DOI: https://doi.org/10.54393/pjhs.v5i10.2407

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (P): 2790-9352, (E): 2790-9344
Volume 5, Issue 10 (October 2024)

Original Article

OPEN ACCESS

Variations in Elbow Carrying Angle Associated with Age, Gender, Height, and Weight: An Analytical Cross-Sectional Study

Jawad Khan[1], Alamgir Khan[1*], Raziq Shah[1], Hamza[1], Syed Ihtisham Kakakhel[2] and Ammad Ali[3]

[1]Department of Orthopedic, Bacha Khan Medical College, Swabi, Pakistan
[2]Department of Family Medicine, Bacha Khan Medical College, Swabi, Pakistan
[3]Sehat Sahulat Programme, Mardan, KPK, Pakistan

ARTICLE INFO

Keywords:
Elbow Carrying Angle, Biomechanics, Body Mass Index, Gender

How to Cite:
Khan, J., Khan, A., Shah, R., Hamza, ., Kakakhel, S. I., & Ali, A. (2024). Variations in Elbow Carrying Angle Associated with Age, Gender, Height, and Weight: An Analytical Cross-Sectional Study : Variations in Elbow Carrying Angle Associated with Age, Gender, Height, and Weight. Pakistan Journal of Health Sciences, 5(10). https://doi.org/10.54393/pjhs.v5i10.2407

***Corresponding Author:**
Alamgir Khan
Department of Orthopedic, Bacha Khan Medical College, Swabi, Pakistan
drkhankmc87@.com

Received Date: 22nd August, 2024
Acceptance Date: 20th October, 2024
Published Date: 31st October, 2024

ABSTRACT

The elbow's carrying angle is a critical biomechanical feature that varies between genders and with physical characteristics like Body Mass Index. **Objective:** To determine the elbow carrying angle and analyze its correlation with physical attributes such as age, gender, height, and weight in a cross-sectional cohort." **Methods:** A cross-sectional study was carried out on 203 patients. The participants were divided into groups according to their height, weight, age, and gender. the mean carrying angles of the elbows on the left and right were measured and compared. Data were collected and analyzed using SPSS version 25.0, and the significance of the differences in carrying angles between the groups was determined by computing p-values. **Results:** There were 76 patients (37.43%) and 127 male patients (62.56%) in the study population. Sixty-six percent of the patients belonged to the 46-60 age range. For the left elbow, the mean carrying angle was 4.6°(±0.23), while for the right elbow, it was 4.5°(±0.12). Gender, limb side, height, and weight all showed significant changes in carrying angles; p-values<0.05 indicated that these variances were statistically significant, especially when comparing different body types and demographic groups. **Conclusions:** It was concluded that the right arm typically exhibits a slightly wider angle than the left when it comes to elbow carrying angles; gender, height, and weight all significantly influence these angles.

INTRODUCTION

An electric goniometer can also be used to measure this angle. Significant variations in carrying angle measurements have been documented [1-3]. The carrying angle is important for grasping goods and is especially helpful in keeping the forearm away from the pelvis during upper limb swing during walking. It is linked to a wide range of conditions affecting the elbow in particular and the upper limb in general. An increase in carrying angle may result in pain and elbow joint instability during workouts and sporting activities including throwing. Increased carrying angle has been linked to reports of ulnar neuropathy. A child's risk for developing different types of elbow fractures can be increased by variations in carrying angle. After trauma and other deformities, its assessment and repair are thought to be essential steps in elbow rehabilitation and restoration for proper function. The correlation between carrying angle and age, sex, dominant side, and physical attributes such as trans-trochanteric diameter, height, forearm length, arm constitution, race, and inter-epicondylar distance has been the subject of numerous research [4-6]. The obliquity of the superior articular surface of the coronoid and the protrusion of the medial trochlear ridge both affect the carrying angle [7]. The carrying angle is eliminated when the shoulder joint is fully extended, or when the ulnar and humeral articular surfaces are aligned in the same plane. It's seen as a secondary sexual feature as well. Furthermore, in both genders, the non-dominant extremity's carrying angle is often smaller than the dominant extremity's. Traumatic injuries, fractures, ligamentous laxity, congenital

DOI: https://doi.org/10.54393/pjhs.v5i10.2407

abnormalities, inflammatory or rheumatic disorders, and genetic factors might also have an impact on it. There may also be notable variations in carrying angles between the left and right sides. Clinicians frequently employ hinged goniometers and visual examinations to assess angulation. Clinical images are useful for monitoring the evolution of deformities or their improvement over time. When the elbow is fully extended, normal alignment variations include a carrying angle of around 15 degrees varus, ranging from almost zero degrees' valgus to at least 20 degrees [8-10]. In healthy children, the carrying angle and the range of motion at the elbow joint increase with age until skeletal maturity [11]. However, a study showed that the clinical carrying angle (CCA) increases up to the age of 15 years, followed by a slight decrease in the angle [12]. The biomechanical relevance of the CA extends to differences observed across genders and life stages, with findings suggesting broader pelvises in females potentially contributing to increased CAs due to a direct correlation with pelvic width [13].

This study aims to determine the elbow carrying angle and analyze its correlation with physical attributes such as age, gender, height, and weight in a cross-sectional cohort.

METHODS

A descriptive cross-sectional study was carried out on 203 patients reported to the Orthopedic Surgery Outpatient Department (OPD) of Khyber Teaching Hospital in Peshawar, from 1st March 2019 (because of COVID tenure we were unable to collect data) to February 16, 2024. Using the WHO calculator, the sample size was determined with a 95% confidence level, a 5% margin of error, an elbow carrying angle of 4.55, and a standard deviation (SD) of 3.37. Patients from both genders, ages 18 to 60, who presented to the orthopedic outpatient department (OPD) with problems unrelated to the exclusion criteria were chosen using a consecutive non-probability sampling technique. Consent was taken from patients and their parents. The ethical permission was taken from Khyber Medical College and was granted permission, No: 355/ADR/KMC. Individuals with a history of congenital upper limb defects, elbow trauma, upper limb fractures, inflammatory diseases, or rheumatic disorders were not allowed to participate. The hospital's ethics committee as well as the department heads gave their assent. Written informed permission was taken from each patient. In-depth medical histories were obtained, and tests were performed to rule out complicating factors. An orthopedic surgeon with experience evaluated elbow carrying angles by hand using a protractor goniometer. For every participant, three successive measurements were made, and the mean value was applied. We also gathered additional weight and height data. SPSS version 25.0 was used to examine the data, which were entered into a proforma that had been pre-designed. For numerical data, mean ± SD was computed; for categorical variables, frequencies and percentages were ascertained. A post-stratification chi-square test was used at a significance threshold of $p<0.05$ to assess the effects of age, gender, side of limb, height, and weight on the carrying angle. Tables were used to display the results.

RESULTS

Age mean and SDs, according to descriptive statistics, were 55 + 8.52. For height, the mean and SDs were 5.5 + 0.07. Weight mean and SDs were 92 + 6.08. The carrying angle of the elbow (left arm) was 4.6 + 0.23 for the mean and SDs. Mean and Standard Deviation for Elbow Carrying Angle (Right Arm): 4.5 + 0.12. In terms of gender distribution, there were 76 (37.43%) female patients and 127 (62.56%) male patients. According to the age distribution, 133 (65.51%) patients were documented in the 46–60-year age group and 70 (34.48%) patients in the 18–45-year age group. Calculations were made to determine the elbow stratification according to age, gender, side of limb, height, and weight (Table 1).

Table 1: Gender and Age Distribution of Patients (n=203)

Categories		Frequencies
Gender	Male	127 (62.56%)
	Female	76 (37.43%)
Age Group	18-45	70 (34.48%)
	46-60	133 (65.51%)

Stratification of the Mean Carrying Angle of the Elbow with Age, Gender, Side of Limb, Height, and Weight were analyzed (Table 2).

Table 2: Stratification of Mean Carrying Angle of Elbow with Age, Gender, Side of Limb, Height, and Weight

Categories		Left Arm Elbow (Mean ± SD)	Right Arm Elbow (Mean ± SD)	p-Value
Age Group	18-45	4.6 ± 0.21	4.5 ± 0.13	0.001
	46-60	4.6 ± 0.24	4.5 ± 0.11	0.024
Gender	Male	4.6 ± 0.22	4.5 ± 0.12	0.001
	Female	4.6 ± 0.23	4.5 ± 0.12	0.113
Side of Limb	Right Arm	4.6 ± 0.23	4.6 ± 0.23	0.001
	Left Arm	4.5 ± 0.12	4.5 ± 0.12	0.001
Height	<5.5 Ft	4.5 ± 0.12	4.6 ± 0.23	0.019
	>5.5 Ft	4.6 ± 0.22	4.5 ± 0.12	0.003
Weight	< 90 Kg	4.6 ± 0.23	4.5 ± 0.11	0.001
	>90 Kg	4.6 ± 0.23	4.5 ± 0.13	0.001

DISCUSSION

Based on the descriptive statistics, the study population's mean age is 55 years, with a standard deviation of 8.52. This suggests that the cohort is quite mature and has a moderate age variation. It has been shown that starting at age nine, females exhibit a noticeably higher carrying angle, which lasts until stability. However, several studies have not discovered any variation in the carrying angle,

DOI: https://doi.org/10.54393/pjhs.v5i10.2407

regardless of age or gender [14, 15]. The participants' average height was 5.5 feet, with a standard deviation of 0.07, indicating that the study population's height distribution was constant. With a mean weight of 92 kg and a standard deviation of 6.08, the weight measures indicate that most participants were within a higher weight range, potentially pointing to an overweight population. Many writers have studied the effect of morphometric variables (BMI, arm length, forearm length, trans-trochanteric diameter, and inter-epicondylar distance) on the carrying angle. Studies have demonstrated a positive correlation between BMI and carrying angle. Many authors have investigated the effects of morphometric variables, including BMI, arm length, forearm length, trans-trochanteric diameter, and inter-epicondylar distance, on the carrying angle. Studies have revealed a positive correlation between carrying angle and BMI [16]. The elbow's mean carrying angle, which is important to understand the biomechanics of the upper limb, was determined to be 4.6 ± 0.23 for the left arm and 4.5 ± 0.12 for the right arm. 76 female patients, or 37.43% of the total, and 127 male patients, or 62.56% of the total, were included in the study. The studied population appears to be primarily male based on the gender ratio, which could be explained by the analyzed demographics' access to healthcare or the frequency of particular ailments. Additionally, the age distribution reveals that 65.51% of patients were in the 46–60 age group, while 34.48% of patients were between the ages of 18 and 45. This suggests that the senior population was the study's primary emphasis, which may be relevant to the topics being looked at, such as those related to joint health and musculoskeletal function. More information on the biomechanical variations in the population can be gained by stratifying the mean carrying angle of the elbow by height, weight, gender, age, and side of the limb. The data demonstrated that, with a little standard deviation fluctuation, the mean carrying angle of the left and right elbows was consistent in both age groups (18–45 years and 46–60 years). A direct comparison of our findings with earlier systematic reviews and meta-analyses is challenging and should be done cautiously due to the variations in worker samples, work characteristics, methodology, and assessment. Research has shown links between exposures at work and the development of elbow problems; more long-term cohort studies might try to confirm these links. Future studies may also look into the effects of changing employment to prevent physical and psychological risk factors that contribute to the development of elbow problems [17, 18]. Significant variations in carrying angles were seen across different strata, notably between genders and limb sides, as evidenced by the p-values. Indicating potential dominance or functional asymmetry in upper limb use, males had a little narrower standard deviation than females, and the right arm consistently displayed a slightly greater mean carrying angle than the left. Individuals taller than 5.5 feet had a slightly larger carrying angle on their left arm, whereas those who were shorter had a greater angle on their right arm, according to further analysis by height and weight. Patients who weighed more than 90 kg had a slightly higher carrying angle in their right arm, according to weight stratification; significant p-values indicated that these differences were not the result of chance. Ansai et al., provided insights into gender differences in CA, noting that females typically exhibit a larger CA and that the dominant limb often has a larger CA than the non-dominant limb [19]. These variations underscore the complexity of CA as a physiological characteristic potentially influenced by multiple factors, including hand grip strength, which has been negatively correlated with CA in young adults [20].

CONCLUSIONS

It was concluded that the majority were men, with small changes in height and weight and constant carrying angles. The statistically significant differences suggest that variations in anatomical characteristics, such as height and weight, may influence elbow carrying angles."

Authors Contribution

Conceptualization: JK
Methodology: JK, AK, RS, AA
Formal analysis: JK, SIK, AA
Writing review and editing: AK, RSK, SIK

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

REFERENCES

[1] Kushwaha NS, Verma V, Singh A, Sharma Y, Singh A. A Study of Factors Associated with Carrying Angle of the Human Elbow in Pediatric Age Group.Cureus. 2022 May; 14(5). doi: 10.7759/cureus.25478.

[2] Rashed AM, Abdel-Wahab N, Moussa EM, Hammam N.Association of Hand Grip Strength with Disease Activity, Disability and Quality of Life in Children and Adolescents with Juvenile Idiopathic Arthritis. Advances in Rheumatology. 2018 Jun; 58: 11. doi: 10.1186/s42358-018-0012-1.

[3] Bhatti U, Sangrasi SA, Effendi S, Ahmadani R, Shaikh SN, Abro A. An Anthropometric Study on the Carrying Angle of Elbow among Children Ages between 10 to 15 Years of Various Schools in Hyderabad, Pakistan: A Cross-Sectional Study. Annals of the Romanian Society for Cell Biology. 2022 Apr; 26(01): 776-81.

[4] Sadacharan CM, Alikhan SB, Packirisamy V, Murlimanju BV. Carrying Angle of the Elbow Joint in Young Caucasian and Indian American Population: A

DOI: https://doi.org/10.54393/pjhs.v5i10.2407

Descriptive Cross-Sectional Study. Journal of the Anatomical Society of India.2022 Jan; 71(1): 42-6. doi: 10.4103/JASI.JASI_145_20.

[5] Verma V, Singh A, Kushwaha NS, Sharma Y, Singh A.Correlation Between Morphometric Measurements and Carrying Angle of Human Elbow. Cureus. 2022 Jul; 14(7). doi: 10.7759/cureus.27331.

[6] Gupta S, Soni A, Aggarwal M, Vohra H, Bansal P. Morphometric Co-Relation of Carrying Angle to Height, Sex,Age and Dominance in Children-A Quantitative Study. Biomedicine. 2022 Mar; 42(1): 23-7. doi: 10.51248/.v42i1.437.

[7] Nemuri S, Rao KJ, Reddy PJ, Kiran VS. Evaluation of Carrying Angle in 1st Yr. Medical Students of SVS Medical College,Mahabubnagar. International Journal of Orthopedic. 2020; 6(3): 218-2. doi:10.22271/ortho.2020.v6.i3d.2203.

[8] Khan MS and Singh RB. Variation in Carrying Angle-A Normative Study. Indian Journal of Orthopedics Surgery. 2023 Dec; 9(4): 237-42. doi: 10.18231/j.ijos.2023.045.

[9] Shah PA and Naqvi WM. Carrying Angle and Its Co-Relation with Different Parameters Height, Length of Forearm, And Age. International Journal of Physiotherapy.2020; 7(5): 211-5. doi: 10.15621/ijphy/2020/v7i5/782.

[10] Balasubramanian P, Madhuri V, Muliyil J. Carrying Angle in Children: A Normative Study. Journal of Pediatric Orthopedics B. 2006 Jan; 15(1): 37-40. doi: 10.1097/01202412-200601000-00008.

[11] Golden DW, Jhee JT, Gilpin SP, Sawyer JR. Elbow Range of Motion and Clinical Carrying Angle in A Healthy Pediatric Population. Journal of Pediatric Orthopedics B. 2007 Mar; 16(2): 144-9. doi:10.1097/BPB.0b013e328010fcf2.

[12] Açikgöz A, Balci R, Göker P, Bozkir M. Evaluation of the Elbow Carrying Angle in Healthy Individuals. International Journal of Morphology.2018; 36(1).doi: 10.4067/S0717-95022018000100135.

[13] Assi MH. Morphometric Measurements of Carrying Angle of the Elbow among Sample of Iraqi Medical Students: An Observational, Cross-Sectional Study. Mustansiriya Medical Journal.2023 Jan; 22(1): 132-7. doi: 10.4103/mj.mj_25_23.

[14] Amgain K, Subedi P, Yadav GK, Neupane S, Khadka S,Sapkota SD. Association of Anthropometric Indices with Menstrual Abnormality among Nursing Students of Nepal: A Cross-Sectional Study. Journal of Obesity.2022; 2022(1): 6755436. doi: 10.1155/2022/6755436.

[15] Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S *et al.* Synthesis Without Meta-Analysis (Swim) in Systematic Reviews: Reporting Guideline. British Medical Journal.2020 Jan; 368. doi: 10.1136/bmj.l6890.

[16] Curti S, Mattioli S, Bonfiglioli R, Farioli A, Violante FS.Elbow Tendinopathy and Occupational Biomechanical Overload: A Systematic Review with Best-Evidence Synthesis.Journal of Occupational Health. 2021 Jan; 63(1): e12186. doi: 10.1002/1348-9585.12186.

[17] Seidel DH, Ditchen DM, Hoehne-Hückstädt UM, Rieger MA, Steinhilber B. Quantitative Measures of Physical Risk Factors Associated with Work-Related Musculoskeletal Disorders of the Elbow:A Systematic Review.International Journal of Environmental Research and Public Health.2019 Jan;16(1): 130. doi: 10.3390/ijerph16010130.

[18] Chiarotto A, Gerger H, van Rijn RM, Elbers RG, Søgaard K, Macri EM *et al.* Physical and Psychosocial Work-Related Exposures and the Occurrence of Disorders of the Elbow: A Systematic Review. Applied Ergonomics.2023 Apr;108:103952.doi: 10.1016/j.apergo.2022.103952.

[19] Ansari MA, Bhagat PS, Thokal D, Ganvir SD. Evaluation of the Carrying Angle of the Elbow Joint in Adolescents and Its Correlation with BMI, Gender and Dominant Side. International Journal of Sciences and Research. 2021; 10: 1321-4. doi: 10.21275/SR21620144356.

[20] Bhattacharyya T, Roy R, Islam M, Agarwal B, Roy SJ. Racial Variation of Carrying Angle of Elbow in North-East Indian Population: A Clinico-Radiological Study. Indian Journal of Orthopedics.2022 Mar: 1-7. doi: 10.1007/s43465-021-00540-0.