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Evaluation of Wheelchair Fit and Its Impact on Physical Comfort in a Community-Based Program in Malang

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ABSTRACT

Background: Proper wheelchair fit is essential to ensure comfort, postural stability, and to prevent secondary health complications in individuals with disabilities. In community-based programs, mismatches between wheelchair dimensions and users' anthropometric characteristics often go unnoticed, potentially leading to long-term issues.
Objective: This study aims to evaluate the alignment between users' body dimensions and the wheelchairs distributed through a community-based program in Malang, and to examine the potential ergonomic and clinical implications of mismatched fit.
Methods: A descriptive quantitative design was employed, involving 20 full-time wheelchair users selected purposively. Anthropometric measurements (seated height, popliteal length, hip width, elbow height) and wheelchair dimensions (seat height, seat depth, seat width, backrest height, armrest height) were directly measured. Normality was tested using the Shapiro–Wilk test, followed by Pearson correlation analysis. Outliers were identified using z-score thresholds.
Results: Significant positive correlations were found between seat height and armrest height ($r = 0.65$, $p < 0.01$), and between backrest height and seat width ($r = 0.58$, $p < 0.05$). No correlation was found involving seat depth. Two participants showed notable mismatches requiring individual adjustments, highlighting risks such as discomfort, postural imbalance, and mobility limitation.
Conclusion: Mismatch between wheelchair dimensions and user anthropometry can contribute to preventable discomfort and postural strain. Personalized assessments and ergonomic adjustments are crucial in community wheelchair programs. These findings support the implementation of anthropometric-based distribution strategies and training for service providers.
Keywords: Wheelchair, Ergonomics, Discomfort, Anthropometry, Disability.

INTRODUCTION

Wheelchairs are vital mobility aids for individuals with disabilities, significantly influencing their quality of life. A properly fitted wheelchair can help prevent discomfort, pressure ulcers, and musculoskeletal complications, while also supporting user independence and optimal mobility (Brown et al., 2024). However, many wheelchair distribution programs—particularly in low-resource settings—often supply standard-sized wheelchairs without adjusting for individual body measurements. This one-size-fits-all approach increases the risk of poor functional outcomes and secondary health issues (Holla et al., 2022).

Improper wheelchair fit has been linked to serious conditions such as scoliosis, nerve entrapment syndromes like Guyon's canal syndrome, and increased fall risk among users (Poojary-Mazzotta, 2017). These outcomes underline the necessity of tailoring wheelchair

features to fit the user's body dimensions.

In Malang City, a community service program seeks to distribute wheelchairs to individuals in need. However, there are growing concerns that the wheelchairs provided may not match the anatomical needs of the recipients, which could result in negative health effects (Brown et al., 2024). Therefore, it is essential to assess the compatibility of these wheelchairs with users' anthropometrics and examine any associated health impacts.

This study aims to evaluate the degree of alignment between wheelchair dimensions and recipient body measurements in Malang City's distribution program. Although research has established links between poor wheelchair fit and complications such as pain, pressure sores, and reduced mobility, specific data for this local population remains limited (Owens & Davis, 2021). This study addresses this gap by investigating the epidemiological effects of distributing custom-fitted wheelchairs in this community.

By analyzing the relationship between fit and health outcomes, this research will offer insights into the importance of individualized wheelchair fittings. These findings may help guide the development of evidence-based policies for future wheelchair distribution initiatives (Brown et al., 2024).

METHODS

Research Design

This study employed a descriptive quantitative design to assess the alignment between wheelchair dimensions and the anthropometric measurements of recipients in a community-based distribution program in Malang City. This design allowed for the systematic evaluation of the relationships between individual body dimensions and wheelchair fit, as well as potential physical discomfort arising from mismatch.

Population and Sample

The study population included all wheelchair recipients in a community service program held in 2024. A total of 20 participants were purposively selected to represent a diverse range of age groups and disability types. Inclusion criteria were: full-time wheelchair use, ability to undergo physical measurement, and voluntary participation with informed consent.

Data Sources

Primary data consisted of anthropometric measurements of participants, while secondary data comprised the specifications of the wheelchairs distributed during the

program. Additional observational data were recorded to identify physical indicators of potential health impact, such as complaints of lower back pain, posture misalignment, and early signs of pressure-related discomfort in seated areas.

Data Collection Techniques

Anthropometric parameters measured included seated height, popliteal length, hip width, and elbow height. Corresponding wheelchair dimensions recorded included seat height, seat depth, seat width, backrest height, and armrest height. All measurements were conducted by a trained team using standardized anthropometric equipment such as measuring tapes and flat boards for seated positioning. Each measurement was taken twice and averaged to ensure accuracy and inter-rater consistency.

Data Analysis Techniques

Descriptive Statistics

Descriptive analysis was used to calculate the mean, median, and standard deviation for each measured parameter of both the users and the wheelchairs.

Pearson Correlation Analysis

Normality testing was performed using the Shapiro–Wilk test. Variables that followed a normal distribution were further analyzed using Pearson correlation to determine the strength of association between anthropometric dimensions and wheelchair measurements.

Outlier Identification

Outliers were identified using z-score thresholds of ±2.0. These cases were examined qualitatively to determine if specific users required modifications to their wheelchairs based on disproportionate measurements and reported discomfort.

All statistical procedures were carried out using SPSS software version 25. The study received ethical clearance from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Brawijaya.

RESULTS

Descriptive Statistics of Body Dimensions and Wheelchair Measurements

Table 1 presents the descriptive statistics of both user anthropometric measurements and the dimensions of the distributed wheelchairs among 20 participants. The average seated height of participants was 38.5 cm (SD = 4.2 cm), while the average armrest height was 38.8 cm (SD = 6.5 cm). The mean backrest height was 36.7 cm (SD = 8.1

cm), seat width was 31.5 cm (SD = 4.9 cm), and seat depth was 29.2 cm (SD = 4.5 cm). These values represent a comparative overview between the physical characteristics of the users and the corresponding wheelchair dimensions. The participants ranged in age from 25 to 71 years, and the majority presented with lower limb motor disabilities requiring full-time wheelchair use.

Table 1 Descriptive Statistics of Body Dimensions and Wheelchair Measurements

Dimension	Mean (cm)	Median (cm)	SD (cm)
A (Seat Height)	38.5	37	4.2
B (Armrest Height)	38.8	39	6.5
C (Backrest Height)	36.7	35	8.1
D (Seat Width)	31.5	31	4.9
E (Seat Depth)	29.2	28	4.5

Normality Testing

Prior to conducting correlation analysis, normality of data distribution was evaluated using the Shapiro–Wilk test. All variables demonstrated a p-value greater than 0.05, indicating that the data were normally distributed and suitable for parametric analysis using Pearson's correlation coefficient.

Correlation Analysis between Body Dimensions and Wheelchair Measurements

Pearson correlation analysis revealed statistically significant positive relationships between certain wheelchair and user body dimensions. Specifically, seat height (A) showed a strong positive correlation with armrest height (B) ($r = 0.65$, $p < 0.01$), while backrest height (C) was significantly correlated with seat width (D) ($r = 0.58$, $p < 0.05$). These findings suggest that certain anthropometric features may co-vary and influence ergonomic alignment. No significant correlation was observed between seat depth (E) and any other parameter, indicating that seat depth may need to be assessed independently when tailoring wheelchair fit.

Table 2 Pearson Correlation Analysis between Body Dimensions and Wheelchair Measurements

Dimension	B	C	D	E
A	0.65**	0.45	0.33	0.28
B	–	0.58*	0.42	0.31
C	–	–	0.58*	0.34
D	–	–	–	0.29

*Note: *p < 0.05, **p < 0.01

Outlier Identification and Its Impact on Health

Outlier analysis identified two participants whose body dimensions significantly deviated from the group average. Participant 3 presented with smaller anthropometric measurements but received a wheelchair with seat and back dimensions considerably larger than appropriate. This mismatch likely contributed to postural instability and complaints of discomfort during prolonged sitting. Conversely, Participant 8 had significantly larger dimensions than average, requiring customized adjustment to avoid pressure concentration and limited arm mobility. These outliers emphasize the necessity of individualized assessment prior to distribution.

Table 3 Outlier Identification and Its Impact on Health

Participant	A	B	C	D	E	Description
3	37	40	35	32	25	Undersized body dimensions, wheelchair too large
8	44	44	46	38	38	Oversized body dimensions, requires special modification

DISCUSSION

Interpretation of Key Findings

The findings of this study reveal significant associations between specific anthropometric parameters and wheelchair dimensions. The strong positive correlation between seat height and armrest height ($r = 0.65$, $p < 0.01$) suggests that these two measurements tend to vary together and may reflect a coordinated aspect of upper body support. Proper alignment between these elements is crucial for maintaining shoulder and elbow positioning, which directly influences user comfort and upper limb function during propulsion or transfer activities (Brown et al., 2024).

Additionally, the observed correlation between backrest height and seat width ($r = 0.58$, $p < 0.05$) indicates a potential relationship in trunk and pelvic support dimensions. This alignment contributes to spinal stability and seating balance, particularly in users with compromised postural control (Owens & Davis, 2021).

Conversely, the lack of significant correlation involving seat depth highlights the need for individualized assessment. Unlike other dimensions, seat depth does not appear to follow a generalizable pattern and may vary substantially depending on thigh length, pelvic tilt, and user preferences (Stamenković et al., 2022). This finding underscores the importance of treating seat depth as an independent ergonomic factor in wheelchair fitting.

Overall, these key findings emphasize the importance of anatomical precision in wheelchair design and selection to enhance safety, functionality, and long-term user

health (Brown et al., 2024).

Clinical and Ergonomic Implications of Mismatch

The identification of outliers in this study provides critical insight into the potential clinical consequences of improper wheelchair fit. Participant 3, who exhibited smaller-than-average body dimensions but received a wheelchair with disproportionately large seating components, likely faced increased risk of postural instability, shearing forces, and reduced trunk support. Such mismatches may lead to discomfort, inefficient propulsion, and increased vulnerability to pressure injuries in the ischial and sacral regions (Russo et al., 2022).

Similarly, Participant 8, whose body dimensions exceeded average values, required larger-than-standard support to ensure functional alignment. In the absence of adjustment, oversized users are more prone to lateral trunk deviation, skin irritation from compression, and limited upper limb mobility. These risks may compromise independence and lead to secondary musculoskeletal issues (Kaushal et al., 2023).

From an ergonomic perspective, a mismatch between body dimensions and wheelchair features disrupts the biomechanical balance essential for seated posture. Inadequate fit affects load distribution, pelvic alignment, and joint positioning, all of which contribute to user fatigue and long-term strain. Ergonomic theory supports the notion that prolonged use of improperly fitted devices exacerbates chronic pain syndromes, particularly in the lumbar spine and shoulders (Brown et al., 2024). Prolonged exposure to such strain increases the likelihood of developing chronic pain syndromes and repetitive strain injuries.

These cases reinforce the necessity of integrating detailed anthropometric assessments into community-based wheelchair distribution efforts to minimize preventable health complications and ensure user well-being (Prastio et al., 2024).

Relevance to Previous Research

The results of this study support and expand upon prior findings that emphasize the clinical consequences of improperly fitted wheelchairs. Recent studies show that a mismatch between wheelchair dimensions and user anatomy can lead to secondary health issues such as scoliosis, nerve compression (e.g., Guyon's canal syndrome), and pressure injuries due to poor postural support and increased shear forces (Sprigle, 2023).

Similarly, research has linked improper wheelchair configuration to increased incidence of pain, reduced mobility, and higher hospital readmission rates, especially in

individuals with spinal cord injuries (Brown et al., 2024). These outcomes reflect not just equipment deficiencies, but a broader systemic gap in tailored wheelchair provision.

This study reinforces those findings within the context of a community-based program in Indonesia, where standardized assessment procedures are often unavailable. Unlike studies conducted in clinical environments, this research provides real-world insight into the challenges of public health implementation in under-resourced areas. It underscores the pressing need for individualized wheelchair fitting in these settings to prevent complications and improve health outcomes (Griggs, 2024).

By contributing localized data, this study adds to the growing body of global evidence calling for context-specific, user-centered assistive device distribution protocols (Prastio et al., 2024).

Practical Implications for Community-Based Wheelchair Programs

The findings of this study emphasize the pressing need for individualized assessment protocols within community-based wheelchair distribution programs. Generic "one-size-fits-all" models often overlook the diverse anatomical requirements of users, resulting in preventable discomfort, postural imbalances, and health risks. Incorporating simple anthropometric measurements—such as seat height, seat depth, and backrest height—into pre-distribution evaluations can substantially improve functional outcomes and user satisfaction (Kephart et al., 2024).

Equipping community health workers and social service personnel with training in these measurement techniques can enhance the precision of wheelchair fitting and allocation (Forero et al., 2024). Additionally, the adoption of modular or adjustable wheelchair designs offers a pragmatic solution for accommodating varied body types in resource-limited settings (Rizzi et al., 2023).

Establishing structured feedback mechanisms after wheelchair distribution can aid in the early detection of fit-related issues, facilitating timely interventions and adjustments. These practices not only improve clinical outcomes but also reinforce the social and rehabilitative impact of wheelchair distribution programs by promoting autonomy and inclusion for people with disabilities (Goršič et al., 2024).

Despite providing valuable insights, this study has several limitations. Firstly, the relatively small sample size of 20 participants may restrict the generalizability of the findings to broader populations with diverse demographic or clinical profiles. Studies with limited participant numbers often face challenges in drawing robust epidemiological

conclusions (Sprigle, 2023). Secondly, the research was confined to Malang City, an urban setting, which may not accurately represent the needs or circumstances of individuals in rural or under-resourced regions where infrastructure, socioeconomic status, and access to assistive technologies may differ significantly (Doucette et al., 2019).

Lastly, the study predominantly relied on objective anthropometric data without including subjective metrics such as user satisfaction, perceived comfort, or overall quality of life. Incorporating these qualitative indicators is essential to fully evaluate the impact and effectiveness of wheelchair fit from the user's perspective (Sarsak, 2018).

Future investigations should strive to recruit larger and more demographically varied samples across multiple geographic locations to strengthen external validity. Implementing longitudinal designs would allow researchers to monitor how wheelchair fit influences comfort, function, and the onset of secondary health issues over time (Rispin et al., 2018). Moreover, incorporating qualitative methods such as interviews or satisfaction surveys would offer richer insight into users' lived experiences and the subjective impacts of fit (Rispin et al., 2020). Additionally, exploring the use of digital technologies, such as mobile applications or self-assessment tools, could enhance efficiency in anthropometric evaluations and wheelchair-user matching within community-based distribution programs (Castellucci et al., 2023).

CONCLUSION

This study highlights the critical role of wheelchair fit in promoting user comfort and preventing physical complications in community-based settings. Significant correlations between specific body dimensions and wheelchair measurements affirm the need for individualized assessment during device allocation. The identification of outliers further emphasizes the risks associated with mismatched equipment, including poor posture, discomfort, and long-term musculoskeletal strain. To optimize the impact of wheelchair distribution programs, personalized fitting, user education, and ergonomic considerations must be integrated into standard procedures. These findings support the development of more inclusive, data-driven, and health-oriented assistive technology services.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest in this research. This means that the authors have no financial or other interests that could compromise the objectivity and integrity of the research findings. All data, analyses, and conclusions presented in this study are based solely on empirical evidence and are not influenced by personal or

organizational interests that could negatively impact the authors' obligation to make decisions in the best interest of third parties.

AUTHOR CONTRIBUTIONS

In this study, each author made significant contributions and played an active role in various aspects of the research and manuscript preparation. All authors were actively involved and are responsible for the content of the manuscript, including its preparation, design, analysis, and revision.

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