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Development of Anthropometrics Database for Ages 19-21 in West Nusa Tenggara: Optimizing Secondary Data for Industrial Product Design

Fikrihadi Kurnia[1]*, Maharsa Pradityatama[2], Akbar Tawaqqal[3]
[1,2,3] Department of Industrial Engineering, Faculty of Engineering, University of Mataram
Jl. Majapahit No.62, Gomong, Kec. Selaparang, Kota Mataram, Nusa Tenggara Barat. 83115
Email: fikrihadi@unram.ac.id

ABSTRACT

This study aims to develop an anthropometric database for individuals aged 19-21 in West Nusa Tenggara (NTB) Province to support ergonomic product design tailored to local physiological needs. A descriptive quantitative approach was employed, involving direct measurements of body dimensions in a sitting posture from 52 samples selected via purposive sampling. Key measurements included sitting height, eye level while seated, shoulder height, popliteal length, and other relevant dimensions, analyzed for normality, sufficiency, and consistency. The data followed a normal distribution with sufficient sample validity. Percentile values (P1, P5, P50, P95, P99) revealed significant variations in body dimensions, providing a robust reference for ergonomic design across sectors like creative industries, education, healthcare, and agriculture. The anthropometric database enables designing inclusive, comfortable, and safe products that accommodate various body sizes, enhancing user experience and efficiency in NTB's key industries. The study is limited to NTB's 19-21 age group and seated posture measurements, restricting its applicability to Indonesia's broader population or other postures. Future research should expand geographic scope and include diverse postures to enrich national anthropometric data.

Keywords: *Anthropometry, Ergonomic Design, Seated Posture, Percentiles, West Nusa Tenggara.*

Introduction

In the era of globalization, the demand for ergonomic products has become increasingly essential to support user comfort and efficiency. Anthropometry is a key element in product design, as accurate and representative anthropometric data can better accommodate users' body dimensions[1]–[4] .[5], [6]. Additionally, anthropometric data helps address mismatches between product dimensions and users' body postures[7]–[10].. However, in Indonesia, particularly in West Nusa Tenggara (NTB) Province, there is a significant gap in the availability of local anthropometric databases tailored to the population's unique physiological characteristics [11].. This situation indicates a data gap that needs to be addressed to support more inclusive industrial product designs [12]This lack of localized data often forces designers to rely on anthropometric data from other countries, which may not accurately reflect the body dimensions of Indonesians. This leads to suboptimal product designs that fail to meet user needs.

According to the World Health Organization (WHO), the youth age range is 10-24. [13]. Data from the Central Bureau of Statistics (BPS) of NTB Province shows that this age group constitutes 25% of NTB's population.[14]. Based on the Ministry of Health criteria, adolescents are 10-19 years old, while adults are those aged 19-44 years. [15]. When linked to the ongoing study, this information indicates that the 19–21 age group represents a transition phase from adolescence to adulthood. [16]. This age is a critical population segment in product design due to significant changes in body posture during this transitional phase. Local anthropometric data for this age group ensures that designed products meet their physiological needs. However, the lack of local anthropometric data often leads product designers and industries to rely on data from other countries, which may not align with the characteristics of the Indonesian population.

This research addresses the gap in Indonesian anthropometric data by developing a localized database for the 19-21 age group in NTB, focusing on body dimensions in a sitting posture. By providing percentile-based measurements, this study offers a foundation for designing ergonomic products that align with the physiological characteristics of NTB's population, reducing reliance on non-representative foreign data. In the context of NTB, this anthropometric database directly supports product design in sectors such as creative industries (e.g., furniture and workspace design), education (e.g., classroom seating), and healthcare (e.g., medical equipment), where ergonomic considerations are critical for user satisfaction and efficiency [10-13]. The creative industry dominates NTB's economic sector, accounting for 85.15% [21]. From January to December 2023, international tourist arrivals to NTB increased significantly, from 2,202 to 7,304 visitors [22]. Agroindustry contributes 21.33% to NTB's economy [17]. Accurate anthropometric data can enhance efficiency in designing public facilities and everyday products the community uses [5, 16]. Therefore, efforts to collect and develop local anthropometric data are critical and relevant.

This study aims to develop an anthropometric database for individuals aged 19–21 in NTB through a descriptive quantitative approach. The collected data focuses on body dimensions in a sitting posture, analyzed using various statistical tests to ensure accuracy, sufficiency, and consistency. The study is expected to produce anthropometric percentile data applicable in multiple industrial design contexts, particularly for the local population. This anthropometric database aims to enable industries to make products that are comfortable and safe and meet the physiological needs of NTB's community. Furthermore, this study contributes to building a more comprehensive national anthropometric database, supporting advancements in local data-driven product design in Indonesia.

Research Methods

Subjects and Objects of Research

This study employs a descriptive quantitative method to measure various anthropometric parameters of sitting posture in samples aged 19-21 years residing in NTB Province. The focus on seated posture was prioritized due to its critical relevance in designing ergonomic products for key sectors such as education (e.g., classroom chairs and desks), office environments (e.g., workstations), and transportation (e.g., vehicle seating), where prolonged sitting is common and directly impacts user comfort and health. The study aims to develop an anthropometric database for secondary data, particularly in industrial product design. The collected data will be analyzed for normality, sufficiency, and consistency and organized into percentiles to facilitate its use in industrial design contexts.

Sample Description

The study population consists of individuals aged 19-21 years residing in NTB Province. Purposive sampling was chosen for its suitability for anthropometric studies, where specific criteria (e.g., age range, regional residence) are critical to ensure the relevance of the collected data for industrial design applications. This approach allowed for focused data collection from a population segment most likely to benefit from the resulting anthropometric database. Inclusion criteria for this study include:

- Aged 19-21 years, representing the transition to adulthood with significant changes in body posture.
- Residing in NTB Province to ensure anthropometric data suitability for the target population in the region.
- Physically healthy, without postural disorders or diseases affecting body composition, ensuring the anthropometric data represent the general state of youth in this age range.

Exclusion criteria are also applied to avoid data collection errors, including:

- Youth undergoing medical treatments that could affect body composition (e.g., spinal injuries or growth disorders).
- Youth unwilling or unable to complete all measurement procedures. The sample size is determined based on data sufficiency tests to ensure that the collected sample adequately represents the population.

Anthropometric Measurements

Measurements were conducted directly on the research subjects using standard anthropometric tools, such as stadiometers, digital scales, and specialized anthropometric measurement devices. The measurement procedures adhered to established ergonomic guidelines, such as those outlined in ISO 7250-1:2017, which provides standards for basic human body measurements for technological design, ensuring accuracy and consistency [24]. A trained team performed the measurements to ensure data accuracy and consistency. The primary anthropometric measurements included body dimensions in a sitting posture. Height and weight were used to calculate body mass index.

- Height: Measured in a standing position to obtain the total height.
- Weight: Measured using a high-accuracy digital scale.
- Sitting height: Distance from the sitting surface to the top of the head while sitting upright.
- Eye sitting height: Distance from the sitting surface to the eyes while sitting.
- Shoulder sitting height: Distance from the sitting surface to the shoulders while sitting.
- Elbow sitting height: Distance from the sitting surface to the elbows when the forearms are parallel to the floor.
- Knee length: Distance from the front of the knee to the sitting surface.
- Popliteal length: Distance from the back of the knee to the lower back.
- Knee height: Distance from the floor to the top of the knee while sitting.
- Popliteal height: Distance from the floor to the underside of the knee (knee crease) while sitting.
- Shoulder breadth: Horizontal distance between the highest points of the shoulders.
- Hip breadth: Horizontal distance between the hips while sitting.
- Upper arm length: Distance from the shoulder to the elbow.
- Forearm length: Distance from the elbow to the wrist.

Statistical Analysis
The collected data were analyzed using several statistical tests. [18, 19]:

- Normality Test: The Shapiro-Wilk Test was employed due to its sensitivity to small samples. A p-value > 0.05 indicates normality, meaning the data does not significantly deviate from a normal distribution, allowing the use of parametric statistical methods for further analysis.
- Data Sufficiency Test: Conducted to ensure the collected sample size is sufficient to represent the population.
- Data Uniformity Test: Performed to check whether the collected data originates from a uniform population.
- Percentile Analysis: Data were processed to produce percentiles (P1, P5, P50, P95, P99) for each anthropometric dimension, which are highly useful in industrial product design.

Results and Discussion

Demographic Data

The demographic characteristics of the sample used in this study were discussed in the initial stages. Demographic data is essential for understanding the population context that serves as the basis for anthropometric data collection, as variations in demographic factors such as age, gender, and nutritional status can affect the size of an individual's body dimensions. By mapping the demographic distribution of the sample, it can be ensured that the resulting anthropometric data represent the relevant groups and can be used as a reference in designing inclusive product designs that meet the physiological needs of the population. This research involves individuals aged 19 to 21 residing in West Nusa Tenggara Province, focusing on residence distribution, body mass index (BMI) status, and gender.

Table 1. Sample demographic data

Demographic Criteria	Frequency	Percentage
Domicile		
Domicile: Lombok	35	67%
Domicile: Sumbawa	17	33%
Body Mass Index		
BMI: Underweight	8	15%
BMI: Normal	42	81%
BMI: Overweight	2	4%
Gender		
Male	29	56%
Female	23	44%

Table 1 shows the demographic characteristics of the research sample. Most samples came from the Lombok Islands (67%), while the rest came from the Sumbawa Islands (33%). Based on the body mass index (BMI), the majority of the samples have a normal BMI (81%), while a small portion are classified as underweight (15%) and overweight (4%). Regarding gender, the number of males is slightly higher (56%) compared to females (44%). This information provides an overview of the population diversity that forms the basis for anthropometric analysis.

Anthropometric Data

This section discusses the results of body dimension measurements conducted on a sample aged 19-21 in the Province of West Nusa Tenggara. The measurements include various body dimensions in a sitting posture, such as sitting height, knee length, hip width, and others, which provide a detailed picture of physical variations within the local population. This data is essential for designing products that match the user's body characteristics, both in ergonomic and functional contexts, and serves as a reference for creating more inclusive and comfortable designs.

Table 2. Anthropometric Dimension Data

Body Dimension	Min (cm)	Average (cm)	Max (cm)	SD
Sitting height	74.0	85.3	96.0	4.4
Eye sitting height	65.0	74.0	85.0	4.2
Shoulder sitting height	47.0	58.7	66.0	5.6
Elbow sitting height	19.0	23.9	30.0	2.9
Knee length	47.0	54.2	58.0	3.1
Popliteal length	35.0	48.1	56.0	5.6
Knee height	46.0	50.6	58.0	2.7
Popliteal height	34.0	41.8	47.0	2.9
Shoulder breadth	39.0	45.5	53.0	3.7
Hip breadth	31.0	39.6	47.0	4.6
Upper arm length	29.0	33.7	38.0	2.2
Forearm length	34.0	42.3	48.0	3.0

Table 2 contains data on body dimensions in a sitting position, including minimum, average, maximum, and standard deviation values for each dimension. For example, sitting height averages 85.3 cm with a standard deviation of 4.4 cm. This data reflects the variation in body sizes within the sample population and is an essential reference in ergonomic product design. The relatively small standard deviation in several dimensions, such as popliteal height (2.9 cm), indicates good uniformity in the data.

Data Feasibility Test

In this section, an analysis is conducted to assess the feasibility of the data collected through normality tests and data adequacy tests. The normality test aims to ensure whether the obtained data follows a normal distribution, which is crucial for further statistical analysis. In addition, a data sufficiency test is conducted to ensure that the number of samples collected is sufficiently representative of the population, providing confidence that the results of this research can be widely used in the design of more effective and appropriate products and meeting ergonomic elements for users.

Table 3. Test of Data Normality

Body Dimension	p-Value	Hipotesis	Result
Sitting height	>0.100	0.05	Normal
Eye-level sitting	>0.100	0.05	Normal
Shoulder height sitting	0.064	0.05	Normal
Elbow height sitting	>0.100	0.05	Normal
Knee-length	0.059	0.05	Normal
Popliteal length	>0.100	0.05	Normal
Knee Height	0.095	0.05	Normal
Popliteal Height	>0.100	0.05	Normal
Width of the Shoulder	>0.100	0.05	Normal
Hip Width	>0.100	0.05	Normal
Upper Arm Length	>0.100	0.05	Normal
Length of the Lower Arm	>0.100	0.05	Normal

The normality test results indicate that all body dimensions have a standard data distribution, with a p-value > 0.05 (Table 3). For example, sitting and eye heights each have a p-value > 0.1, indicating that the data are suitable for further analysis using standard distribution-based statistical techniques. This ensures the validity of data used for various design purposes. Table 4 evaluates the adequacy of the sample size for each measured body dimension. Based on the analysis, all body dimensions have an N′ value (the minimum required sample size) smaller than N (the actual sample size, 52). For example, sitting height has an N′ of 4.2, much smaller than 52, indicating that the data collected is more than sufficient to represent the population. These results affirm that the conducted research has a high reliability level in depicting the local population's body size distribution.

Table 4. Data sufficiency test

Body Dimensions	N'	N	Result
Sitting height	4.2	52	Sufficient
Eye-level sitting	5.0	52	Sufficient
Shoulder height sitting	14.2	52	Sufficient
Elbow height sitting	23.2	52	Sufficient
Knee-length	5.3	52	Sufficient
Popliteal length	21.0	52	Sufficient
Knee Height	4.6	52	Sufficient
Popliteal Height	7.6	52	Sufficient
Width of the Shoulder	10.3	52	Sufficient
Hip Width	21.5	52	Sufficient
Upper Arm Length	6.8	52	Sufficient
Length of the Lower Arm	7.8	52	Sufficient

Percentile

Table 5 shows the percentile values of various measured body dimensions, including the 1st percentile (P1), 5th percentile (P5), 50th percentile (P50), 95th percentile (P95), and up to the 99th percentile (P99). Each percentile provides an overview of the distribution of body sizes within the population, ranging from the smallest to the largest groups. This information is essential in designing a product that needs to adjust the seat height, such as chairs or tables, to suit most users without neglecting extreme body sizes.

Table 5. Percentile values for each anthropometric dimension

Body Dimensions	Percentile				
	P1	P5	P50	P95	P99
Sitting height	75.0	78.0	85.3	92.5	95.6
Eye-level sitting	64.3	67.2	74.0	80.9	83.8
Shoulder height sitting	45.7	49.5	58.7	67.8	71.6
Elbow height sitting	17.1	19.1	23.9	28.7	30.6
Knee-length	46.8	49.0	54.2	59.3	61.5
Popliteal length	35.2	39.0	48.1	57.3	61.1
Knee Height	44.3	46.1	50.6	55.1	57.0
Popliteal Height	35.0	37.0	41.8	46.6	48.6
Width of the Shoulder	36.9	39.4	45.5	51.5	54.1
Hip Width	28.8	32.0	39.6	47.2	50.4
Upper Arm Length	28.5	30.0	33.7	37.3	38.8
Length of the Lower Arm	35.4	37.4	42.3	47.2	49.2

The percentile data directly informs specific design parameters for ergonomic products, ensuring comfort, safety, and inclusivity across various applications:

- Seat Height: Popliteal height, ranging from 35.0 cm (P1) to 48.6 cm (P99), is critical for determining chair seat height. To accommodate 90% of the population (P5–P95), seat height should be between 37.0 cm and 46.6 cm. This ensures that users' feet rest flat on the floor, reducing pressure on the thighs and preventing discomfort during prolonged sitting, such as in classrooms or offices.
- Seat Depth: With popliteal length ranging from 39.0 cm (P5) to 57.3 cm (P95), chair seat depth should be designed within this range, ideally around 39.0–48.1 cm (P5–P50), to avoid leg discomfort. A seat that is too deep can cause pressure behind the knees for smaller users, while a shallow seat may not adequately support larger users. For example, lecture hall chairs in

NTB’s universities should incorporate adjustable or fixed depths within this range to enhance student comfort.

- Desk Height and Armrest Positioning: Elbow sitting height (P5: 19.1 cm to P95: 28.7 cm) guides desk height and armrest placement. Desks should be adjustable between 65–75 cm above the floor (adding typical seat height) to align with elbow height, ensuring a neutral wrist posture during writing or typing. For instance, classroom desks in NTB schools can use this range to prevent shoulder strain among students.
- Screen Level: Eye sitting height, ranging from 67.2 cm (P5) to 80.9 cm (P95), informs the positioning of computer screens or visual displays. The top of the screen should align with eye level, approximately 67–81 cm above the sitting surface, to minimize neck strain. In office settings, adjustable monitor stands can accommodate this range, enhancing comfort for NTB’s workforce in administrative or creative industries.
- Desk Width and Seat Width: Hip width (P5: 32.0 cm to P95: 47.2 cm) and shoulder breadth (P5: 39.4 cm to P95: 51.5 cm) guide seat and desk width. Chairs should have a minimum width of 47.2 cm to comfortably fit 95% of users, while desks should provide at least 51.5 cm of clearance to accommodate shoulder breadth, ensuring freedom of movement. For example, in NTB’s healthcare sector, examination chairs designed with a 47–50 cm width can cater to most patients, improving accessibility.
- Backrest Height: Shoulder sitting height (P5: 49.5 cm to P95: 67.8 cm) indicates that chair backrests should extend to at least 67.8 cm above the seat to support taller users' upper back and shoulders. In educational settings, lecture chairs with backrests covering this range can reduce back fatigue during long study sessions.

These design considerations ensure that products are inclusive, accommodating both average (P50) and extreme (P1, P99) body sizes. For instance, in NTB’s creative industry, furniture designers can use these percentiles to craft adjustable office chairs that cater to the 19-21 age group, enhancing productivity. In healthcare, wheelchairs designed with a seat width of 47.2 cm and an adjustable seat height of 37.0–46.6 cm can serve a diverse patient population, improving mobility and comfort.

This research has several limitations that need to be considered. First, the study’s sample of 52 individuals aged 19–21 in West Nusa Tenggara (NTB) provides a foundational anthropometric database but is relatively small, potentially limiting its representation of the region’s diverse population. While the sample was selected to reflect the target age group, factors such as socio-economic status, ethnicity, and geographic distribution within NTB were not fully accounted for due to logistical constraints. For instance, NTB’s population includes varied ethnic groups (e.g., Sasak, Balinese, and Sumbawanese), which may exhibit differences in body dimensions influenced by genetic and environmental factors. Additionally, socio-economic disparities could affect nutrition and growth, impacting anthropometric variability. These limitations suggest that the database may not fully capture the region’s anthropometric diversity, potentially reducing the generalizability of the findings to broader NTB populations. Future studies should employ larger, stratified samples that explicitly account for these demographic factors to enhance representativeness, ensuring more comprehensive coverage of NTB’s population for industrial design applications.

Second, the measurements were focused solely on the sitting posture, restricting the applicability of the data to product designs requiring measurements in other postures, such as standing, walking, or dynamic working positions. Third, purposive sampling, while relevant for targeting specific criteria (e.g., age and health status), introduces potential bias by limiting the sample to participants who meet predefined conditions, which may not fully capture the diversity of the NTB population. Additionally, the descriptive quantitative approach, although suitable for the study's objectives, may limit the generalizability of findings due to the non-random selection process. To address these limitations in future research, stratified or cluster sampling could ensure wider demographic representation, including diverse socioeconomic groups, ethnicities, or geographic areas within NTB and beyond. Furthermore, integrating measurements of standing posture, movement-based data, or dynamic tasks (e.g., reaching or lifting) would provide a more comprehensive anthropometric database, enabling the design of products that support a broader range of activities and postures. These enhancements would enrich the national anthropometric database and improve its applicability to diverse industrial design contexts.

Future research should pursue a national anthropometric data integration roadmap, targeting broader Indonesian populations. This could involve standardized measurement protocols (e.g., ISO 7250-1) applied across regions like Java, Sumatra, and Papua, using stratified or cluster sampling to capture diverse ethnicities, ages, and socio-economic groups. For instance, including groups such as Javanese, Batak, and Papuan populations would account for anthropometric variability driven by genetic and environmental factors. Expanding the dataset to include standing posture, walking, and dynamic task measurements (e.g., reach and grip dimensions) would support the design of more versatile products, such as workstations, public seating, and rehabilitation tools. Collaborative efforts with regional universities and industries could facilitate data collection, ensuring the database's scalability and applicability to Indonesia's diverse industrial design needs.

Conclusion

This research has successfully established an anthropometric database for individuals aged 19-21 in West Nusa Tenggara (NTB) Province, focusing on body dimensions in a sitting posture. Three key outcomes highlight the study's impact: First, a percentile-based database (P1, P5, P50, P95, P99) was developed, providing a robust reference for accommodating diverse body sizes among NTB youth. Second, the data's reliability was validated through rigorous statistical tests, including Shapiro-Wilk for normality ($p > 0.05$) and sample adequacy tests, ensuring suitability for parametric analysis and design applications. Third, the database has immediate applicability in local product design, enabling the creation of ergonomic chairs, desks, and rehabilitation tools tailored to NTB's population, enhancing comfort and functionality in sectors like education, healthcare, and creative industries. However, the study's scope is limited to NTB's 19-21 age group and seated posture, restricting its generalizability to Indonesia's broader population or other postures. Future research should pursue a national data integration roadmap to address this, combining regional anthropometric databases through standardized measurement protocols (e.g., ISO 7250-1) and stratified or cluster sampling to capture diverse demographics. Incorporating standing posture, movement-based, and dynamic task data will further enrich the database, supporting the design of inclusive products across Indonesia's varied industrial contexts.

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