

A COMPARATIVE STUDY OF HAND DIMENSIONS BETWEEN THAI AND OTHER POPULATIONS BY GENDER: A LITERATURE REVIEW

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Abstract: Hand anthropometric data are critical for designing hand-operated tools and devices that appropriately fit human hand dimensions. Well-fitted tools improve usability, comfort, and safety while reducing the risk of hand-related musculoskeletal disorders. A key ergonomic design factor is the anatomical difference between male and female hands, which affects grip strength, reach, and tool interaction. This study conducted a structured literature review to synthesize gender-based differences in hand anthropometry among the Thai population and compare them with international findings. Articles were retrieved using the keywords “Hand Anthropometry” and “Hand Anthropometry AND Thai” from six academic databases: Scopus, PubMed, ScienceDirect, SpringerLink, Google Scholar, and TCI. The selection process involved six exclusion steps. First, duplicates and non-anthropometric topics were removed (4 articles). Second, studies unrelated to hand dimensions were excluded (27 articles). Third, studies with fewer than five participants or overly technical focus were excluded (2 articles). Fourth, studies not reporting participant nationality were removed (50 articles). Fifth, studies involving clinical populations or robotics were excluded (12 articles). Sixth, articles lacking sex-disaggregated data or full-text access were removed (12 articles). In total, 45 articles met the inclusion criteria. The analysis showed that Thai males had hand dimensions 3.36–13.42% larger than females, with the most significant differences (over 10%) in hand width. Compared to international studies, hand length in the Thai population demonstrated a greater gender-based gap. These findings emphasize the need to integrate sex-specific anthropometric data in ergonomic design. A nationwide anthropometric survey using standardized digital tools is recommended to support inclusive product development and safety standards in Thailand.

Keywords: hand dimensions, gender, ergonomics, Thai population

1. Introduction

In everyday life and across various occupations, humans use a wide range of tools and devices depending on the context of use, including hand tools and industrial equipment (Kaewdok et al., 2022; Mandahawi et al., 2008; Nag et al., 2003; Okunribido, 2000; Saengchaiya & Bunterngrchit, 2004). The design of tasks and tools, under the concept of “fitting the person to the task” (Imrhan et al., 2009), requires aligning job demands with the physical capabilities of workers—particularly for hand-related tasks that involve the use of tools or personal protective equipment for the hands, which are the primary organs involved in most work activities. However, efficiency and safety are often compromised by poor design that fails to consider proper hand fit (Courtney, 1984; Imrhan et al., 2009; Mandahawi et al., 2008), or by machinery built according to the anthropometric standards of the manufacturing country rather than those of the importing country (Imrhan et al., 2009; Kaewdok et al., 2022; Mandahawi et al., 2008; Okunribido, 2000).

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In Thailand, many types of equipment, hand tools, and protective devices are imported from abroad—often designed using Western anthropometric standards that differ significantly from those of the Thai population. As a result, workers frequently encounter issues such as improper grip size, glove fit, and control handle reach. These mismatches not only reduce comfort and performance but also increase the risk of fatigue and injury, particularly when gender differences in hand size and strength are not adequately considered.

Anthropometric and biomechanical characteristics of the hand—such as grip dimensions and muscle force—should be compatible with the size, shape, and functional requirements of tools. For example, the gripping force, stabilization requirements, twisting, and squeezing actions necessary for operating equipment must align with human capabilities. A mismatch between human body dimensions and equipment size can negatively affect task quality and overall work performance (Imrhan et al., 2009), and also pose risks to worker safety and health.

Many countries have recognized the importance of anthropometric data in designing tools and user interfaces tailored to specific local populations. However, a review of the existing literature reveals two major sources of variation in hand anthropometry: gender differences and cross-national differences.

This issue is particularly relevant for Thailand, where much of the industrial and protective equipment is imported rather than locally designed, leading to potential mismatches in size and fit across genders. Therefore, the objective of this study is to compile anthropometric data on hand dimensions among the Thai population, analyze gender-based differences, and compare the findings with studies from other countries to support the ergonomic design of tools and hand-operated equipment.

2. Materials and Methods

This study conducted a structured literature review to identify hand anthropometry studies relevant to both Thai and international populations. A total of 201 articles were retrieved from six academic databases—Scopus, PubMed, Science Direct, Springer Link, Google Scholar, and the Thai Citation Index (TCI)—covering the publication period from 1993 to 2022. The English keywords used for the search were “Hand Anthropometry” and “Hand Anthropometry AND Thai.”

As illustrated in Figure 1, the initial pool of articles underwent a rigorous multi-stage screening process. The first exclusion stage removed 43 articles that were duplicates or unrelated to hand anthropometry. The second stage excluded 27 studies that did not specifically focus on hand dimensions. The third stage removed 2 studies with sample sizes fewer than five participants or those with an overly narrow technical scope. In the fourth stage, 50 articles were excluded due to the absence of participant nationality information. The fifth stage excluded 22 studies involving special populations, such as students, patients with specific health conditions, or robotic models. Lastly, the sixth stage removed 12 articles that either lacked sex-disaggregated data or did not provide access to the full text.

After applying these six exclusion criteria, a total of 45 articles remained and were deemed eligible for full analysis.

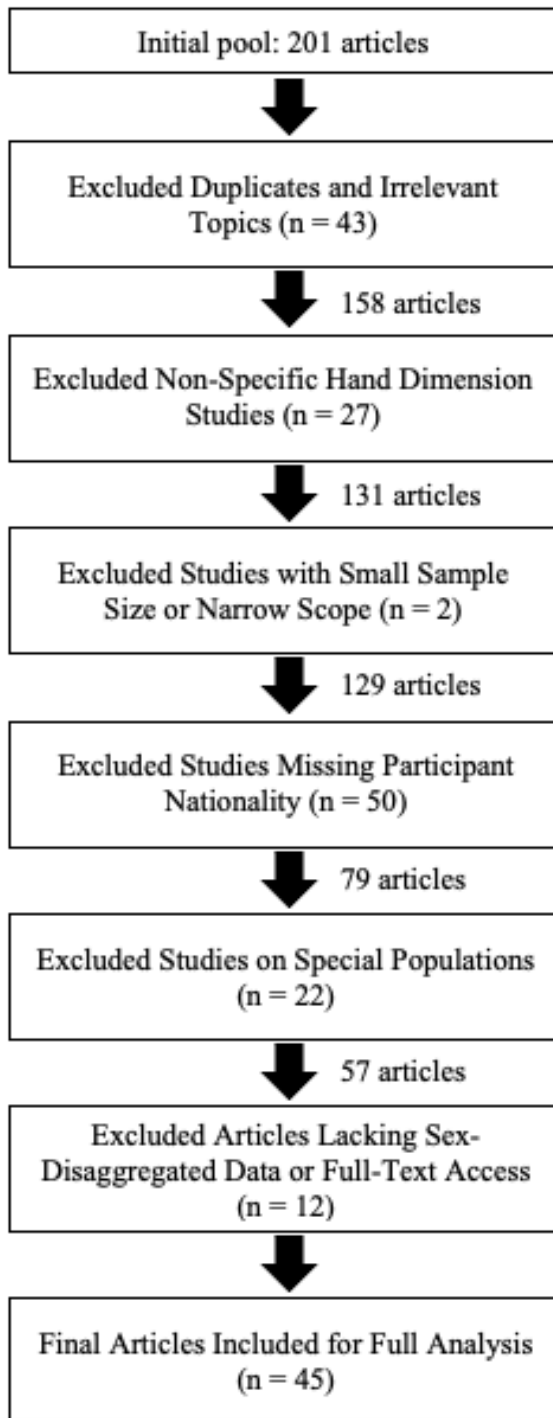


Figure 1 Flow diagram of article selection and exclusion process in the structured literature review

3. Results and Discussion

3.1 Number of Included Articles and Sample Characteristics

This literature review identified 45 articles that met the inclusion criteria, comprising a total of 18,780 participants. The data were summarized based on the geographic distribution across continents and the nationality of participants. The majority of studies were conducted in Asia, accounting for 30 articles with a combined sample of 15,286 individuals. The five leading countries were: (1) India with 9 articles and 5,574 participants, (2) Bangladesh with 7 articles and 2,114 participants, (3) Thailand with 4 articles and 1,281 participants, (4) Korea with 3 articles and 963 participants, and (5) Iran with 2 articles and 4,249 participants. In Africa, 6 studies were identified with 955 participants, the largest proportion being Nigerian samples (2 articles, 371 participants). In the Americas, 5 studies with 1,906 participants were reported, with Cambodia contributing the most (2 articles, 326 participants). In Oceania, only 1 article was found, conducted in Australia with 402 participants. Meanwhile, Europe contributed 2 articles with a total of 1,510 participants, of which Spain represented the largest subgroup (139 participants).

The study with the largest sample size included 3,720 industrial workers and aimed to develop an anthropometric database for the Iranian population, while also comparing body dimensions with four Asian countries—Taiwan, China, Japan, and Korea (Sadeghi et al., 2015). Conversely, the study with the smallest sample size investigated only a single participant, a surgeon, using a 3D hand-scanning device to examine hand functions while wearing surgical gloves. This study aimed to address specific ergonomic challenges encountered during surgical procedures. (Seifert et al., 2019).

When classifying studies by sample type, three groups emerged as the most frequently investigated: (1) laborers, comprising 27 studies with 13,675 participants, mostly from industrial factories without specification of the sector, (2) adults with no occupation specified, reported in 11 studies with 2,682 participants, but identified as belonging to the working-age population, and (3) elderly individuals, reported in 3 studies with 1,131 participants. In addition, 4 studies included general population samples (1,292 participants) without clear specification of occupation or age categories.

3.2 Hand Dimensions of the Thai Population: Findings and Interpretations

Among the 45 studies included in this review, four were conducted in Thailand, involving a total of 1,281 participants. These studies reported hand anthropometric measurements in millimeters, along with standard deviations, across various hand dimensions, as summarized in Table 1. The data were categorized by sex, with a total of 53 distinct hand dimensions reported—comprising 28 length, 13 width, 10 depth, and 2 circumference measurements.

However, only 31 of these dimensions were measured for both males and females, while the remaining 22 dimensions were reported exclusively for females. To ensure consistency and relevance in the analysis, the present study selected data from the most recent Thai publications for each dimension (with reference numbers listed in Table 1), focusing only on dimensions available for both sexes.

The percentage difference between male and female hand dimensions was calculated using the following formula (Equation 1) (Mandahawi et al., 2008):

$$\%(M - F) = \frac{100 * (Mean_{male} - Mean_{female})}{Mean_{male}} \dots \dots \dots Eq. (1)$$

This calculation was applied only to the 31 dimensions for which data were available for both sexes. The results, including both the raw anthropometric data and the calculated percentage differences, are presented in Table 1. In cases where a dimension was reported by only one study, a single value is shown. For dimensions reported in multiple studies, a range of values (from minimum to maximum) is provided to reflect variability across sources (see Table 1).

Despite the valuable insights provided by the four Thai studies, several knowledge gaps remain evident.

First, no comparative analysis has been conducted between Thai hand dimensions and those of populations in other countries, limiting cross-cultural ergonomic applicability.

Second, the range of hand dimensions examined was relatively narrow (53 in total), and only a few studies covered the full set of dimensions, leading to incomplete representativeness.

Third, the existing Thai data were mostly derived from a single adult age group (30–39 years), whereas international datasets typically include a wider age range (18–65 years) following ISO standards.

These limitations highlight the need for future Thai anthropometric studies encompassing broader demographic coverage and standardized measurement protocols to improve national and international ergonomic design reference data.

Table 1. Hand Anthropometric Measurements of Thai Population by Sex and Percentage Differences Across 53 Dimensions

ID	Hand Dimensions	Male (mm)		Female (mm)		% Difference (M–F) [Other Studies]
		\bar{x}	SD	\bar{x}	SD	
Length Dimensions (L)						
1	Fingertip of Digit 3 (Middle Finger) to Wrist Joint (FTD3-WJ)			181.99	7.10	- [-]
2	Hand Length (HL)	182.00	9.00	170.00	8.00	6.59 [2.51-11.62]
3	Fingertip to carpometacarpal joint (FTD3-BD1)			139.35	5.26	- [1.65-9.59]
4	Palm length (PL)	102.20	5.00	95.80	5.70	6.26 [6.91-10.79]
5	Fingertip to metacarpophalangeal joint (FTD3-MJ)			97.23	4.35	- [6.33]
6	Fingertip to root digit 1 (1DL)	61.00	4.90	55.80	4.60	8.52 [8.02-16.44]
7	Fingertip to root digit 2 (2DL)	69.00	4.60	65.50	4.40	5.07 [5.71-8.48]

ID	Hand Dimensions	Male (mm)		Female (mm)		% Difference (M-F) [Other Studies]
		\bar{x}	SD	\bar{x}	SD	
8	Fingertip to root digit 3 (3DL)	74.40	5.20	71.90	4.70	3.36 [3.77-8.75]
9	Fingertip to root digit 4 (4DL)	69.40	4.90	66.40	4.50	4.32 [6.76-8.57]
10	Fingertip to root digit 5 (5DL)	55.20	4.50	52.40	4.40	5.07 [5.50-10.20]
11	1st joint to root digit 3 (1J-RD3)			52.98	2.60	- [3.42-8.99]
12	1st joint to root digit 5 (1J-RD5)			34.46	3.02	- [3.74-13.10]
13	Fingertip to 2nd joint digit 3 (FT-2JD3)			50.86	1.50	- [3.10]
14	Fingertip to 2nd joint digit 5 (FT-2JD5)			38.87	1.61	- [6.26]
15	1st joint to root digit 1 (1J-RD1)	32.60	3.40	30.30	3.40	7.06 [6.90]
16	2nd joint to root digit 2 (2J-RD2)	44.20	4.00	41.50	3.60	6.10 [0.00]
17	2nd joint to root digit 3 (2J-RD3)	49.10	4.00	46.50	3.70	5.30 [3.15-10.92]
18	2nd joint to root digit 4 (2J-RD4)	46.70	3.70	44.30	3.60	5.14 [4.17]
19	2nd joint to root digit 5 (2J-RD5)	37.00	3.80	32.40	3.40	12.43 [1.02-16.81]
20	2nd joint to 1st joint digit 2 (2J-1JD2)	25.20	2.90	23.50	2.70	6.75 [4.76]
21	2nd joint to 1st joint digit 3 (2J-1JD3)	28.00	2.70	26.00	2.80	7.14 [4.00]
22	2nd joint to 1st joint digit 4 (2J-1JD4)	26.40	2.60	24.50	2.50	7.20 [4.35]
23	2nd joint to 1st joint digit 5 (2J-1JD5)	20.10	2.50	18.00	2.50	10.45 [6.25]
24	Fingertip to 1st joint digit 1 (FT-1JD1)	28.80	2.30	26.70	2.40	7.29 [8.82]
25	Fingertip to 1st joint digit 2 (FT-1JD2)	23.20	1.90	22.00	2.20	5.17 [11.54]
26	Fingertip to 1st joint digit 3 (FT-1JD3)	24.60	2.00	22.90	2.00	6.91 [6.10-7.41]
27	Fingertip to 1st joint digit 4 (FT-1JD4)	24.10	2.20	22.50	1.90	6.64 [10.71]
28	Fingertip to 1st joint digit 5 (FT-1JD5)	20.80	1.90	19.30	2.00	7.21 [2.34-8.00]
Breadth Dimensions (B)						
29	Maximum width of hand (MHB)	96.70	5.40	86.00	4.70	11.07 [4.64-14.64]
30	Hand breadth (HB)	87.00	19.00	81.00	20.00	6.90 [3.83-14.60]
31	Breadth of the knuckles (BK)			77.96	3.36	-

ID	Hand Dimensions	Male (mm)		Female (mm)		% Difference (M-F) [Other Studies]
		\bar{x}	SD	\bar{x}	SD	
						[5.30 -11.27]
32	Breadth at 1st joint digit 1 (1JD1B)	20.10	2.00	19.20	1.30	4.48 [12.20]
33	Breadth at 2nd joint digit 2 (2JD2B)	17.00	1.60	15.30	1.40	10.00 [9.69-10.94]
34	Breadth at 2nd joint digit 3 (2JD3B)	17.00	1.50	15.10	1.30	11.18 [4.75-12.86]
35	Breadth at 2nd joint digit 4 (2JD4B)	15.80	1.30	14.10	1.30	10.76 [11.75]
36	Breadth at 2nd joint digit 5 (2JD5B)	14.90	1.40	12.90	1.20	13.42 [5.73-13.58]
37	Breadth at 1st joint digit 3 (1JD3B)			15.53	0.94	- [8.44-18.90]
38	Breadth at 1st joint digit 5 (1JD5B)			15.21	0.69	- [6.03-12.08]
39	Breadth at tip digit 3 (TD3B)			13.45	0.71	- [6.10-13.67]
40	Breadth at tip digit 5 (TD5B)			11.08	0.80	- [4.37-14.25]
41	Maximum Spread of Hand (MSL)	196.40	17.40	181.50	12.90	7.59 [13.37]
42	Maximum Hand Depth (MHD)			35.63	2.53	- [3.64-36.70]
43	Depth at Wrist Joint (DMJ)			32.39	2.65	- [10.93]
44	Depth at Back Knuckle of Index Finger (DK2)			24.09	2.63	- [1.25-10.71]
45	Depth at Metacarpophalangeal Joint of Middle Finger (MCP-D3)			27.30	2.09	- [5.17]
46	Depth at 2nd Joint of digit 3 (2JD3D)			16.60	0.74	- [3.58-12.23]
47	Depth at 1st Joint of digit 3 (1JD3D)			12.58	0.84	- [6.96-13.51]
48	Depth at Tip of digit 3 (TD3D)			10.27	0.77	- [3.21-10.91]
49	Depth at 2nd Joint of digit 5 (2JD5D)			13.72	0.92	- [9.19-17.06]
50	Depth at 1st Joint of digit 5 (1JD5D)			10.62	0.85	- [3.89-13.49]
51	Depth at Tip of digit 5 (TD5D)			9.04	0.68	- [2.72-6.65]
Circumference Dimensions (C)						
52	Maximum Hand Circumference (MHC)	200.00	14.80	182.00	16.00	9.00 [10.53-13.22]
53	Wrist Circumference (WC)	166.00	11.00	155.00	13.00	6.63 [5.61-11.36]

Note. “% Difference” refers to sex-based percentage difference calculated using the formula:

3.3 Comparison of Hand Dimensions by Percentage Difference Categories

Based on the analysis of hand dimensions between males and females in Thailand (see Table 1), the percentage differences ranged from 3.36% to 13.42%, with male measurements consistently larger than those of females. To facilitate interpretation, these differences were classified into three levels: low (less than 5%), moderate (5% to 10%), and high (10% or greater), as summarized in Table 2.

Within the low-difference category, three dimensions were identified: Fingertip to root digit 3 (3DL), Fingertip to root digit 4 (4DL), and Breadth at 1st joint digit 1 (1JD1B). In Thailand, 3DL showed a difference of 3.36%, which was comparable to the finding in Bangladesh at 3.77% (Imrhan et al., 2009), but significantly lower than that of Australia, which reported 8.75% (Ishak et al., 2012). For 4DL, Thailand exhibited a 4.32% difference, while studies in South Korea (Jee & Yun, 2015) and Brazil reported 6.76% and 8.57%, respectively (de Souza & Kunkel, 2022). In the case of 1JD1B, the Thai data indicated a 4.48% difference, whereas a study conducted in South Korea reported a markedly higher difference of 12.20% (Jee et al., 2015).

These findings suggest that although gender-based differences in some hand dimensions appear minimal in the Thai population, substantial variations can be observed in other countries—even within the same region. This reinforces the importance of employing localized anthropometric data when designing hand-operated tools, interfaces, and ergonomic solutions.

Table 2. Classification of Hand Dimension Differences Between Males and Females by Percentage Levels

Group	% Difference (M–F)	[Values from Other Studies]	Dimension Category	Dimension
1. Low (<5%)	3.36	[3.77-8.75]	Length	8: Fingertip to root digit 3 (3DL)
	4.32	[6.76-8.57]	Length	9: Fingertip to root digit 4 (4DL)
	4.48	[12.20]	Breadth	Dimension 32 Breadth at 1st joint digit 1 (1JD1B)
2. Moderate (5–10%)	5.07	[5.71-8.48]	Length	7: Fingertip to root digit 2 (2DL)
	5.07	[5.50-10.20]	Length	10: Fingertip to root digit 5 (5DL)
	5.14	[4.17]	Length	18: 2nd joint to root digit 4 (2J-RD4)
	5.17	[11.54]	Length	25: Fingertip to 1st joint digit 2 (FT-1JD2)
	5.30	[3.15-10.92]	Length	17: 2nd joint to root digit 3 (2J-RD3)
	6.11	[0.00]	Length	16: 2nd joint to root digit 2 (2J-RD2)
	6.26	[6.91-10.79]	Length	4: Palm length (PL)
	6.59	[2.51-11.62]	Length	2: Hand Length (HL)
	6.63	[5.61-11.36]	Circumference	53: Wrist Circumference (WC)
	6.64	[10.71]	Length	27: Fingertip to 1st joint digit 4 (FT-1JD4)
	6.75	[4.76]	Length	20: 2nd joint to 1st joint digit 2 (2J-1JD2)

Group	% Difference (M-F)	[Values from Other Studies]	Dimension Category	Dimension
	6.90	[3.83-14.60]	Breadth	30: Hand breadth (HB)
	6.91	[6.10-7.41]	Length	26: Fingertip to 1st joint digit 3 (FT-1JD3)
	7.06	[6.90]	Length	15: 1st joint to root digit 1 (1J-RD1)
	7.14	[4.00]	Length	21: 2nd joint to 1st joint digit 3 (2J-1JD3)
	7.20	[4.35]	Length	22: 2nd joint to 1st joint digit 4 (2J-1JD4)
	7.21	[2.34-8.00]	Length	28: Fingertip to 1st joint digit 5 (FT-1JD5)
	7.29	[8.82]	Length	24: Fingertip to 1st joint digit 1 (FT-1JD1)
	7.59	[13.37]	Breadth	41: Maximum Spread of Hand (MSL)
	8.52	[8.02-16.44]	Length	6: Fingertip to root digit 1 (1DL)
	9.00	[10.53-13.22]	Circumference	52: Maximum Hand Circumference (MHC)
3. High (≥10%)	10.00	[9.69-10.94]	Breadth	33: Breadth at 2nd joint digit 2 (2JD2B)
	10.45	[6.25]	Length	23: 2nd joint to 1st joint digit 5 (2J-1JD5)
	10.76	[11.75]	Breadth	35: Breadth at 2nd joint digit 4 (2JD4B)
	11.07	[4.64-14.64]	Breadth	29: Maximum width of hand (MHB)
	11.18	[4.75-12.86]	Breadth	34: Breadth at 2nd joint digit 3 (2JD3B)
	12.43	[1.02-16.81]	Length	19: 2nd joint to root digit 5 (2J-RD5)
	13.42	[5.73-13.58]	Breadth	36: Breadth at 2nd joint digit 5 (2JD5B)

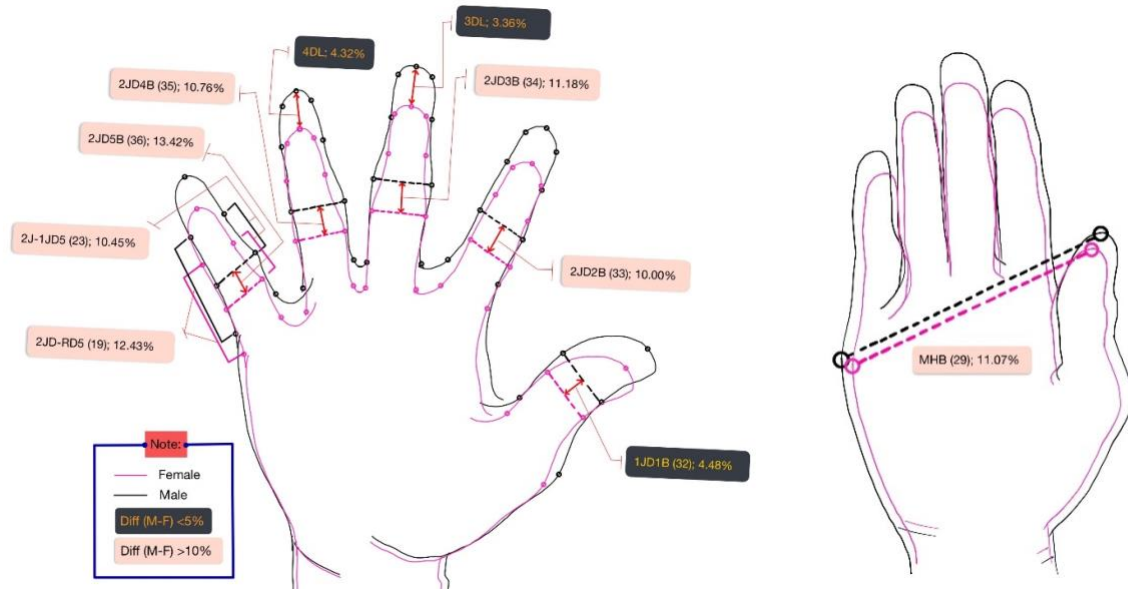


Figure 2: Percentage Differences in Hand Dimensions Between Males and Females in the Thai Population

In the moderate difference category (5% to 10%), a total of 21 hand dimensions were identified in the Thai population. For example, dimension 2, Hand Length (HL), exhibited a 6.59% difference between males and females. This is notably higher than the difference reported in Bangladesh, where it was only 2.51% (Talapatra & Mohsin, 2021), but lower than in Colombia, where the value reached 11.62% (Oviedo-Trespalcios et al., 2017). In dimension 6, Fingertip to root digit 1 (1DL), the sex-based difference in Thailand was 8.52%, which was comparable to South Korea at 8.02% (Jee & Yun, 2015), but significantly lower than in Australia, where the difference was 16.44% (Ishak et al., 2012).

For dimension 16, 2nd joint to root digit 2 (2J-RD2), Thailand reported a moderate difference of 6.10%, whereas a study in South Korea found no significant sex-based difference (Jee & Yun, 2015). Likewise, dimension 30, Hand Breadth (HB), showed a moderate difference of 6.90% in Thailand, compared with 3.83% in Bangladesh and 14.60% in India (Kumar & Singh, 2016).

In the high difference category ($\geq 10\%$), seven hand dimensions were identified. Among these, the greatest difference was found in dimension 36, Breadth at 2nd joint digit 5 (2JD5B), which showed a 13.42% difference in Thailand—the highest among all measured dimensions in the Thai sample. A similar result was reported in Colombia, where the same dimension had a difference of 13.58% (Oviedo-Trespalcios et al., 2017).

Regarding dimension 19, 2nd joint to root digit 5 (2J-RD5), Thailand exhibited a difference of 12.43%. A comparable value was found in Bangladesh, where a study involving industrial workers reported a difference of 12.05% (Shahriar et al., 2020) Another study in the general adult population in Bangladesh reported an even higher difference of 16.81% (Imrhan et al., 2009), although the occupational background of participants was not clearly specified.

Overall, the analysis of percentage differences in Table 2 indicates that length-related dimensions generally showed low to moderate sex-based differences, while breadth-related dimensions tended to exhibit high differences, often exceeding 10%. These findings highlight that width-based hand characteristics may be more strongly influenced by anatomical sex differences than length dimensions in the Thai population.

From Figure 2, clear differences in hand dimensions between males and females can be observed, illustrating potential ergonomic challenges when these differences are either minimal (less than 5%) or substantial (greater than 10%). Gender-based variations in hand size have direct implications for the design of hand-operated tools such as protective gloves, screwdrivers, computer peripherals, and medical instruments, where size mismatches can increase muscular effort, cause discomfort, and lead to cumulative strain during prolonged use. These findings emphasize the importance of developing gender-specific or adjustable ergonomic designs to ensure proper fit, comfort, and safety across user groups.

3.4 Comparing Thai percentage with international ranges

A comparative analysis of gender-based percentage differences in hand dimensions between the Thai population and findings from other countries was conducted using Table 3. The comparison was based on 31 dimensions and revealed varied patterns when positioning Thai data against international findings. In some cases, the percentage differences observed in Thailand were below the reference values reported elsewhere; in others, they fell within the reference range; and in several dimensions, the Thai values were above those reported internationally.

Specifically, 12 dimensions in the Thai dataset showed percentage differences that were below those found in other countries. These included both cases in which only one international study was available and instances where the Thai figures were smaller than the minimum values reported across multiple studies. To illustrate the extent of these differences, ratio values were calculated by dividing the international percentage by the corresponding Thai value. For example, Breadth at 1st joint digit 1 (1JD1B) showed a difference of only 4.48% in Thailand, while a study in South Korea reported 12.20% (Jee et al., 2015), which is approximately 2.72 times greater. Similarly, Fingertip to 1st joint digit 2 (FT-1JD2) had a difference of 5.14% in Thailand, whereas the corresponding figure in South Korea was 11.54% (Jee & Yun, 2015), or 2.23 times greater. These findings highlight that male and female hand dimensions in Thailand differ less markedly than in some other countries, particularly South Korea.

Furthermore, 12 dimensions in the Thai sample exhibited percentage differences that fell within the ranges reported in international studies. These included a combination of length, breadth, and circumference measurements, reflecting general alignment with global findings. However, seven dimensions demonstrated percentage differences in Thailand that were above those reported elsewhere. Interestingly, all of these dimensions were related to length, suggesting that Thai males and females may exhibit more pronounced differences in hand length than populations in other countries. While most of these differences remained under 10%, they were particularly evident in segments between the second and first joints of the index, middle, ring, and little fingers.

These results have important implications for ergonomic and inclusive product design. Since certain gender-based differences in hand dimensions are greater in Thailand than in other populations, imported tools and hand-operated equipment designed using foreign anthropometric standards may not properly fit Thai users. This is especially relevant for unisex products, where improper fit may affect comfort, performance, and user safety. Therefore, the incorporation of localized anthropometric data should be prioritized in product development for use in Thailand.

Table 3. Comparative analysis of gender-based percentage differences in hand dimensions and reference values from previous studies

Group	Aspect	% Difference (M-F)	[Other Studies]	Ratio*	Dimension
a) Below	Breadth	4.48	[12.20]	2.72	32: Breadth at 1st joint digit 1 (1JD1B)
		7.59	[13.37]	1.76	41: Maximum Spread of Hand (MSL)
		10.76	[11.75]	1.09	35: Breadth at 2nd joint digit 4 (2JD4B)
	Length	3.36	[3.77-8.75]		8: Fingertip to root digit 3 (3DL)
		4.32	[6.76-8.57]		9: Fingertip to root digit 4 (4DL)
		5.07	[5.71-8.48]		7: Fingertip to root digit 2 (2DL)
		5.07	[5.50-10.20]		10: Fingertip to root digit 5 (5DL)
		5.17	[11.54]	2.23	25: Fingertip to 1st joint digit 2 (FT-1JD2)
		6.26	[6.91-10.79]		4: Palm length (PL)
	a) Below	Length	6.64	[10.71]	1.61
7.29			[8.82]	1.21	24: Fingertip to 1st joint digit 1 (FT-1JD1)
Circumference		9.00	[10.53-13.22]		52: Maximum Hand Circumference (MHC)
b) Within	Breadth	6.90	[3.83-14.60]		30: Hand breadth (HB)
		10.00	[9.69-10.94]		33: Breadth at 2nd joint digit 2 (2JD2B)
		11.07	[4.64-14.64]		29: Maximum width of hand (MHB)
		11.18	[4.75-12.86]		34: Breadth at 2nd joint digit 3 (2JD3B)
		13.42	[5.73-13.58]		36: Breadth at 2nd joint digit 5 (2JD5B)
	Length	5.30	[3.15-10.92]		17: 2nd joint to root digit 3 (2J-RD3)
		6.59	[2.51-11.62]		2: Hand Length (HL)
		6.91	[6.10-7.41]		26: Fingertip to 1st joint digit 3 (FT-1JD3)

		7.21	[2.34-8.00]		28: Fingertip to 1st joint digit 5 (FT-1JD5)
		8.52	[8.02-16.44]		6: Fingertip to root digit 1 (1DL)
		12.43	[1.02-16.81]		19: 2nd joint to root digit 5 (2J-RD5)
	Circumference	6.63	[5.61-11.36]		53: Wrist Circumference (WC)
c) Above	Length	5.14	[4.17]	0.81	18: 2nd joint to root digit 4 (2J-RD4)
		6.11	[0.00]	0.00	16: 2nd joint to root digit 2 (2J-RD2)
		6.75	[4.76]	0.71	20: 2nd joint to 1st joint digit 2 (2J-1JD2)
		7.06	[6.90]	0.98	15: 1st joint to root digit 1 (1J-RD1)
		7.14	[4.00]	0.56	21: 2nd joint to 1st joint digit 3 (2J-1JD3)
		7.20	[4.35]	0.60	22: 2nd joint to 1st joint digit 4 (2J-1JD4)
		10.45	[6.25]	0.60	23: 2nd joint to 1st joint digit 5 (2J-1JD5)

Remark: (*) Ratio = International Value/Thai Value

Figure 3 provides a visual summary of the 31 hand dimensions analyzed in this study, highlighting the magnitude of gender-based differences and their positioning relative to international reference values. Dimensions are color-coded by difference level—green (<5%), blue (5–10%), and red ($\geq 10\%$)—while arrows indicate whether the Thai differences are greater (\blacktriangle) or smaller (\blacktriangledown) than those reported in other countries. Dimensions without arrows fall within the reference range.

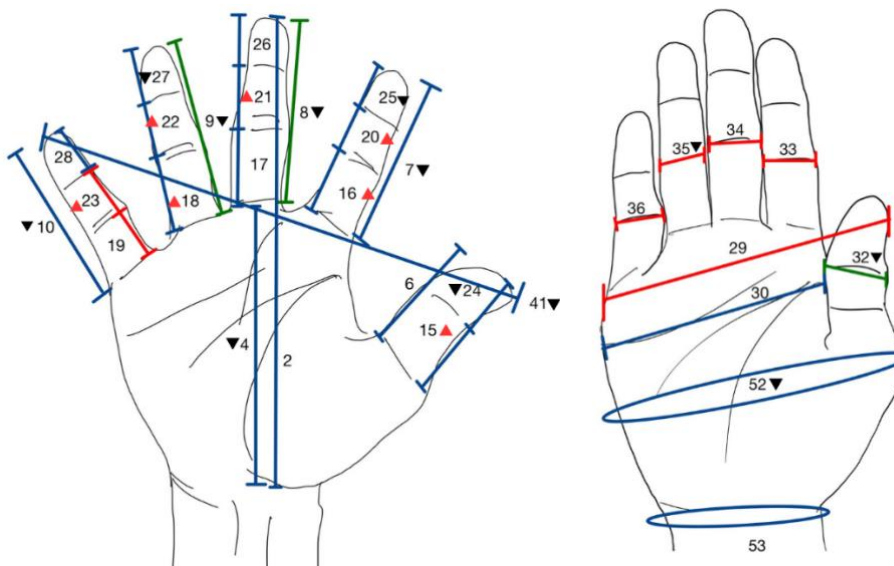


Figure 1 Gender-based differences in 31 Thai hand dimensions compared with international data.

4. Conclusion

This study provided a comparative overview of hand anthropometric data from Thailand and other countries, offering insights not only for the design of tools, equipment, and reach zones but also for guiding decisions related to product selection and procurement. The findings are particularly relevant to ensuring that hand-operated devices are compatible with the physical characteristics of the Thai population. The analysis revealed significant gender-based differences in hand dimensions, highlighting the importance for designers, occupational safety professionals, and organizational decision-makers to account for these differences when evaluating workplace performance, health, and safety.

The review also emphasized a critical gap in the availability of Thai-specific anthropometric data. Compared to studies conducted in other Asian and non-Asian countries, the number of Thai-based studies is limited, and many hand dimensions commonly measured internationally have not yet been explored in Thailand. This underlines the need for more comprehensive and detailed national research that includes all relevant hand dimensions. Such data would be highly valuable to designers aiming to create or adapt tools, equipment, and work environments that are ergonomically appropriate for the local population.

Additionally, this review encountered limitations related to the scope of database coverage. The literature search was confined to a limited number of academic databases and may have missed relevant studies—particularly theses and unpublished research reports that could contain useful anthropometric information. To improve data completeness and ensure more robust applications of anthropometric findings, future reviews should expand their scope to include national thesis repositories and institutional research databases. Doing so would enhance the utility of such data for ergonomic design and occupational safety initiatives in Thailand.

Building on these findings, future research on the Thai population should aim to establish a comprehensive national hand anthropometric database. This can be achieved by expanding the number of hand dimensions measured to 86, as identified in this review, compared to the current maximum of only 41 dimensions reported in previous Thai studies. Moreover, future investigations should include a broader age range (18–59 years) rather than a single working-age subgroup, thereby providing a more representative dataset for ergonomic design applications. Such an expanded dataset would not only support the design and adaptation of tools, equipment, and workstations for Thai workers but also contribute to forensic applications, including the refinement of predictive equations for demographic estimation—such as age, sex, and stature prediction—from hand measurements.

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Declaration of Interest Statement

The authors declare that they have no conflict of interests.

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