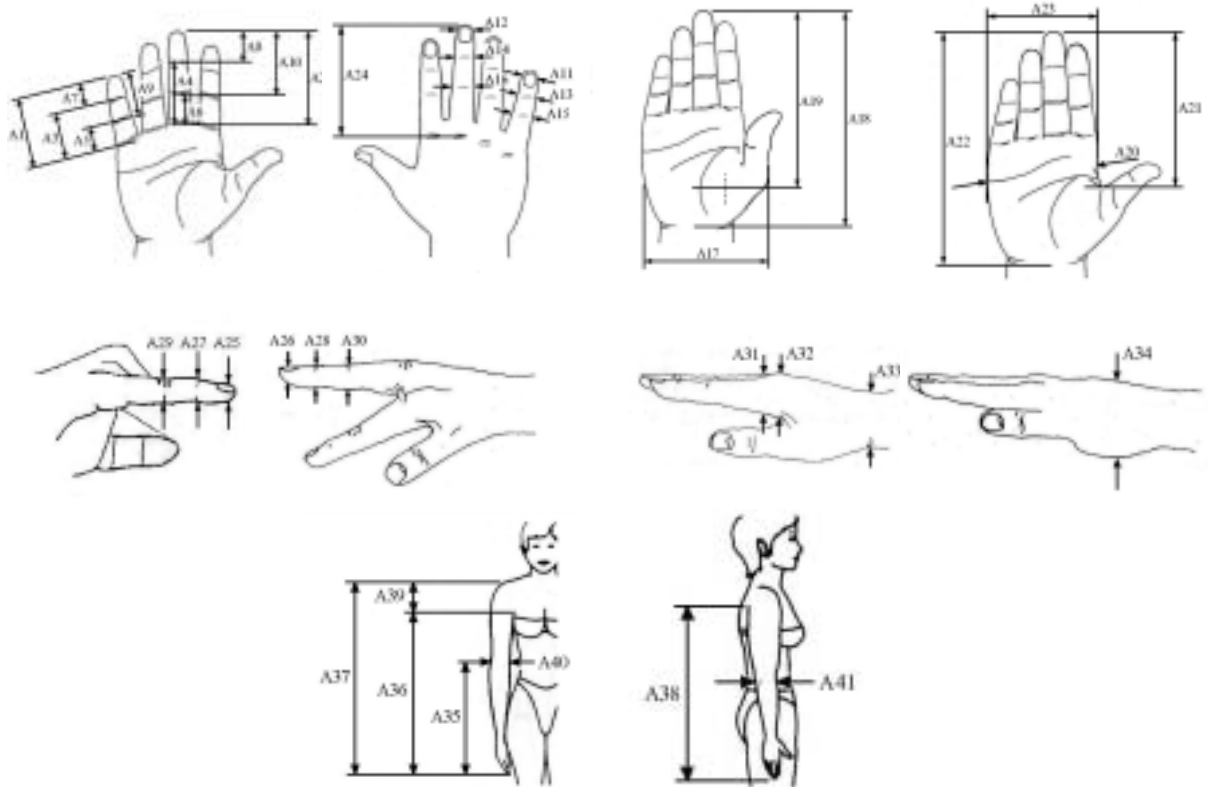


Figure 1 The 41 Dimensions Measured.

field is generated by a stationary component called “transmitter”. A component used to determine the positions and orientations of the object is called “receiver”. The whole facility consists of a system electronic unit (SEU), 1 or 2 receivers, and a transmitter. The ISOTRAK II has a RS-232 interface to a computer. The resolution of this unit is 0.0038 cms/cm of range. This system was assessed and suggested that it has sufficient precision and reliable facility for this purpose [2].

2.3 Measuring Procedure

At the beginning of the measurement, 46 anatomical landmarks were identified and marked on the right hand and arm of each subject. Then, these points were digitized and the coordinates (x, y, and z) were recorded into a computer. After that, these digitized coordinates were used in calculating 41 hand dimensions. The ISO 7250:1996 (E) [1] basic human body measurement for technological design, along with the dimensions measured by Davies et al.

[3] were utilized in this work with some adaptations. All of the measurements were carried out in the subjects’ work places. The 41 dimensions measured in this study are presented in Figure 1. The names of all 41 dimensions are as follow: A1: fingertip to root digit 5, A2: fingertip to root digit 3, A3: 1st joint to root digit 5, A4: 1st joint to root digit 3, A5: 2nd joint to root digit 5, A6: 2nd joint to root digit 3, A7: fingertip to 1st joint digit 5, A8: fingertip to 1st joint digit 3, A9: fingertip to 2nd joint digit 5, A10: fingertip to 2nd joint digit 3, A11: width at tip digit 5, A12: width at tip digit 3, A13: width at 1st joint digit 5, A14: width at 1st joint digit 3, A15: width at 2nd joint digit 5, A16: width at 2nd joint digit 3, A17: maximum width of hand, A18: length of hand, A19: fingertip to carpometacarpal joint, A20: width at knuckles, A21: third digit to base of thumb, A22: fingertip to wrist joint, A23: hand breadth at metacarpals, A24: fingertip to metacarpophalangeal joint, A25: depth at tip digit 5, A26: depth at tip digit 3, A27: depth at 1st joint digit 5, A28: depth

at 1st joint digit 3, A29: depth at 2nd joint digit 5, A30: depth at 2nd joint digit 3, A31: depth at metacarpophalangeal joint digit 3, A32: depth at

knuckles, A33: depth at wrist joint, A34: maximum depth of hand, A35: fingertip to elbow joint, A36: fingertip to acromion, A37: fingertip to front axilla, A38: fingertip to back axilla, A39: acromion to front axilla, A40: elbow breadth, A41: depth at elbow joint.

Table 1 Descriptive Statistics for Hand Dimensions (IN mm) of Thai Female Workers Obtained from this Study

| Dimension | Mean | SD | Percentile | |
|-----------|--------|-------|-----------------|------------------|
| | | | 5 th | 95 th |
| A1 | 55.89 | 3.34 | 50.39 | 61.39 |
| A2 | 76.77 | 3.24 | 71.44 | 82.10 |
| A3 | 34.46 | 3.02 | 29.49 | 39.42 |
| A4 | 52.98 | 2.60 | 48.70 | 57.25 |
| A5 | 17.02 | 2.18 | 13.43 | 20.61 |
| A6 | 25.91 | 2.19 | 22.31 | 29.51 |
| A7 | 21.44 | 1.40 | 19.13 | 23.74 |
| A8 | 23.79 | 1.34 | 21.59 | 25.99 |
| A9 | 38.87 | 1.61 | 36.22 | 41.52 |
| A10 | 50.86 | 1.50 | 48.38 | 53.33 |
| A11 | 11.08 | 0.80 | 9.76 | 12.40 |
| A12 | 13.45 | 0.71 | 12.29 | 14.62 |
| A13 | 12.85 | 0.68 | 11.74 | 13.96 |
| A14 | 15.53 | 0.94 | 13.99 | 17.07 |
| A15 | 15.21 | 0.69 | 14.08 | 16.35 |
| A16 | 18.02 | 0.82 | 16.67 | 19.37 |
| A17 | 89.95 | 4.02 | 83.33 | 96.57 |
| A18 | 177.22 | 7.04 | 165.63 | 188.80 |
| A19 | 139.35 | 5.26 | 130.70 | 148.00 |
| A20 | 71.96 | 3.36 | 66.44 | 77.48 |
| A21 | 116.09 | 4.64 | 108.46 | 123.73 |
| A22 | 181.99 | 7.10 | 170.32 | 193.67 |
| A23 | 70.16 | 3.29 | 64.75 | 75.56 |
| A24 | 97.33 | 4.35 | 90.17 | 104.49 |
| A25 | 9.04 | 0.68 | 7.91 | 10.16 |
| A26 | 10.27 | 0.77 | 9.00 | 11.54 |
| A27 | 10.62 | 0.85 | 9.22 | 12.03 |
| A28 | 12.58 | 0.84 | 11.19 | 13.96 |
| A29 | 13.72 | 0.92 | 12.20 | 15.24 |
| A30 | 16.60 | 0.74 | 15.39 | 17.81 |
| A31 | 24.09 | 2.63 | 19.77 | 28.42 |
| A32 | 27.30 | 2.09 | 23.86 | 30.75 |
| A33 | 32.39 | 2.65 | 28.03 | 36.75 |
| A34 | 35.63 | 2.53 | 31.47 | 39.78 |
| A35 | 399.13 | 12.28 | 378.94 | 419.33 |
| A36 | 688.03 | 19.29 | 656.30 | 719.76 |
| A37 | 602.09 | 21.53 | 566.68 | 637.51 |
| A38 | 591.43 | 22.11 | 555.06 | 627.81 |
| A39 | 86.20 | 8.05 | 72.97 | 99.44 |
| A40 | 52.34 | 3.31 | 46.89 | 57.79 |
| A41 | 48.14 | 2.59 | 43.89 | 52.39 |

3. Results

According to the calculating results, the means, standard deviations, and the 5th and 95th percentiles of the 41 dimensions are presented in Table 1. Then, some 18 dimensions obtained from this study were used to compare with Hong Kong, British, and Indian populations from Courtney and Ng [4-5], and Davies et al. [3, 6], respectively. The mean values and standard deviations of the 18 dimensions of the 4 populations compared are presented in Table 2. A two-tailed t-test with the level of significance of 5% without assumption of equal variances was used in the comparisons. The comparison results is presented in Table 3.

Table 2 Summary Data of Hand Dimensions (IN mm) of Thai Female Workers Obtained from this Study and the Other Populations

| Dimension | Thai n = 150 | | Hong Kong n = 100 | | British n = 92 | | Indian n = 20 | |
|-----------|-----------------|------|----------------------|------|-------------------|-----|------------------|------|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| A1 | 55.89 | 3.34 | 55.7 | 3.88 | 56.9 | 4.4 | 57.4 | 3.9 |
| A2 | 76.77 | 3.24 | 77.49 | 3.70 | 77.8 | 5.3 | 77.5 | 4.5 |
| A11 | 11.08 | 0.80 | 10.83 | 0.95 | 10.6 | 1.1 | 10.5 | 0.8 |
| A12 | 13.45 | 0.71 | 13.38 | 0.87 | 13.3 | 1.1 | 12.8 | 1.1 |
| A13 | 12.85 | 0.68 | 12.63 | 0.88 | 12.5 | 1.1 | 12.3 | 0.9 |
| A14 | 15.53 | 0.94 | 14.88 | 0.83 | 15.1 | 1.2 | 14.5 | 1.05 |
| A15 | 15.21 | 0.69 | 14.51 | 0.90 | 13.7 | 1.3 | 13.9 | 1.05 |
| A16 | 18.02 | 0.82 | 17.38 | 0.97 | 17.6 | 1.3 | 17.0 | 1.1 |
| A25 | 9.04 | 0.68 | 8.27 | 0.71 | 9.0 | 1.1 | 8.2 | 0.9 |
| A26 | 10.27 | 0.77 | 9.46 | 0.92 | 10.4 | 1.1 | 10.0 | 0.7 |
| A27 | 10.62 | 0.85 | 10.49 | 0.81 | 10.4 | 1.1 | 10.2 | 0.7 |
| A28 | 12.58 | 0.84 | 12.15 | 0.82 | 12.6 | 1.1 | 12.2 | 0.7 |
| A29 | 13.72 | 0.92 | 12.98 | 0.92 | 13.7 | 1.3 | 13.7 | 1.4 |
| A30 | 16.6 | 0.74 | 15.73 | 0.84 | 16.8 | 1.3 | 16.4 | 0.8 |
| A17 | 89.95 | 4.02 | 91.48 | 4.47 | 94.1 | 5.6 | 94.1 | 5.6 |
| A32 | 27.30 | 2.09 | 24.37 | 1.47 | 26.4 | 2.9 | 26.4 | 2.9 |
| A34 | 35.63 | 2.53 | 29.73 | 2.82 | 40.5 | 4.9 | - | - |
| A21 | 116.09 | 4.64 | 115.8 | 5.39 | 125.9 | 8.8 | 128.6 | 7.1 |

Table 3 The Comparison Results between the Thai Female Industrial Workers Obtained from this Study and the other Population S = ($p < 0.05$), HS = ($p < 0.001$), NS = The Null Hypothesis Cannot be Rejected

| Dimension | Thai vs. Hong Kong | | Thai vs. British | | Thai vs. Indian | |
|-----------|--------------------|---------|------------------|---------|-----------------|---------|
| | t | Results | t | Results | t | Results |
| A1 | 0.41 | NS | -1.89 | NS | -1.86 | NS |
| A2 | -1.63 | NS | -1.68 | NS | -0.70 | NS |
| A11 | -6.73 | HS | 3.64 | HS | 3.05 | HS |
| A12 | 0.67 | NS | 1.17 | NS | 2.57 | S |
| A13 | 2.11 | S | 2.75 | S | 3.26 | S |
| A14 | 5.61 | HS | 2.93 | S | 4.54 | S |
| A15 | 6.59 | HS | 10.29 | HS | 5.43 | HS |
| A16 | 5.61 | HS | 2.78 | S | 5.00 | HS |
| A25 | 8.62 | HS | 0.31 | NS | 4.98 | HS |
| A26 | 7.27 | HS | -0.99 | NS | 1.49 | NS |
| A27 | 1.21 | NS | 1.64 | NS | 2.11 | S |
| A28 | 4.00 | HS | -0.15 | NS | 1.93 | NS |
| A29 | 6.23 | HS | 0.13 | NS | 0.06 | NS |
| A30 | 8.62 | HS | -1.35 | NS | 1.12 | NS |
| A17 | -2.82 | S | -6.20 | HS | -3.21 | S |
| A32 | 13.01 | HS | 2.59 | S | 1.34 | NS |
| A34 | 17.25 | HS | -8.84 | HS | - | - |
| A21 | 0.48 | NS | -9.88 | HS | -7.66 | HS |

The results shown in the Table 3 indicated that all of the populations compared tended to have the same finger lengths. For the finger widths, the Thai females tended to have wider fingers than the others. For the finger depths, the Thai woman tended to have thicker fingers than the Hong Kong females but they tended to have the same finger depths with British and Indian women. For the hand widths, the Thai females tended to have narrower hands than the other populations studied. For the hand depths, the Thai women tended to have thicker hands than the Hong Kong females but they tended to have the same hand depths with the Indian women. For the hand lengths, the British and Indian women tended to have longer hands than the Thai females but the Hong Kong women tended to have the same hand lengths with the Thai population.

4. Conclusions

As the anthropometric data of Thai female industrial workers presented in this work, ones who wish to design some facilities concerning with females' hands should implement this information in order to get the better design to fit the users. Especially, if this data is used in designing of machine guards, the number of hand accidents must be decreased.

Based on the data collected, the comparison results indicated that the Thai females tended to have wider and thicker fingers but narrower knuckles than the females from Hong Kong, British, and India. Therefore, when design some facilities, the right set of hand anthropometric data must be considered.

This work concentrated on only the Thai female population. In some cases, the data from the Thai males is needed in the design. Therefore, a study to measure the hands of Thai male population should be conducted.

References

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