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Original Research Article

Variation in carrying angle - A normative study

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ABSTRACT

Background: The synovial joint that comprises the elbow is a hinge joint with a single degree of freedom, allowing for flexion and extension movements. The primary objective of this study was to investigate the varying carrying angles that were observed.

Materials and Methods: An observational study was conducted in the Department of Orthopaedics Heritage Institute of medical sciences Varanasi. Around 500 samples were taken for a period of 2 years. All patients of both genders inclusive of age group 8 to 19 years were taken with their consent. Asymptomatic individuals without any deformity, fractures, anomalies and previous history of surgery around elbow were included. All with previous elbow injuries and anomalies around elbow, history of Endocrine disorders, athletes and deformity occurring after any elbow injury were excluded.

Results: The present study was conducted in the Department of Orthopaedics, Heritage Institute of Medical Sciences, Varanasi with the objective to observe the physiological factors responsible for the change in the carrying angle in normal individuals in a tabulated manner. A total of 500 patients were included in the study. There was no significant ($p>0.05$) difference in carrying angle between male and females among different age groups. There was no significant ($p>0.05$) difference in carrying angle between male and females among different height groups. Only age was positively significantly ($r=0.48$, $p=0.001$) correlated with carrying angle.

Conclusion: Females had a considerably higher carrying angle (12.96±2.44) than males (12.19±1.74) ($p=0.001$). There was no significant difference in carrying angle across height groups or genders ($p>0.05$). Age correlated positively with carrying angle ($r=0.48$, $p=0.001$).

1. Introduction

The synovial joint that comprises the elbow is a hinge joint with a single degree of freedom, allowing for flexion and extension movements (Fornalski et al., 2003).[1] It is formed by the articulation of the upper ends of the radius and ulna with the lower end of the humerus. The angle formed between the arm's median axis and the completely extended and supinated forearm, known as the carrying angle, describes the forearm's lateral obliquity (Acikgoz et al., 2018).[2] This angle is most accurately measured when the forearm is supinated, the elbow is fully extended, and the shoulder is rotated outward.

The carrying angle is influenced by the projection of the medial trochlear ridge and the obliquity of the superior articular surface of the coronoid (Lim et al., 2014).[3] When the ulnar and humeral articular surfaces are aligned in the same plane during maximum flexion, the carrying angle is eliminated, which occurs when the shoulder joint is fully extended.

In the typical working position of the forearm, almost complete supination results in a more straightened alignment between the upper arm and the forearm. The

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carrying angle is crucial for tasks involving carrying objects as it allows the arms to clear the hips during swinging movements while walking (Robert McMinn, 2019).[4] The carrying angle varies between individuals and is generally greater in females compared to males, possibly due to differences in body proportions and the occurrence of pregnancy (Maria Luisa Zampagni et al., 2008; Balasubramanian et al., 2006).[5,6] It is also considered a secondary sexual characteristic. Additionally, the carrying angle tends to be lower in the non-dominant extremity compared to the dominant extremity in both genders.

The normal carrying angle ranges from 5° to 10° for males and 10° to 15° for females. Values above 15 degrees are referred to as cubitus valgus, while values below 5 degrees are termed cubitus varus. The carrying angle's pathophysiology can be influenced by factors such as elbow joint overextension, gender, age, and anthropometric parameters like the distance between the trochanters and height. It can also be affected by traumatic injuries, fractures, ligamentous laxity, congenital deformities, rheumatic or inflammatory diseases, and hereditary conditions (Terra et al., 2011).[7] Significant differences in carrying angles between the left and right sides can also occur.

The carrying angle's variation has implications for the muscular strength of the upper extremities, particularly the hands (Hogrel, 2015).[8] As individuals grow and their skeletons develop, the carrying angle adjusts accordingly. It is particularly important for maintaining proper forearm clearance during activities involving object carrying. Research aims to establish baseline carrying angle values for different age groups and understand how the angle evolves with skeletal growth (Tomori et al., 2018).[8]

Increased carrying angle can lead to elbow pain, instability during throwing activities or exercise, and reduced elbow flexion function, increasing the risk of dislocation or fractures (Langenskiold and Kivilaakso, 1967).[9] Grip strength, an integral performance requiring multiple muscles, is closely related to the carrying angle and is used to assess upper limb damage and determine appropriate treatments (Sharma et al., 2013).[10] Hand grip strength relies on the coordinated functioning of the muscles in the forearm, prescapular region, and shoulder. Changes in the carrying angle can impact grip strength (Rashed et al., 2019).[11]

Visual assessment and hinged goniometers are commonly used by clinicians to evaluate angulation. Clinical pictures are helpful in tracking deformity progression or improvement over time. Normal variations in alignment include a carrying angle of approximately 15 degrees of varus when the elbow is fully extended, ranging from nearly zero degrees of valgus to at least 20 degrees (Herring, 2021).[13] Varus deformity can result from improperly fused elbow fractures, while normal valgus alignment is gradually acquired during childhood.

The primary objective of this study was to investigate the varying carrying angles that were observed.

2. Materials and Methods

An observational study was conducted in the Department of Orthopaedics Heritage Institute of medical sciences Varanasi. Around 500 samples were taken for a period of 2 years. All patients of both genders inclusive of age group 8 to 19 years were taken with their consent. Asymptomatic individuals without any deformity, fractures, anomalies and previous history of surgery around elbow. All with previous elbow injuries and anomalies around elbow, history of Endocrine disorders, athletes and deformity occurring after any elbow injury were excluded.

"Carrying angle: The carrying angle of the elbow of both handsmeasured using a full circle goniometer made of flexible clear plastic. All the bony landmarks were palpated and marked. The measurement was taken by placing the goniometer's measurement plate at the fulcrum (biceps brachii tendon) of elbow. The fixed arm is placed on the median axis of the upper arm, the movable arm adjusted on the median axis of forearm. The arrow on the goniometer measurement plate indicates the angle (Balasubramanian et al, 2006).[7]

Measurement of height of the sample was taken using an inch tape. Height was measured from vertex to heel of the individual with bare foot in anatomical position in centimeters. The length of the arm is measured from the angle of acromion to the lateral epicondyle of humerus.

The forearm length is measured from the lateral epicondyle of the humerus to the tip of the radial styloid process (Chakravarty and Bordaloi, 2020). Axis of arm is defined by the midpoints of two lines perpendicular to the shaft spaced as far apart as possible Axis of forearm is defined by the midpoints of two lines perpendicular to the forearm bones (lateral border of the radius and medial border of the ulna).

3. Results

The present study was conducted in the Department of Orthopaedics, Heritage Institute of Medical Sciences, Varanasi with the objective to observe the physiological factors responsible for the change in the carrying angle in normal individuals in a tabulated manner. A total of 500 patients were included in the study.

About one third of patients were between 17-19 years of age (31.6%) followed by 8-10 (31.2%), 11-13 (25.6%) and 14-16 (11.6%). About half of patients were males (51.8%). Height between 131-150 cms was among more than one third of patients (42.6%) followed by 110-130 cms (38.6%), 151-170 cms (17.6%) and >170 cms (1.2%) (Table 1).

Table 1: Distribution of variables among the study participants (N=500)

S. No.	Variable	Frequency	Percentage
1	**Age**		
	8-10	156	31.2
	11-13	128	25.6
	14-16	58	11.6
	17-19	158	31.6
2	**Gender**		
	Male	259	51.8
	Female	241	48.2
3	**Height in Cms**		
	110-130	193	38.6
	131-150	213	42.6
	151-170	88	17.6
	>170	6	1.2

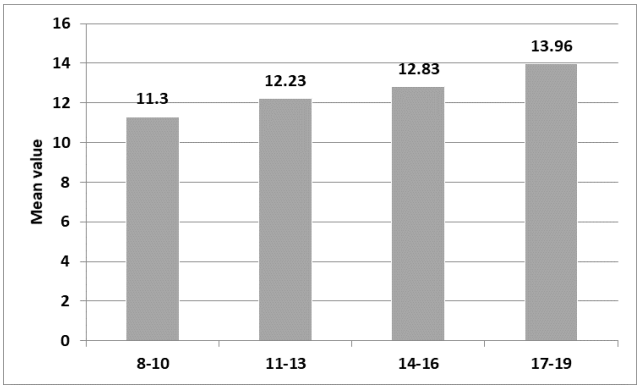

Figure 1: Comparison of carrying angle with age

Figure 1 shows the comparison carrying angle with age. The carrying angle was higher among age 17-19 years (13.96±1.37) than 14-16 (12.83±2.34), 11-13 (12.23±2.33) and 8-10 (11.30±1.63) years. However, difference was statistically insignificant (p>0.05).

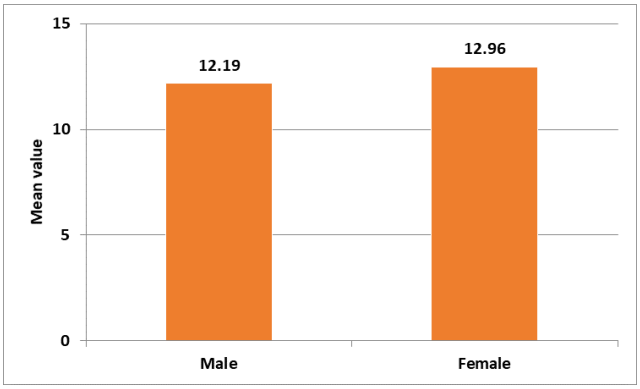

Figure 2: Comparison of carrying angle with gender

Figure 2 shows the comparison carrying angle with gender. The carrying angle was significantly (p=0.001) higher among females (12.96±2.44) compared to males (12.19±1.74).

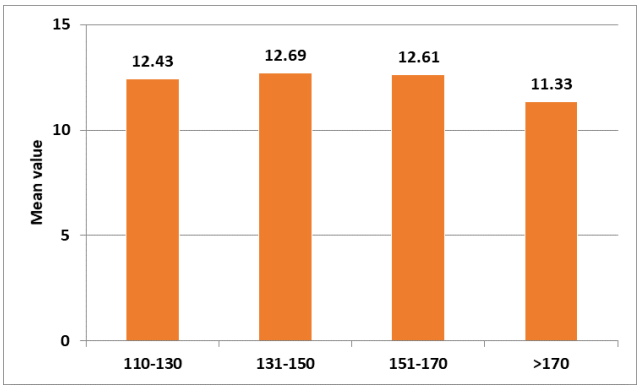

Figure 3: Comparison of carrying angle with Height

Figure 3 shows the comparison carrying angle with height. There was no significant (p>0.05) difference in carrying angle among different height groups.

Table 2: Comparison of carrying angle with age and gender

Age in years	Carrying angle (Mean±SD		p-value [1]
	Male	Female	
8-10	11.43±1.67	11.16±1.58	0.30
11-13	11.93±2.01	12.57±2.62	0.22
14-16	12.11±1.48	13.78±2.91	0.34
17-19	13.23±1.08	14.68±1.26	0.19

[1]Unpaired t-test

Table 2 shows the comparison carrying angle with age and gender. There was no significant (p>0.05) difference in carrying angle between male and females among different age groups.

Table 3: Comparison of carrying angle with height and gender

Height in cms	Carrying angle (Mean±SD		p-value [1]
	Male	Female	
110-130	12.09±1.72	12.78±2.42	0.34
131-150	12.28±1.86	13.01±2.54	0.11
151-170	12.25±1.58	13.43±2.02	0.09
>170	11.60±2.07	10.00±1.42	0.13

[1]Unpaired t-test

Table 3 shows the comparison carrying angle with height and gender. There was no significant (p>0.05) difference in carrying angle between male and females among different height groups.

Table 4 shows the correlation of carrying angle with age and height. Only age was positively significantly (r=0.48, p=0.001) correlated with carrying angle.

Table 4: Correlation of carrying angle with age and height

	Carrying angle	
	Correlation coefficient	**p-value** [1]
Age in years	0.48	0.001*
Height in cms	0.07	0.50

[1]Pearson correlation

4. Discussion

When the elbow joint is fully extended and in the supinated position, the forearm is not in a straight line with the arm; rather, it is laterally deflected, and an angle is formed between the long axis of the arm and the long axis of the forearm. This occurs when the elbow joint is in the fully extended and supinated position. The carrying angle of the elbow refers to this particular angle of the elbow (Snell, 2004).[12]

It would appear that the carrying angle is developed as a reaction to the pronation of the forearm, and its function is to keep the swinging upper extremity away from the side of the pelvis while walking (Khare et al, 1999).[13]

The most distal location of the trochlea in comparison to the capitulum in the humerus and a minor valgus angulation of the trochlear notch of the ulna in relation to the shaft of the humerus are the anatomical explanations for this phenomenon (Maria Luisa Zampagni et al, 2008.[5]

The carrying angle and the range of motion at the elbow joint both increase with age up to the time that skeletal maturity is reached in children who are healthy (Golden et al, 2007).[14]

The clinical carrying angle (CCA), on the other hand, is shown to increase up to the age of 15 years, after which it shows a modest decrease in angle. This was shown in a study. According to the findings of the same study, the increase rate each year for boys was found to be 0.42, while the rate for girls was found to be 0.60. The average carrying angle for males and females in adults is 10 degrees, and it is 13 degrees, respectively (Balasubramanian et al, 2006).[6]

An increase in the carrying angle during the growing years might raise the risk of elbow instability, pain during exercise and throwing, decreased flexion at the elbow, increased likelihood of dislocation of the elbow, and increased likelihood of fracture of the distal humeral epiphysis (Robinson et al, 2017).[15]

In addition to this, it has been noted that a carrying angle of more than 15 degrees is a risk factor for non-traumatic injuries. Several studies have been conducted to investigate the relationship between carrying angle and factors such as age, sex, dominant side, and body characteristics such as trans-trochanteric diameter, height, length of the forearm, length of the arm constitution, race, and inter-epicondylar distance (Allouh et al, 2016).[16]

A study that was done on healthy Chinese children and published in Dai, 1999[17] found that there is a negative association between Baumann's angle and carrying angle. When treating displaced supracondylar fracture, however, it was discovered that Baumann's angle was an incorrect indication of the carrying angle (Mohammad et al, 1999).[18] There has not been a lot of research done on the effect that body features have on the carrying angle at the elbow in the paediatric population.

The present study was carried out in the Department of Orthopaedics at the Heritage Institute of Medical Sciences in Varanasi with the intention of observing and tabulating the physiological parameters responsible for the change in the carrying angle in normal individuals. The study had a total of five hundred different participants.

The patients in this study ranged in age from 8-10 years old (31.2 percent), 11-13 years old (25.6 percent), and 14-16 years old. The oldest patient in this study was 17-19 years old (31.6 percent) (11.6 percent). Roughly half of the patients were identified as male (51.8 percent). According to the findings of Bhatti et al (2022),[19] out of a total of 500 cases, there were 125 females and 125 males between the ages of 10 and 15. The research conducted by Sadacharan et al. (2022)[20] includes the participation of two hundred students from the American population. 100 of them were white (50 females and 50 males), and the other 100 were Native Americans (100 males and 100 females) (50 females and 50 males). All of these volunteers ranged in age from 18 to 30 years old. Kushwaha et al. (2022)[21] found that the average age was 5.84 years with a standard deviation of 4.76 years. There were 98 males, making up 70% of the total, and there were 42 girls, making up 30% of the total.

In the present study, Height between 131-150 cms was among more than one third of patients (42.6%) followed by 110-130 cms (38.6%), 151-170 cms (17.6%) and >170 cms (1.2%).

The current study showed that the carrying angle was higher among age 17-19 years (13.96±1.37) than 14-16 (12.83±2.34), 11-13 (12.23±2.33) and 8-10 (11.30±1.63) years. However, difference was statistically insignificant ($p>0.05$). Bhatti et al (2022)[19] showed that the carrying angle increases by age on the right side of the hand. After 13 years of age, it increased on the left side. By increasing age carrying angle also increased till the age of 15 years.

According to the findings of this research, the carrying angle was substantially ($p = 0.001$) greater among females (12.96±2.44) than it was among males (12.19±1.74). In line with the findings of this investigation, Bhatti et al. (2022)[19] discovered that the carrying angle was much greater in females than in males. It was found by Sadacharan et al (2022)[20] that there was no statistical significance when comparing the carrying angle between the sexes and sides of both ethnic groups ($P > 0.05$). Both over the right and left upper extremities, the carrying angle was greater (P

<0.05) in Caucasians than in Indian Americans. This was the case regardless of race. This was noticed in both males and females of the population. The analysis that compared the carrying angles of males and females found that the carrying angle of females was greater (P <0.05) than that of males in both the Caucasian and Indian American populations. In the research carried out by Gupta et al. (2022),[22] the mean carrying angle was found to be 8.9 degrees on the right side and 8.5 degrees on the left side in females. In contrast, the mean carrying angle was found to be 7.1 degrees on the right side and 6.4 degrees on the left side in males. The angle was more on the side that was dominant than it was on the side that was not dominant. The carrying angle was shown to be greater in females than in males, according to Nemuri et al (2020).[23] Therefore, the median carrying angle for females was 16 degrees on the right side and 9 degrees on the left. The typical carrying angle for males was 10 degrees on the right side and 6 degrees on the left. The mean carrying angle for males was found to be 10.33± 1.56 degrees in the right limb and 12.11 ±1.72 degrees in the left limb in the research conducted by Chakravarty and Bordaloi (2020).[24] For females, the mean carrying angle was found to be 11.73 ±2.73 degrees on the right side and 11.45 ±3.26 degrees on the left side. It was discovered by Beigh et al. (2019)[25] that the carrying angle differs between males and females, with females having values that are higher in both their dominant and non-dominant limbs in comparison to males.[19]

The carrying angle in the Indian population was investigated by Walankar and Verma (2018).[26] In a standing anatomical position, carrying angle was measured with a half circle universal goniometer in 600 healthy people ranging in age from 21 to 80 years. Males had a mean carrying angle of 10.18 degrees and 9.160 degrees, while females had a mean carrying angle of 14.20 degrees and 13.090 degrees in their dominant and non-dominant arms, respectively. It was observed that females had a greater carrying angle than men. Additionally, the dominant arm had a larger carrying angle than the non-dominant arm.[12]

In this particular investigation, a comparison of carrying angle between different height groups revealed no statistically significant differences (p>0.05). According to the findings of this study, the amount of difference in carrying angle between boys and girls of varying ages did not meet the criteria for statistical significance (p>0.05). According to the findings of this particular study, there was not a significant difference (p>0.05) in the carrying angle between males and females across a variety of height categories. In this particular research, the only variable that showed a significant positive correlation with carrying angle was the participant's age (r = 0.48, p = 0.001). Kushwaha et al. (2022)[21] found that the mean CCA on the left side was 8.77 + 2.03, and they found this to be significant. The RCA on the right side had a mean of 8.85 + 2.09 points. The RCA on the left side had a mean value of 9.07 2.13. The CCA was found to be linked with a number of other variables, including age, secondary sexual features, weight, height, arm length, forearm length, inter-epicondylar distance, trans-trochanteric distance, and Baumann's angle, according to the results of a bivariable analysis. It was discovered that there was a substantial inverse correlation between CCA and BMI. When comparing carrying angle with height and forearm length, Shah and Naqvi (2020)[27] discovered that the p-value was less than 0.05, which indicated that there was a significant correlation between the three variables. Therefore, there existed an inverse relationship between the height of the individual and the carrying angle. Due to the fact that the height and forearm length are directly related to one another, it follows that the forearm length is also related to the carrying angle. When comparing carrying angle to age, the p-value was determined to be more than 0.05, indicating that the correlation was not significant. As a result, there was not a significant difference in carrying with age because the patients were all within the same age range. The conclusion of the study was that the carrying angle was dependent on the length of the bone in the forearm. If the bone length was much longer, then the angulation of the proximal articulation of the proximal articular surface would be lower; as a result, the carrying angle would be lower; and vice versa.

According to the findings of Nemuri et al. (2020),[23] there was a statistically significant variation in the carrying angle between boys and females of the same age group. Carrying angle on the dominant side was greater than on the non-dominant side. In females, the researchers found no evidence of a significant correlation between the carrying angle and the hip circumference. In females, the researchers found no evidence of a significant correlation between the angle of carrying and their weight.

5. Conclusion

About one third of patients were between 17-19 years of age (31.6%), followed by 8-10 (31.2%), 11-13 (25.6%), and 14-16 (11.6%). Approximately half of the patients were males (51.8%). In terms of height, more than one third of patients fell within the range of 131-150 cm (42.6%), followed by 110-130 cm (38.6%), 151-170 cm (17.6%), and >170 cm (1.2%). The carrying angle was higher among individuals aged 17-19 years (13.96±1.37) compared to those aged 14-16 (12.83±2.34), 11-13 (12.23±2.33), and 8-10 (11.30±1.63) years, but the difference was not statistically significant (p>0.05). However, the carrying angle was significantly higher among females (12.96±2.44) compared to males (12.19±1.74) (p=0.001). There was no significant variation in carrying angle observed among different height groups (p>0.05), and no significant difference between males and females across age groups or height groups (p>0.05). A significant

positive correlation was found between age and carrying angle (r=0.48, p=0.001).

6. Author Contributions

a) Conceptualization, Data collection, Manuscript drafting and critical revision of the manuscript – Dr. Rakesh Singh; b) Manuscript drafting, and data collection – Dr. Pankaj Singh; c) Manuscript revision and supervision – Dr. Avinash Dwivedi ; d) Statistical Analysis and data curation – Dr. Shadab Khan; and e) Supervision and Critical revision of Manuscript – Dr. Rakesh Singh.

7. Source of Funding

Nil.

8. Conflicts of Interest

Nil.

References

1. Fornalski S, Gupta R, Lee TQ. Anatomy and Biomechanics of the Elbow Joint. *Tech Hand Up Extrem Surg*. 2003;7(4):168–78.
2. Acikgöz AK, Balci RS, Göker P, Bozkir MG. Evaluation of the Elbow Carrying Angle in Healthy Individuals. *Int J Morphol*. 2018;36(1):135–9.
3. Lim V, Jacob NA, Ghani MFS, Wang DC, Ad K. An Anthropometric Study on the Carrying Angle of Elbow among Young Adults of Various Ethinicities in Malaysia. *NJIRM*. 2014;5(6):20–3.
4. McMinn RMH. Last's Anatomy - Revised Edition. Australia: Churchill Livingstone; 2019.
5. Zampagni ML, Casino D, Martelli S, Visani A, Marcacci M. A protocol for clinical evaluation of the carrying angle of the elbow by anatomic landmarks. *J Shoulder Elbow Surg*. 2008;17(1):106–12.
6. Balasubramanian P, Madhuri V, Muliyil J. Carrying angle in children: a normative study. *J Pediatr Orthop B*. 2006;15(1):37–40.
7. Terra BB, Silva BCM, Carvalho HBF, Dobashi ET, Pinto JA, Ishida A. Evolution of the carrying angle of the elbow: a clinical and radiographic study. *Acta Ortop Bras*. 2011;19(2):79–82.
8. Hogrel JY. Grip strength measured by high precision dynamometry in healthy subjects from 5 to 80 years. *BMC Musculoskelet Disord*. 2015;16:139.
9. Langenskiöld A, Kivilaakso R. Varus and valgus deformity of the elbow following supracondylar fracture of the humerus. *Acta Orthop Scand*. 1967;38:313–20.
10. Sharma K, Mansur DI, Khanal K, Haque MK. Variation of Carrying Angle With Age, Sex, Height and Special Reference to Side. *Kathmandu Univ Med J (KUMJ)*. 2013;11(44):315–8.
11. 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. *Adv Rheumatol*. 2019;58(1):11. doi:10.1186/s42358-018-0012-1.
12. Snell RS. Clinical Anatomy. 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2004.
13. Khare GN, Goel SC, Saraf SK, Singh G, Mohanty C. New observations on carrying angle. *Indian J Med Sci*. 1999;53(2):61–7.
14. Golden DW, Jhee JT, Gilpin SP, Sawyer JR. Elbow range of motion and clinical carrying angle in a healthy pediatric population. *J Pediatr Orthop B*. 2007;16(2):144–9.
15. Robinson PM, Griffiths E, Watts AC. Simple elbow dislocation. *Shoulder Elbow*. 2017;9(3):195–204.
16. Allouh MZ, Ghaida JHA, Jarrar AA, Khasawneh RR, Mustafa AG, Bashaireh KM, et al. The carrying angle: racial differences and relevance to inter-epicondylar distance of the humerus. *Folia Morphol (Warsz)*. 2016;75(3):388–92.
17. Dai L. Radiographic evaluation of Baumann angle in Chinese children and its clinical relevance. *J Pediatr Orthop B*. 1999;8(3):197–9.
18. Mohammad S, Rymaszewski LA, Runciman J. The Baumann angle in supracondylar fractures of the distal humerus in children. *J Pediatr Orthop*. 1999;19(1):65–9.
19. 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 RSCB*. 2022;26(1):776–81.
20. Sadacharan CM, Alikhan SB, Packirisamy V, Murlimanju BV. Carrying angle of the elbow joint in young Caucasian and Indian American population: A descriptive cross‑sectional study. *J Anat Soc India*. 2022;71:42–6.
21. 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;14(5):e25478. doi:10.7759/cureus.25478.
22. 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;42(1):23–30.
23. Nemuri S, Rao J, Reddy PJ, Kiran VS. Evaluation of carrying angle in 1st yr. Medical students of SVS medical college, Mahabubnagar. *Int J Orthop Sci*. 2020;6(3):218–22.
24. Chakravarty M, Bordaloi RR. Evaluation of the carrying angle in the ethnic Assamese community. *J Evid Based Med Healthc*. 2020;7(51):3090–3.
25. Beigh IA, Bhat TA, Mantoo SA, Bhat SA, Mohammad J. Carrying Angle variations between dominant and non-dominant Limb in Jammu region of North India. *J Med Sci Clin Res*. 2019;7(11):936–9.
26. Walankar P, Verma C. Measurement of the carrying angle in healthy Indian population. *Int J Sci Res*. 2018;7(5):3–4.
27. Shah PA, Naqvi WM. Carrying angle and its co-relation with different parameters height, length of forearm and age. *Int J Physiother*. 2020;7(5):211–5.

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