

Research Article

Correlation of Carrying Angle to Height, Age, Dominance of Hand and Marital Status in Females of Haryana - A Cross-Sectional Study

Dr. Shavi Garg^{1*}, Suchita², Usha Verma³

^{1*}Assistant Professor, Department of Anatomy, Shri Atal Bihari Vajpayee Govt. Medical College, Chhainsa (Faridabad)-121004.

²M.B.B.S. Student, Shri Atal Bihari Vajpayee Govt. Medical College, Chhainsa (Faridabad)-121004

³Professor, Department of Anatomy, Pt. B.D. Sharma, PGIMS, Rohtak, Haryana

Email: ¹shavi1551@gmail.com, ³uv.2077@gmail.com

Corresponding Author: Dr.Shavi Garg

Assistant Professor, Department of Anatomy, Shri Atal Bihari Vajpayee Govt. Medical College, Chhainsa (Faridabad)-121004.

Email: shavi1551@gmail.com

Received: 11.02.26, Revised: 14.03.26, Accepted: 17.04.26

ABSTRACT

Introduction and Rationale: Knowledge of the carrying angle is important in the diagnosis of certain clinical conditions like cubitus varus, cubitus valgus and neuropathies. Carrying angle also gives immense knowledge about biomechanics of elbow joint and weight transmission. The aim of this study is to understand variations in carrying angle among married and unmarried females. The difference is thought to be associated with wider pelvis structure which a female has after normal delivery. Carrying angle is useful in preoperative surgical planning as well.

Objective: The primary objective of the study is to evaluate the carrying angle among married and unmarried females and the relation of the carrying angle to gravida. Also, the association of other factors such as height, weight, age, and dominance of hand difference in females of age group 5-50 years will be studied.

Method: 300 healthy females participated in the study. The carrying angle was measured by a goniometer. Height (cm) and weight (kg) were measured by a height measuring scale and an electronic weighing machine respectively. BMI was calculated.

Results: The mean carrying angle in married females is $13.3 \pm 2.1^\circ$ and in unmarried females is 12.9 ± 2.0 . The angle was more in married females. It also shows an increasing trend with age upto puberty, then it plateaus and decreases in old age. Whereas, with increased height the carrying angle also increases.

Keywords: Carrying Angle, Goniometer, Cubitus Valgus, Cubitus Varus.

INTRODUCTION

Carrying angle refers to the angle between the median axis of the arm and the median axis of the forearm when the elbow joint is fully extended and supinated in the frontal plane. The angle is formed due to the configuration of the joint formed between the trochlear notch of the ulna and the trochlear notch of the humerus.^[1] The angle is important in walking, the swaying of arms without contacting the hips and carrying objects. This angle is formed due to the obliquity of the articulation between the humerus and the olecranon of the ulna and seems to fluctuate with many factors like sex, width of the shoulders, dominance of hand, height and age.^[2]

In a normal population from the age of 20 onwards males present an anatomical carrying angle of between 5° and 10° while females present between 10° and 15° .^[2,3,4] Any

differences in physiology such as hip and shoulder width as in females may lead to producing a more acute angle in females. This is the main reason which caused people to regard this angle as a secondary sexual trait.^[5] Also, the use of a dominant hand may influence the angle. For instance, in most persons, the carrying angle of the dominant hand is often slightly bigger than the other hand since it is repeatedly used and functionally adapted.^[6] Taller individuals, in comparison to the shorter ones, have larger carrying angles; this is due to the overall change in structure and morphology of the upper limb with height. Certain studies have shown that the carrying angle is also influenced by the age of an individual. It follows an increasing pattern till adolescence, reaches the maximum value, and then slightly decreases to stabilise. Gravida might influence the carrying angle too.

Carrying angle pathologies include cubitus valgus (angle greater than 15 degrees) and cubitus varus (angle less than 5 degrees) these can arise from fracture, congenital deformity or laxity of skin ligaments.^[7] Cubitus valgus for instance tends to pull the ulnar nerve that runs behind the medial epicondyle thus leading to ulnar nerve dysfunction. These deformities require proper perioperative carrying angle measurements for surgery to be performed. Knowledge of the carrying angle is very important in clinical practice especially among orthopaedic surgeons dealing with elbow fractures, dislocations, and reconstructions. Variations in the carrying angle are also important in forensics and anthropology in the determination of sex and race in skeletal fragments.^[8] Further, knowledge of these variations is of great significance to the biomechanical engineers during the preparation of prosthetic elbows and Pre-contoured anatomical plates, which enhance the patient's condition during reconstructive and replacement surgeries.^[9,10] In pregnant women, certain hormonal changes, changes in ligament laxity and postural changes alter the carrying angle. Thus, carrying angle research should be prioritised in both clinical and mechanical reconstruction of elbow problems.

METHODS

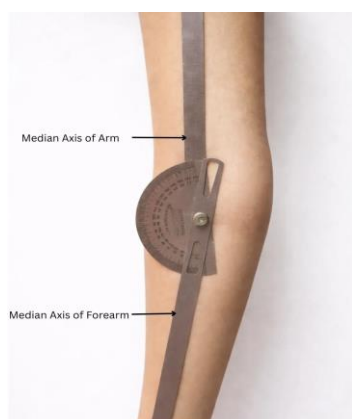


Fig 1: Measurement of Carrying Angle

RESULTS

The cross-sectional study was conducted among 300 female participants, including both married and unmarried women. The mean carrying angle observed in the study population was 12.9 ± 2.0 . With the help of descriptive statistics, the demographic data were presented in Table 1. The carrying angle showed negative correlation with age, Participants aged 19-30 years had the highest

The present study was carried out after the approval of the Institutional Ethics Committee. Three hundred healthy females willing to give consent participated in the study.

Carrying angle (Degrees)

The subject was asked to fully extend and supinate the forearms and palms facing forward then the carrying angle was measured by a goniometer (model no. HCG-SSG-180 manufacturer XYZ HCG)

Height (Centimetres)

It was measured in centimetres using a height measuring scale

Weight (Kilograms)

The weight of the subject was measured by an electronic weighing machine.

Various other parameters like age, dominance of hand and gravida status of married females were also studied.

Selection and Description of Participants

Inclusion Criteria

Females above the age of 5 years and married females who had normal delivery and are willing to participate in the study.

Exclusion Criteria:

Females who had

- Caesarean section
- History of upper limb fracture
- Congenital abnormalities of upper limb
- Upper limb deformity
- Pregnancy

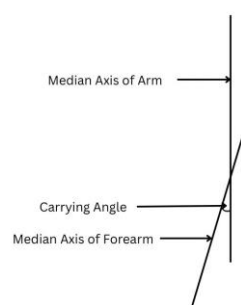


Fig2- Carrying angle by Goniometer mean carrying angle ($13.5 \pm 2.1^\circ$), while those in the 46–55 years group showed a slightly lower mean angle ($12.7 \pm 1.8^\circ$). When compared based on marital status, married females exhibited a slightly higher mean carrying angle ($13.3 \pm 2.1^\circ$) than unmarried females ($12.9 \pm 2.0^\circ$). The majority of participants were right-hand dominant. The mean carrying angle was marginally higher in right-handed females ($13.0 \pm 2.0^\circ$) compared

to left-handed females ($12.8 \pm 2.1^\circ$). A positive correlation was observed between height and carrying angle ($r \approx +0.38$). Participants with a height >165 cm demonstrated a higher mean carrying angle ($13.7 \pm 2.2^\circ$), while those <155

cm showed a lower value ($12.4 \pm 1.8^\circ$). This suggests that as height increases, the carrying angle also tends to increase, possibly reflecting proportional skeletal development and humeroulnar alignment in taller individuals.

Table 1: Correlation of Mean Carrying Angle with Demographic Parameters

Parameter	Group/Category	Mean Carrying Angle $\pm$ SD	p value	Correlation
Age(years)	5-12	$11.2 \pm 1.9^\circ$	0.041 (Significant)	Positive till adolescence, then plateau and decrease
	13-18	$12.8 \pm 2.0^\circ$		
	19-30	$13.5 \pm 2.1^\circ$		
	31-45	$13.0 \pm 1.9^\circ$		
	46-55	$12.7 \pm 1.8^\circ$		
Hand Dominance	Right Handed	$13.0 \pm 2.0^\circ$	0.284 (Not significant)	No significant correlation
	Left Handed	$12.8 \pm 2.1^\circ$		
Height (in cm)	<155	$12.4 \pm 1.8^\circ$	0.018 (Significant)	Positive ($r=0.38$)
	155-165	$13.0 \pm 1.9^\circ$		
	>165	$13.7 \pm 2.2^\circ$		

Table 2: Correlation of Carrying Angle with Marital Status

Parameter	Group/Category	Mean Carrying Angle $\pm$ SD	p value	Correlation
Marital Status	Unmarried	$12.9 \pm 2.0^\circ$	0.037 (Significant)	positive
	Married	$13.3 \pm 2.1^\circ$		

DISCUSSION

The cross-sectional study was completed to determine the relationship between carrying angle and height, age, hand dominance, and marital status associated with females. This research enhances the existing literature on anthropometry and biomechanics of the upper limbs.

This study suggests that taller females seem to have large carrying angles relative to their height. In 2008, Ozandac et al. assessed upper-limb kinematics and reported that limb length and alignment affect the elbow angle during

both static and dynamic activities.^[11] In a study previously conducted on anthropometric analysis on upper-limb measurements across North Indian females by Khare et al., it was observed that skeletal proportions differ significantly among people with different heights which might affect elbow alignment.^[2] Based on the ethnicity factor, it was observed that the carrying angle increases with age during adolescence, but then plateaus in adulthood. Paraskevas et al. examined carrying-angle changes across age groups and found a gradual reduction linked to decreased

ligament elasticity.^[6] This observation is in alignment with the study completed by Yilmaz et al and Rajesh et al. Yilmaz et al. (2005) analyzed skeletal development stages and highlighted that soft-tissue laxity is greater in younger individuals supporting the higher angles observed in young females in this study.^[12]

It was further observed that the dominant arm has a larger carrying angle as compared to the non-dominant arm. Paraskevas et al compared carrying angles of both limbs and found that the dominant arm shows greater values than the non dominant side for which repeated functional use might be responsible.^[6] Arm dominance among college athletes was studied and it was noted that carrying angle increases the dominant limb.^[13] Balasubramanian et al. Studied upper-limb movements in day to day activities , it's variation with dominance and suggested that habitual muscle use might cause these differences.^[5]

CONCLUSION

Our study's noteworthy conclusion is that married females had a statistically significant higher mean carrying angle than unmarried women. Although research explicitly comparing carrying angle to marital status are sparse, age-related skeletal remodelling, hormonal effects like changes in ligament laxity or joint configuration after pregnancy, and lifestyle differences between married and unmarried females are possible explanations for an increase in angle in multigravida females. In our study, married females, especially older and post-pregnancy, displayed a greater angle, which may be explained by the findings of Bari et al. and Verma et al. who proved that sex hormones and body structure influence carrying angle.^[14,15] Also, in a study previously conducted it was also seen that long-term postural and biomechanical adaptations associated with childbearing and routine household activity may contribute to anatomical modifications in the upper limbs.

Therefore, the higher carrying angle seen in married females in this study could be due to combined hormonal effects, greater ligament laxity linked to reproductive history, and lifestyle-related musculoskeletal changes.

REFERENCES

1. An KN, Morrey BF, Chao EYS. Carrying angle of the human elbow joint. *Journal of Orthopaedic Research*. 1983;1(9):369-78.
2. Khare GN, Goel SC, Saraf SK, Singh G, Mohanty C. New observations on carrying angle. *Indian journal of medical sciences*. 1999 Feb 1;53(2):61-7.
3. Atkinson, William & Elftman, Herbert. The carrying angle of the human arm as a secondary sex character. *The Anatomical Record*. 2005; 91. 49 - 52.
4. Sharma K, Mansur DI, Khanal K, Haque MK. Variation of carrying angle with age, sex, height and special reference to side. *Kathmandu University Medical Journal (KUMJ)*. 2013;11(44):315-18
5. Balasubramanian P, et al. Carrying angle in children: A normative study. *Journal of Pediatric Orthopaedics Part B*. 2006;15(1):37-40.
6. Paraskevas, G., Papadopoulos, A., Papaziogas, B. et al. Study of the carrying angle of the human elbow joint in full extension: A morphometric analysis. *Surgical and Radiologic Anatomy*. 2004;26(1):19-23.
7. Terra B, Silva B, Carvalho H, Dobashi E, Pinto J, Ishida A. Evolution of the carrying angle of the elbow: a clinical and radiographic study. *Acta Orthopaedica Brasileria* 2011;19(2):79-82
8. Punia RS, Sharma R, Usmani JA. The carrying angle in an Indian population. *Journal of Anatomical Society of India*. 1994;43(2):107-10.
9. Purkait, Ruma & Chandra, Heeresh. An Anthropometric Investigation into the Probable Cause of Formation of 'Carrying Angle': A Sex Indicator. *Journal of Indian Academy of Forensic Medicine*. 2004(26) 14-19.
10. Kincaid, Brian & An, Kai-Nan. Elbow joint biomechanics for preclinical evaluation of total elbow prostheses. *Journal of biomechanics* 2013; 46.
11. Ozandaç Polat, Sema & Işık et al. Evaluation of the Association Between Carrying Angle, Hand Grip Strength, Lateral Pinch Strength, and Hand Functional Index in Nursing Students. *International Journal of Morphology*. 2023 (41). 1357-1363.
12. Yilmaz, E., Karakurt, L., Belhan, O., Bulut, M., Serin, E., Avci, M. Variation of carrying angle with age, sex, and special reference to side. *Orthopedics*. 2005;28(11):1360-63.
13. Nayak, S., Kumar, P. & Oraon, A.K. Relationship of carrying angle with grip strength and anthropometric

- measurements in young adults. Bulletin of Faculty of Physical Therapy.2023; 28, 16
14. Verma, Vikas & Singh, Arpit & Singh Kushwaha, Narendra & Sharma, Yashwardhan & Singh, Ajai. Correlation Between Morphometric Measurements and Carrying Angle of Human Elbow. Cureus.2022; 14 7 e.27331.
 15. Bari W, Alam M,Omar S: Goniometry of elbow carrying angle: a comparative clinical study on sexual dimorphism in young males and females. International Journal of Research in Medical Sciences 2017 (3):3482-4.