







Anthropometric Design of a Patient Transfer Aid for Wheelchair to Bed Transfer: Enhancing Safety and Reducing Musculoskeletal Risk

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ABSTRACT

This study develops an anthropometric-based patient transfer aid for wheelchair-to-bed transfer aimed at reducing musculoskeletal disorder (MSD) risk among healthcare workers. The research was conducted at Pesanggrahan Community Health Center involving 100 respondents whose anthropometric data were used as the basis for ergonomic design development, including body weight, hip width, elbow-to-elbow breadth, forearm length, foot length, and popliteal height. The collected data were analyzed using validity, reliability, adequacy, uniformity, and percentile methods (5th, 50th, and 95th percentiles) to ensure statistical robustness and to derive ergonomic design dimensions. The results were translated into engineering specifications, including a lifting capacity of 100 kg, base width of 50 cm, handle spacing of 43.2 cm, seat width of 25 cm, and minimum clearance of 45 cm. The proposed design was developed using solid works software through parametric 3D modeling and assembly integration to ensure geometric accuracy, structural feasibility, and functional system configuration. The design enables seated-position transfer without requiring patients to stand, improving usability for individuals with limited mobility and reducing caregiver physical strain. From an ergonomic perspective, the system is expected to reduce MSD risk by minimizing manual lifting, trunk flexion, and asymmetric loading during transfer activities. However, the study is limited to CAD-based design and does not yet include prototype fabrication or biomechanical validation. The findings demonstrate that integrating anthropometric data with SolidWorks-based engineering design provides an effective and practical approach for developing ergonomic patient transfer aids in healthcare environments.

Keywords: anthropometry, ergonomics, patient transfer aid, MSD, healthcare design

ABSTRAK

Pemindahan pasien dari kursi roda ke tempat tidur merupakan aktivitas manual handling yang memiliki risiko tinggi menimbulkan keluhan muskuloskeletal pada tenaga kesehatan, terutama nyeri punggung bawah. Penelitian ini mengusulkan desain alat bantu transfer pasien yang memungkinkan proses perpindahan dilakukan dalam posisi duduk, sehingga pasien tidak perlu berdiri terlebih dahulu sebelum dipindahkan ke tempat tidur. Penelitian dilakukan di Puskesmas Pesanggrahan dengan menggunakan pendekatan antropometri untuk menentukan dimensi utama alat. Data dikumpulkan melalui observasi aktivitas transfer pasien, identifikasi kebutuhan pengguna, serta pengukuran antropometri langsung terhadap 100 responden. Dimensi tubuh yang digunakan dalam proses perancangan meliputi berat badan, lebar pinggul, lebar siku ke siku, panjang lengan bawah, panjang telapak kaki, dan tinggi popliteal. Data kemudian diolah melalui uji kecukupan, uji keseragaman, dan perhitungan persentil untuk



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menghasilkan spesifikasi dimensi alat yang diusulkan, meliputi kapasitas angkat, lebar alas, jarak antar pegangan, panjang dudukan, lebar dudukan, dan jarak minimum penurunan. Hasil penelitian ini berupa usulan desain alat bantu transfer pasien berbasis CAD yang diharapkan dapat meningkatkan kesesuaian dimensi alat, kestabilan pasien, dan kemudahan kerja operator pada proses perpindahan pasien dari kursi roda ke tempat tidur. Penelitian ini memberikan alternatif rancangan berbasis antropometri yang dapat diterapkan di fasilitas pelayanan kesehatan, khususnya puskesmas.

Kata kunci: antropometri, ergonomi, alat bantu transfer pasien, perpindahan kursi roda ke tempat tidur, keselamatan kerja

1. Introduction

Occupational health and safety is a fundamental aspect in protecting workers, both physically and psychologically, while carrying out tasks in the work environment [1,2]. In healthcare service facilities (Fasyankes), the implementation of K3 is not only aimed at protecting medical personnel but also patients, visitors, and the surrounding environment from work-related risks [3,4]. Therefore, ergonomic intervention in healthcare systems is essential to ensure safe and sustainable service delivery [5,6].

One of the most critical occupational health problems in healthcare is musculoskeletal disorders (MSDs), particularly lower back pain among nurses and caregivers [7,8]. Lower back pain is commonly caused by manual handling activities such as lifting, supporting, and transferring patients [9,10]. Improper working posture and repetitive physical load significantly increase the risk of injury in healthcare workers [11-14]. This condition indicates that manual patient handling remains a major ergonomic challenge in clinical environments.

Anthropometry plays an important role in ergonomic product design by providing quantitative data related to human body dimensions [15-18]. These data are widely applied in workstation design, assistive devices, and healthcare equipment to improve usability and safety [19,20]. By integrating anthropometric parameters, product design can be adapted to user variability, thereby reducing biomechanical load and improving operational efficiency [21,22].



Figure 1. Patient transfer aid tools

Patient transfer aids have been developed using various engineering approaches such as Quality Function Deployment (QFD), ergonomic redesign, and mechanical support systems [4], [15]. However, most existing devices still focus on bed-to-bed transfer systems and are not specifically optimized for wheelchair-to-bed transfer conditions. In many cases, the patient is still required to partially stand during the transfer process, which limits usability for patients with low mobility or elderly users [25]. This creates a functional gap between existing assistive devices and real clinical needs in community health centers.

In addition, previous studies have not sufficiently integrated local anthropometric variability into the design of patient transfer devices. Many designs are based on generic or non-local body dimension standards, which may lead to mismatches between device geometry and actual user characteristics. This mismatch can increase discomfort, reduce stability, and increase physical workload for healthcare workers. Therefore, a more context-specific ergonomic design approach is required.

Based on these limitations, this study proposes an anthropometric-based design of a patient transfer aid specifically for wheelchair-to-bed transfer. The design process emphasizes the translation of local anthropometric data into engineering dimensions, including seat geometry, handle spacing, structural clearance, and load capacity. Unlike previous studies that focus mainly on mechanical systems, this research integrates statistical anthropometric analysis with CAD-based engineering design to improve ergonomic compatibility.

The novelty of this research lies in the integration of population-based anthropometric measurement with functional engineering design parameters for healthcare transfer activities. This approach is expected to improve dimensional fit, reduce musculoskeletal load, and enhance safety during patient transfer operations in healthcare facilities, particularly at community health centers. Therefore, the objective of this study is to develop an anthropometric-based patient transfer aid design that is ergonomically appropriate, structurally feasible, and suitable for wheelchair-to-bed transfer applications in real healthcare environments.

2. Methods

2.1 Research Design and Approach

This study employed a quantitative and engineering-based ergonomic design approach to develop a patient transfer aid for wheelchair-to-bed transfer. The design process integrates anthropometric measurement, statistical data processing, and Computer-Aided Design (CAD) modeling to ensure dimensional compatibility between the device and users.

The research was structured into five main stages: (1) problem identification in healthcare facilities, (2) field observation of patient transfer activities, (3) anthropometric data collection, (4) statistical processing and percentile analysis, and (5) ergonomic design development and CAD visualization.

2.2 Study Location and Respondents

The study was conducted at the Emergency Unit of Pesanggrahan Community Health Center, South Jakarta. The site was selected due to the high frequency of wheelchair-to-bed patient transfers and the reported occurrence of musculoskeletal complaints among healthcare workers.

The population consisted of patients requiring transfer assistance. In this study, patients were treated as the primary anthropometric reference group, while healthcare workers were involved as operational informants for workflow analysis.

A sample size of 100 respondents was determined using the Slovin formula with a defined margin of error. These respondents were used as the basis for anthropometric measurement and dimensional analysis of the proposed device.

2.3 Anthropometric Variables and Measurement Procedure

Anthropometric measurements were conducted directly on respondents using standard anthropometric tools. The measured variables included:

- Body weight (kg)
- Hip width (cm)
- Elbow-to-elbow breadth (cm)
- Forearm length (cm)
- Foot length (cm)
- Popliteal height (cm)

These variables were selected based on their functional relevance to patient transfer activities, particularly in determining seat dimensions, support structure, handle spacing, and clearance requirements.

All measurements were conducted following standardized ergonomic anthropometric procedures to minimize measurement error and ensure consistency across respondents.

2.4 Data Quality Testing (Validity, Reliability, Adequacy, Uniformity)

To ensure the reliability of the dataset, several statistical tests were performed:

a) Validity Test

Pearson correlation analysis was used to evaluate the relationship between each anthropometric variable and total measurement score. Variables with significance values below 0.05 were considered valid.

b) Reliability Test

Internal consistency was evaluated using Cronbach's Alpha to ensure measurement stability across variables.

c) Data Adequacy Test

The adequacy test was performed using the comparison between calculated sample size (N') and actual sample size ($N = 100$). All variables satisfied the adequacy condition, indicating sufficient sample representation.

d) Uniformity Test

Uniformity analysis was conducted using control limits (BKA and BKB) to ensure that data distribution remained within acceptable statistical boundaries and did not contain extreme outliers.

2.5 Percentile Analysis for Design Determination

Percentile analysis was applied to translate anthropometric data into design dimensions. The 5th, 50th, and 95th percentiles were used to represent small, medium, and large user populations.

- 5th percentile → minimum design limit
- 50th percentile → average design reference
- 95th percentile → maximum safety and clearance limit

This method ensures that the resulting design accommodates a wide range of user body dimensions while maintaining ergonomic safety.

2.6 Engineering Design and SolidWorks Modeling

The final stage of this study involved translating anthropometric results into engineering design specifications for a patient transfer aid. The design development was carried out using SolidWorks software, which was used to generate both 2D technical drawings and 3D parametric models of the proposed device.

SolidWorks was selected due to its capability to perform parametric modeling, assembly simulation, and structural visualization, which are essential for evaluating the geometric feasibility and ergonomic compatibility of the design. The software enabled precise adjustment of key components such as seat geometry, handle spacing, structural frame dimensions, and lifting mechanism layout based on anthropometric percentile data.

Key engineering considerations incorporated into the SolidWorks modeling process included:

- Load capacity design based on maximum user weight (95th percentile anthropometric data) with an added safety factor
- Structural configuration of the frame to ensure stability during patient transfer operations
- Ergonomic alignment of handle positioning to minimize musculoskeletal strain on healthcare workers
- Clearance design to ensure safe wheelchair-to-bed transition without obstruction

The SolidWorks model was developed iteratively, starting from basic sketching, followed by part modeling, assembly configuration, and final visualization of the full system. This process allowed validation of spatial relationships between components before physical prototyping.

The final output consists of a fully assembled 3D model of the patient transfer aid, which serves as the basis for future mechanical simulation, structural analysis (FEA), and prototype fabrication.

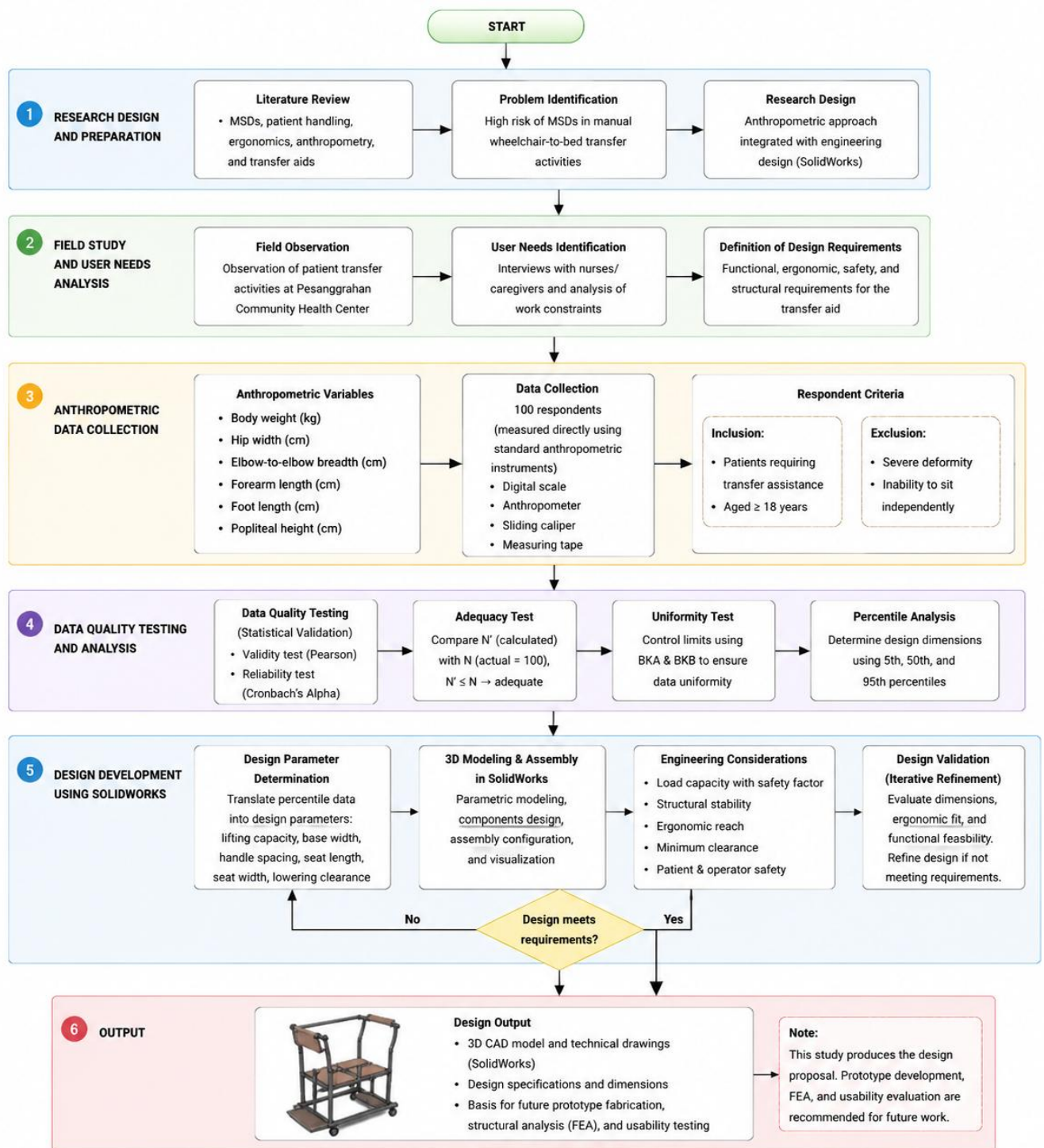


Figure 2. Research flowchart

3. Results and Discussion

3.1. Population Data Processing

Based on patient population data obtained from the Emergency Room of Pesanggrahan Community Health Center during the period of July 1, 2024 to December 31, 2024, the total number of patient visits requiring service in the observed unit was 4,196. Because this study focused on the dimensional design of a patient transfer aid, the patient group was used as the anthropometric population for determining the sample size. Using the Slovin formula, the required sample size was calculated as 97.67225, which was then rounded up to 100 respondents. Therefore, anthropometric measurements were conducted on 100 patient respondents and used as the quantitative basis for determining the dimensional specifications of the proposed transfer device.

P L B	Pearson Correlation	.327	.234	.286	1	.572	.554	.573
	Sig. (2-tailed)	.001	.019	.004		.000	.000	.000
	N	100	100	100	100	100	100	100
P T K	Pearson Correlation	.484	.320	.314	.572	1	.718	.660
	Sig. (2-tailed)	.000	.001	.001	.000		.000	.000
	N	100	100	100	100	100	100	100
T P O	Pearson Correlation	.363	.223	.250	.554	.718	1	.572
	Sig. (2-tailed)	.000	.026	.012	.000	.000		.000
	N	100	100	100	100	100	100	100
T o t a l	Pearson Correlation	.866	.731	.768	.573	.660	.572	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
	N	100	100	100	100	100	100	100

Based on Table 1, all anthropometric variables show significance values below 0.05 in the Total column and Pearson correlation values above the critical r-value of 0.195 for 100 respondents. These results indicate that each measured variable has an acceptable relationship with the overall data structure and can be retained in further processing. In other words, the body dimensions used in this study were considered adequate to represent the data set required for the subsequent design analysis.

In addition to validity testing, reliability testing was also conducted to examine the consistency of the measured anthropometric variables. Reliability is important because the design process requires measurement data that are not only relevant, but also sufficiently stable for repeated interpretation in determining product dimensions. The results of the reliability test are shown in Table 2.

Table 2. Reliability test of anthropometric data

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.727	.815	6

Table 2 shows a Cronbach's Alpha value of 0.727 and a standardized Cronbach's Alpha value of 0.815 for six anthropometric variables. These values indicate that the set of measurement variables has acceptable consistency for use in further analysis. Thus, the anthropometric data in this study can be regarded as sufficiently consistent to support the next stages of adequacy testing, uniformity analysis, percentile calculation, and the translation of user dimensions into design specifications.

3.3. Adequacy Test

After the validity and reliability requirements were met, a data adequacy test was performed to determine whether the number of respondents was sufficient for each anthropometric variable observed. This test is important to ensure that the collected sample size is large enough to support the statistical analysis and design decisions. The results of the adequacy test are presented in Table 3.

Table 3. Results of the anthropometric data adequacy test

Body Code	$\sum Xi$	$(\sum Xi)^2$	$\sum Xi^2$	N'	N	Information
Bb	6192	38340806	391550	33.87	100	Enough
Lp	4929	24290112	244527	10.69	100	Enough
Sks	5474	29964676	302288	14.06	100	Enough
Plb	4311	18584721	186907	9.12	100	Enough
Ptk	2329	5424241	54545	8.88	100	Enough
Tpo	4550	20697950	207557	4.45	100	Enough

Table 3 shows that all observed anthropometric variables have N' values lower than the actual number of respondents used in this study, namely N = 100. This means that the available sample size was sufficient for all measured dimensions, including body weight, hip width, elbow-to-elbow breadth, forearm length, foot length, and popliteal height. Therefore, the anthropometric data set can be considered adequate and statistically acceptable to be continued into the uniformity test and percentile calculation stage.

3.4. Uniformity Test

Once the adequacy of the data had been confirmed, a uniformity test was carried out to determine whether the anthropometric data were distributed within acceptable control limits and did not show extreme deviations that could bias the design results. This step is necessary because the final design dimensions should be based on data that are reasonably homogeneous and representative of the respondent group. The results of the uniformity test are shown in Table 4.

Table 4. Results of the anthropometric data uniformity test

No	Measurement	Average (X Bar)	St. Dev (σ)	BKA	BKB	Information
1	Weight	61.9	9.1	89.2	34.6	Uniform Data
2	Hip Width	49.4	4.1	58.2	40.6	Uniform Data
3	Elbow to Elbow	54.7	5.2	70.1	39.1	Uniform Data
4	Lower arm length	43.1	3.3	53	33.2	Uniform Data
5	Length of the sole of the foot	23.3	1.7	28.4	18.2	Uniform Data
6	Popliteal Height	45.5	2.4	52.7	38.3	Uniform Data

As shown in Table 4, all measured anthropometric variables were classified as uniform data. The average values of each dimension remain within the corresponding upper and lower control limits, indicating that no extreme irregularities were identified in the data set. This finding strengthens the suitability of the anthropometric data for design purposes, because the resulting dimensions are derived from measurements that are statistically stable and representative of the observed patient respondents.

3.5. Percentile

After the anthropometric data were confirmed to be adequate and uniform, percentile calculations were performed to determine the dimensional range that would be used in designing the transfer aid. The use of the 5th, 50th, and 95th percentiles in this study was intended to represent small, average, and large user body sizes so that the proposed device could accommodate a broader user range. The percentile calculation results for each body dimension are presented in Table 5.

Table 5. Results of anthropometric data percentile calculations

Dimensions	5 th percentile	50 th percentile	95 th percentile
Bb	43.8	64.2	84.7
LP	42.6	49.4	56
Credits	46.0	54.7	63.4
Plb	36.8	42.9	48.9
Ptk	20.4	23.3	26.2
Tpo	41.5	45.5	49.5

Table 5 shows the distribution of the main anthropometric dimensions used in the design process. Body weight ranges from 43.8 kg at the 5th percentile to 84.7 kg at the 95th percentile, indicating that the transfer aid must be structurally capable of accommodating a fairly wide variation in user load. Hip width ranges from 42.6 cm to 56 cm, which becomes an important basis for determining the width of the support area. Elbow-to-elbow breadth ranges from 46.0 cm to 63.4 cm and is relevant for determining handle spacing and upper-body accommodation. Forearm length, foot length, and popliteal height also show dimensional variation that directly

influences seat length, foot placement, and vertical positioning. Overall, these percentile values provide the main quantitative basis for translating user body dimensions into the final specifications of the proposed transfer aid.

To strengthen the engineering relevance of the proposed design, the anthropometric-based dimensional translation is not only used for geometric definition, but also for ensuring biomechanical compatibility between the user and the transfer system. This approach minimizes deviation between human body posture and device constraints, thereby reducing unnecessary joint stress during transfer activities. The use of percentile-based design ensures that both smaller and larger users can be accommodated without requiring compensatory postural adjustments from healthcare workers.

3.6. Visual Design Plan

Based on the percentile results, the main dimensions of the proposed patient transfer aid were determined by aligning each design component with the most relevant anthropometric parameter. Dimensions related to load-bearing capacity were derived from body weight data, while dimensions associated with user accommodation and physical interaction with the device were derived from hip width, elbow-to-elbow breadth, forearm length, foot length, and popliteal height. In this study, dimensional tolerances were also added to several components to ensure practical feasibility, user comfort, and safe operational clearance during transfer. The resulting dimensional specifications of the proposed device are summarized in Table 6.

Table 6. Dimensional specifications for patient transfer devices

No	Specification	Size
1	Hydraulic lifting capacity	100 kg
2	Base width	50 cm
3	Distance between handles	43.2 cm
4	Chair length	50 cm
5	Seat width	25 cm
6	Minimum clearance distance	45 cm

Table 6 presents the final dimensional specifications of the proposed patient transfer device. The lifting capacity was set at 100 kg to accommodate the upper body-weight range represented by the 95th percentile value of 84.7 kg, while still providing an additional safety margin. The base width of 50 cm was determined from the median hip-width dimension to provide sufficient support and balance during transfer. The handle spacing, chair length, seat width, and minimum clearance distance were also derived from the percentile values of the corresponding body dimensions so that the device could better match patient body characteristics. These specifications indicate that the proposed design was not determined arbitrarily, but was quantitatively translated from anthropometric data into functional dimensions of the transfer aid.

To ensure engineering accuracy and geometric consistency, the proposed design was developed using SolidWorks software. The design process in SolidWorks began with the creation of 2D sketches based on the calculated anthropometric dimensions, followed by the development of individual 3D parts using parametric modeling. These parts were then assembled into a complete system to evaluate structural configuration, spatial relationships, and functional integration between components such as the frame structure, seating system, handle mechanism, and lifting system.

The use of SolidWorks enables precise control of dimensional parameters and allows iterative refinement of the design to ensure consistency between anthropometric requirements and engineering constraints. In addition, the software facilitates visualization of the device in both 2D technical drawings and 3D models, which improves the evaluation of ergonomic suitability, assembly feasibility, and operational functionality before physical prototyping. These visualizations are presented in Figures 4 and 5.

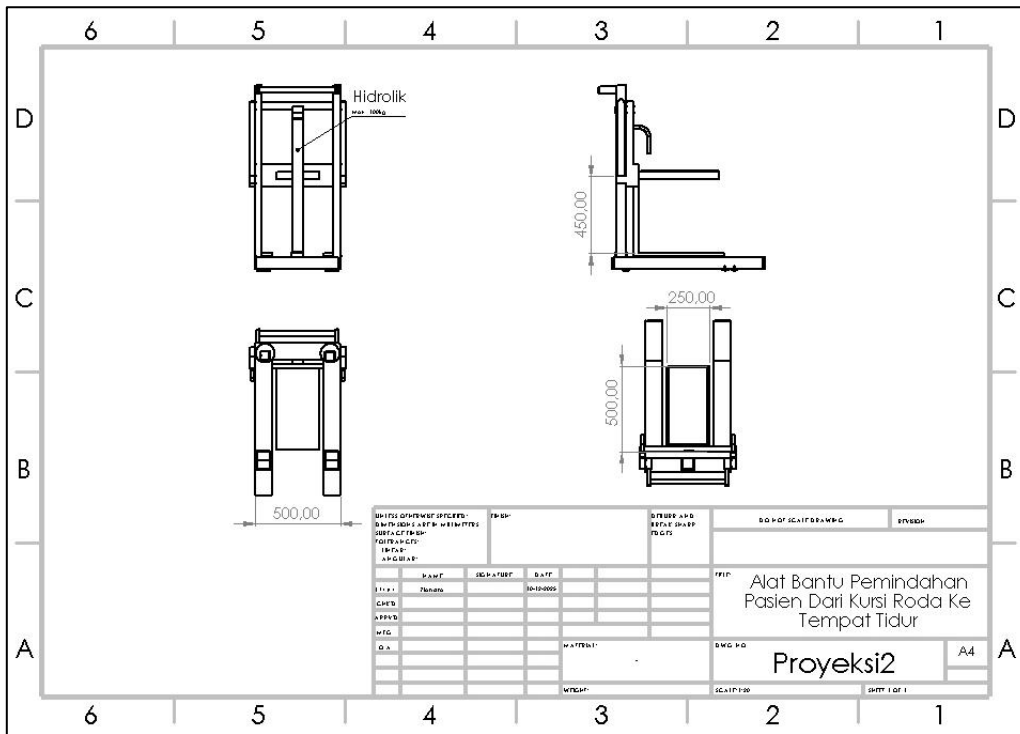


Figure 4. 2D design of patient transfer assistance tool

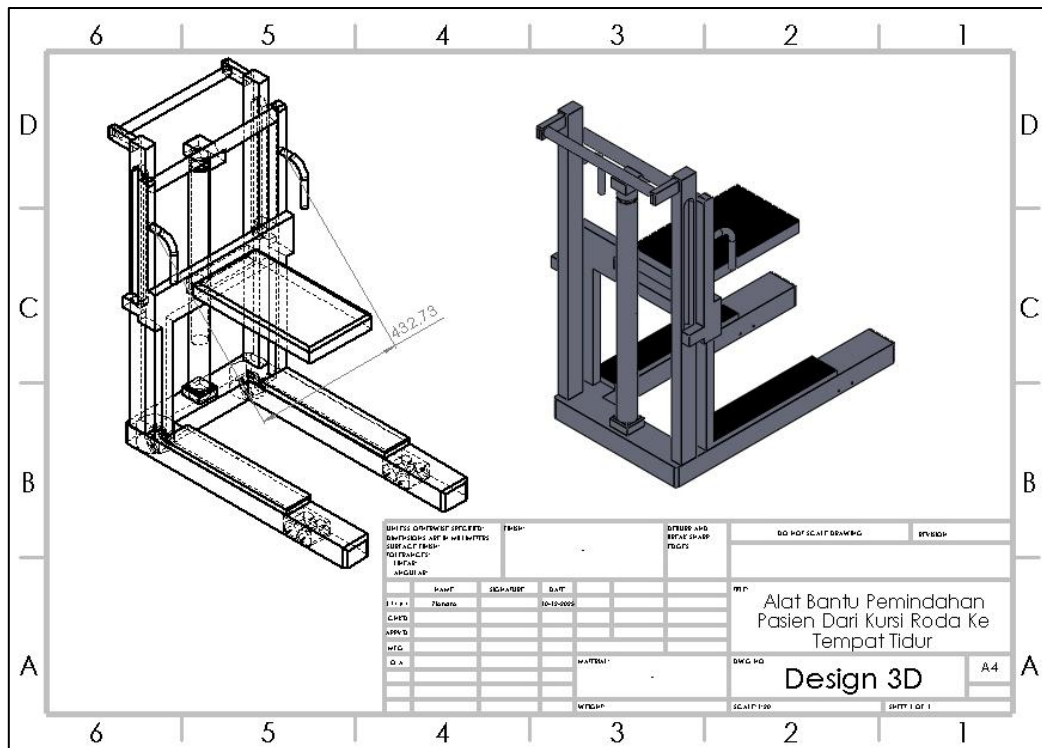


Figure 5. 3D design of patient transfer assistance tool

The 2D and 3D design visualizations show that the proposed transfer aid consists of a support frame, seating area, handle system, and lifting mechanism arranged to facilitate patient transfer in a seated position. From a design perspective, these visualizations confirm that the anthropometric dimensions have been translated into a tool configuration that emphasizes body support, user stability, and operator accessibility. The visual models also demonstrate that the proposed design is structurally directed toward reducing the need for manual lifting by allowing the transfer process to be performed in a more controlled and ergonomically oriented manner.

From an ergonomic perspective, the proposed patient transfer aid is expected to reduce musculoskeletal disorder (MSD) risk by minimizing trunk flexion, excessive manual lifting, and asymmetric loading on

healthcare workers during wheelchair-to-bed transfer activities. Unlike conventional manual handling methods that rely heavily on caregiver physical strength, the proposed design introduces a structural support system that redistributes patient load through a mechanical lifting mechanism. This configuration reduces repetitive strain on the lumbar spine, which is identified as one of the primary risk regions in manual patient handling tasks. As a result, the system contributes to improved postural safety, reduced physical workload, and enhanced operational ergonomics in healthcare service environments.

4. Conclusions

This study successfully developed an anthropometric-based patient transfer aid for wheelchair-to-bed transfer using data from 100 respondents at Pesanggrahan Community Health Center. The anthropometric parameters, including body weight, hip width, elbow-to-elbow breadth, forearm length, foot length, and popliteal height, were effectively translated into engineering design specifications using percentile-based analysis. The resulting design was implemented and modeled using SolidWorks software, ensuring geometric consistency and structural feasibility.

The final design specifications include a lifting capacity of 100 kg, base width of 50 cm, handle spacing of 43.2 cm, seat width of 25 cm, and minimum clearance of 45 cm. These dimensions were derived to ensure ergonomic compatibility between users and the transfer aid, thereby improving dimensional fit and operational safety during wheelchair-to-bed transfer activities.

From an ergonomic perspective, the proposed design contributes to reducing musculoskeletal disorder (MSD) risk by minimizing manual lifting, trunk flexion, and asymmetric loading on healthcare workers. The integration of anthropometric data with engineering design principles demonstrates that user-centered design can significantly improve safety and comfort in patient handling systems.

However, this study is limited to design development and CAD-based evaluation without physical prototype testing or biomechanical validation. Therefore, future research is recommended to include prototype fabrication, finite element analysis (FEA), and ergonomic assessment using REBA or RULA methods to further validate the effectiveness and safety of the proposed system in real clinical environments.

References

- [1] P. Ari Wibowo, B. Swastika, and Z. Abidin, "The Influence of Occupational Safety and Health (K3) on Employee Work Productivity," *J. Health Sciences. Society.* , vol. 11, No. 2, pp. 197–204, 2022, doi: <https://doi.org/10.3322/jikm.v11i02.1220>.
- [2] ME Juliana, AU Roga, and SL Purimahua, "Introduction of Potential Hazards And K3 Prevention For Employees Of Se'i Pig Meat Makers At The Se'i Pig Yellow Bamboo Depot, Kupang City," *J. Budimas* , vol. Vol. 7, No, 2025.
- [3] A. Agustin, LKR Puji, and R. Andriati, "The Relationship Between Work Duration, Length of Service, and Work Posture and Low Back Pain Complaints Among Staff at Office X, South Jakarta," *J. Heal. Res. Sci.* , vol. 3, no. 1, pp. 13–22, 2023, doi: 10.34305/jhrs.v2i02.506.
- [4] Saeful Nurochim, NR As'ad, and AN Rukmana, "Waistbag Product Design Using the Quality Function Deployment (QFD) Method," *J. Ris. Tek. Ind.* , vol. 1, no. 1, pp. 1–13, 2021, doi: 10.29313/jrti.v1i1.91.
- [5] NA Febrianti, E. Yusmanisari, and S. Fithrotul Umami, "Occupational Safety and Health with Nurse Performance," *J. Nursing Prof.* , vol. 5, No. 2, pp. 289–295, 2024, doi: <https://doi.org/10.36590/kepo.v5i2.1193>.
- [6] I. Svinarky and Z. Zulkifli, "The Role of the Manpower Office in Protecting Occupational Health and Safety (K3) of Workers in Batam City," *J. Cahaya Keadilan* , vol. 9, no. 1, pp. 1–14, 2021, doi: 10.33884/jck.v9i1.2702.
- [7] Yanti Supriyanti and Wakhit Ahmad Fahrudin, "Analysis of machine performance effectiveness using the Total Productive Maintenance method at PT. BII," *JENIUS J. Terap. Tek. Ind.* , vol. 6, no. 2, pp. 252–260, 2025, doi: 10.37373/jenius.v6i2.1868.
- [8] A. Purbasari, "Ergonomic Analysis of Work Posture in Pillar Printing Operators that Cause Musculoskeletal Risks," *Sigma Tek.* , vol. 2, no. 2, p. 143, 2019, doi: 10.33373/sigma.v2i2.2064.
- [9] NW Silalahi, E. Erwin, and GT Utami, "Overview of Low Back Pain Prevention Efforts in Nurses at Selasih Hospital, Pangkalan Kerinci," *Coping Community Publ. Nurs.* , vol. 10, no. 5, p. 530, 2022, doi: 10.24843/coping.2022.v10.i05.p09.
- [10] RA Sinanto, RN Agustin, R. Nabila, and A. Candra, "The Effect of Work Posture on Musculoskeletal Disorders in Indonesian Workers; Meta-Analysis of the Udinus Public Health Undergraduate Study Program," vol. 2, no. 1, pp. 189–201, 2024.
- [11] SN Romlah, D. Fitriani, D. Susanti, S. Lokonathan, N. Nambiar, and F. Devasa, "Correlation between

- posture of job and musculoskeletal disorders complaints among emergency department nurses in general hospital district of Tangerang city," *Malaysian J. Med. Heal. Sci.* , vol. 16, no. 4, pp. 119–124, 2020.
- [12] McConnellsburg, "Work More Efficiently With The 10 Basic Principles Of Ergonomics," 2020, [Online]. Available: <https://www.jlg.com/en/directaccess/%0A2021/03/15/work-more-efficiently-with-the-10-%0Abasic-principles-of-ergonomics>
- [13] M. Ahmad Salcha, A. Juliani, and F. Borotoding, "The Relationship between Work Posture and Musculoskeletal Disorders in Rice Farmers," *Miracle J. Public Heal.* , vol. Vol. 4 No., 2021, doi: 10.36566/mjph/Vol4.Iss2/260.
- [14] RO Putri, S. Jayanti, and B. Kurniawan, "The Relationship Between Work Posture and Work Duration and Muscle Pain Complaints in Tofu Factory X Workers in Semarang City," *J. Health. Society.* , vol. 9, no. 6, pp. 733–740, 2021, doi: 10.14710/jkm.v9i6.31300.
- [15] D. Andrean, S. Suliawati, and M. Arfah, "Improving the Design of an Ergonomic Brick Transporter Using the Rapid Entire Body Assessment (REBA) Approach," *Fact. J. Ind. Manaj. and Rekayasa Sist. Ind.* , vol. 1, no. 3, pp. 86–92, 2023, doi: 10.56211/factory.v1i3.255.
- [16] A. Candra, F. Hendra, and R. Effendi, "Proposal for Improving Rollforming Machine Effectiveness Using the Overall Equipment Effectiveness (OEE) Method," *Suara Tek. J. Ilm.* , vol. 13, no. 1, p. 30, 2022, doi: 10.29406/stek.v13i1.3851.
- [17] RM Hutasoit et al. , "RESEARCH ARTICLE Anthropometric Study: Factors Affecting Cephalic Index in the Timor Tribe at Kupang City-East Nusa Tenggara," vol. 8, no. 1, pp. 39–49, 2025, doi: <https://doi.org/10.30596/amj.v8i1.21323>.
- [18] M. Makomulamin, NP Sari, and F. Sridefina, "Implementation of Anthropometry on the Design of Study Tables and Chairs in Pekanbaru 17 Public Elementary School Students Against the Prevention of Musculoskeletal Disorders (MSD's)," *J. Pengabd. Health. Community* , vol. 2, no. 3, pp. 255–262, 2023, doi: 10.25311/jpkk.vol2.iss3.1395.
- [19] Noviard, R. Syelly, and M. Andri, "Design of an Anthropometric Measuring Instrument Based on the Internet of Things," *J. SIMTIKA Vol. 6, No. 2, May 2023* , vol. 6, no. 2, pp. 1–9, 2023, [Online]. Available: <https://ejournal.undhari.ac.id/index.php/simtika/article/download/1090/458/5410>
- [20] S. Nurmutia, Ruspindi, and Rusmalah, *INDUSTRIAL ERGONOMICS* , 1st ed. South Tangerang: UNPAM PRESS, 2022.
- [21] Puji Priyono and F. Yuamita, "Development and Design of Tobacco Leaf Cutting Tools Using the Quality Function Deployment (QFD) Method," *J. Technol. and Manaj. Ind. Terap.* , vol. 1, no. 3, pp. 137–144, 2022, doi: 10.55826/tmit.v1iiii.45.
- [22] EL Miftahul Imtihan, "Aquascape Product Design Using the Quality Function Deployment (QFD) Method," *JENIUS J. Terap. Tek. Ind.* , vol. 1, no. 1, pp. 21–29, 2020, doi: 10.37373/jenius.v1i1.24.
- [23] H. Hotmauli, B. Anna, and H. Siboro, "Design of Tables and Chairs for Design Laboratory Tutorial," Using, *Inov. Principles, Methods. Anthropometry, Sinaga Approach*, vol. 23, no. 1, pp. 34–45, 2021, [Online]. Available: <https://talenta.usu.ac.id/jsti/article/view/4880>
- [24] RS Wahyuni, Y. Yuniar Rohmatin, M. Raharja, and T. Ayu Annisa, "Development of Package Box Design Based on Anthropometric Data," *J. Ilm. Tek.* , vol. 3, No.#, pp. 36–44, 2024.
- [25] M. Ridzwan and L. Latnawati, "Creation Of The Easy Move Pw25 Device For Transferring Patients From/To A Wheelchair And To/From A Bed At The Pesangrahan Community Health Center, South Jakarta Administrative City," 2025.