

An Evaluation of Carrying Angle of the Elbow Joint and Its Relation with Hip Circumferences: A Comparative Cross-Sectional Institutional Study

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Abstract: ***Background:** The elbow joint is a uniaxial joint, where elbow allows flexion and extension, the ulna moving on the trochlea and the radial head on the capitulum. The term "carrying angle" is named for the way of the forearm angles away from the body when something is carried, such as a pail of water. This angle is made by the axes of the arm and forearm when the elbow is fully extended. The forearm diverges laterally forming an angle that is greater in the women. This allows clearance of the wider female pelvis as the limbs swing during walking; however, no significant difference exists regarding the function of the elbow. The study was conducted to study the anthropometric data of the carrying angle and its relation with hip-circumferences among the subjects. **Materials and methods:** A cross-sectional study was carried out among 300 MBBS students for duration of 2 years. Measurement of Carrying Angle were taken by using a Manual Goniometer after taking proper consent and in presence of female attendant for female students. Hip circumference was measured using simple measuring tape and correlations between two variables were determined with Pearson's correlation coefficient study. **Results:** A total of 300 under graduate students were included in the study, age ranging from 18 to 25 years. The findings indicated that, among the male participants 62.5 % had a normal Carrying Angle, 37.5 % had an abnormal Carrying Angle and among the female participant 52 % had a normal carrying angle and 48.4 % had an abnormal Carrying Angle. The hip circumference among the study participants reveals, among the male subjects mean SD was 89.05±9.87 (63-108) and among the female subject the mean SD was 93.27±7.78 (73-115). The mean differences of SD between the two sexes were 4.22 cm. After comparing the carrying angle and hip circumferences both sexes. Pearson's correlation coefficients value between the two variables were 0.873, 0.833, 0.797 and 0.673; which reveals a positive correlation and the p value of the study was 0.004 (p <0.05) which indicates statistically significant study. **Conclusion:** This study describes the brief anatomy of elbow, elbow joint and its surrounding structures and hip circumference of the study subjects. The study reveals a correlation between carrying angles and hip circumferences.*

Keywords: Carrying angle; Trochlea; Goniometer; Hip-circumference.

1. Introduction

The elbow joint is situated 2 cm below a line joining the two epicondyles of humerus. It slopes downwards and medially from its lateral extremity. The angle is obscured in full forearm pronation and disappears on full elbow flexion, when the shafts of the ulna and humerus come to lie in the same plane. The borders of the triangle join the olecranon, radial head and lateral epicondyle of the humerus. ⁽¹⁾ The forearm diverges laterally forming an angle that is greater in the women. This allows clearance of the wider female pelvis as the limbs swing during walking; however, no significant difference exists regarding the function of the elbow. ⁽²⁾ The carrying angle is the angle of deviation of long axis of forearm from the long axis of arm in extended forearm. It varies from individual to individual. ⁽³⁾

The carrying angle of the elbow, formed by the humerus and ulna with the hand and forearm fully supinated and the elbow fully extended, has been reported to range from 11° to 14° in men and from 13° to 16° in women. The carrying angle is typically about a degree greater on the dominant compared with the non-dominant side. Valgus (cubitus valgus) or varus (cubitus varus) mal-alignment is diagnosed when the carrying angle is greater than or less than these normal values, respectively. ⁽⁴⁾ The wider carrying angle in females avoids

rubbing of forearms with the wider female pelvis while carrying loads, for example, buckets filled with water from one place to another. ⁽⁵⁾

The factors responsible for formation of the carrying angle are as follows, a) The medial flange of the trochlea is 6 mm deeper than the lateral flange. b) The superior articular surface of the coronoid process of the ulna is placed oblique to the long axis of the bone. ⁽⁶⁾ Flexion is limited by the anterior surfaces of the forearm and arm coming into contact. Extension is checked by the tension of the anterior ligament and the brachialis muscle. Flexion is performed by the brachialis, biceps brachii, brachioradialis and pronator teres muscles. Extension is performed by the triceps and anconeus muscles. During fully extension of elbow the long axis of the forearm lies at an angle to the long axis of the arm. ⁽⁷⁾ In full flexion, the coronoid process is received by the coronoid fossa and the radial head is received by the radial fossa on the anterior surface of the humerus. In full extension, the olecranon process is received by the olecranon fossa on the posterior aspect of the humerus. ⁽⁸⁾

The study was conducted to compare the right and left carrying angle with their hip-circumferences among the participants and to study the proportion of subject having abnormal carrying angle.

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2. Materials and Methods

A comparative cross-sectional study was conducted in the Department of Anatomy, AGMC, Agartala for 2 years. All healthy 1st professional MBBS students those who are willing to participate in this study was included. History of fracture of arm or forearm bones and hip, not interested to participate in the study, neuropathies were excluded for this study.

Informed consent form was obtained from all participants before measurements. A simple random sampling method was used. The study tools used were Manual Goniometer (Amazecare Stainless Steel Medium Sized), A Simple Measuring tape, Stature meter, Weight machine, Written informed consent.

Pre-designed proforma was used for data collection. The carrying angle of the elbow of both sides was measured using a half-circle Goniometer when arm and forearm is fully extended and in supine position. Hip Circumferences were measured at the widest part of the hip keeping the measuring tape parallel to the ground.

Analysis of data was done by the student “t” test, Pearson’s correlation coefficient (r) test and percentage was calculated using SPSS 29.0 program. The significance of the test i.e., the p value less than **0.05** is considered as significant.

3. Results

A total of **300** under graduate students were included in the study with a mean age of 20 ± 1.8 years ranging from **18 to 25** years. The mean carrying angle among the participants were $11.38 \pm 2.57^\circ$ in male and $13.17 \pm 2.62^\circ$ in female. Hip circumferences of the subjects were 89.05 ± 9.87 cm (63-108) and 93.27 ± 7.78 cm (73-115) in male and female respectively. The Correlation of hip circumferences with right and left carrying angle measured in male, p-value were **0.873** and **0.833** (not significant >0.05) and in female p-value were **0.797** and **0.673**. However, there was no correlation between hip circumference and carrying angle of the elbow among Male participants. In Female, there is a significant association between abnormality in both carrying angle and hip circumference (p value **0.002**).

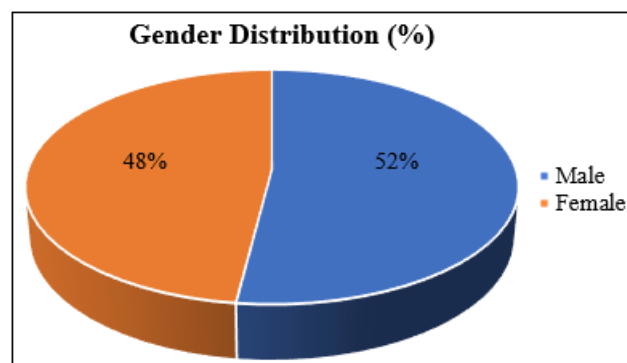


Figure 1: Gender distribution of the study population (N= 300)

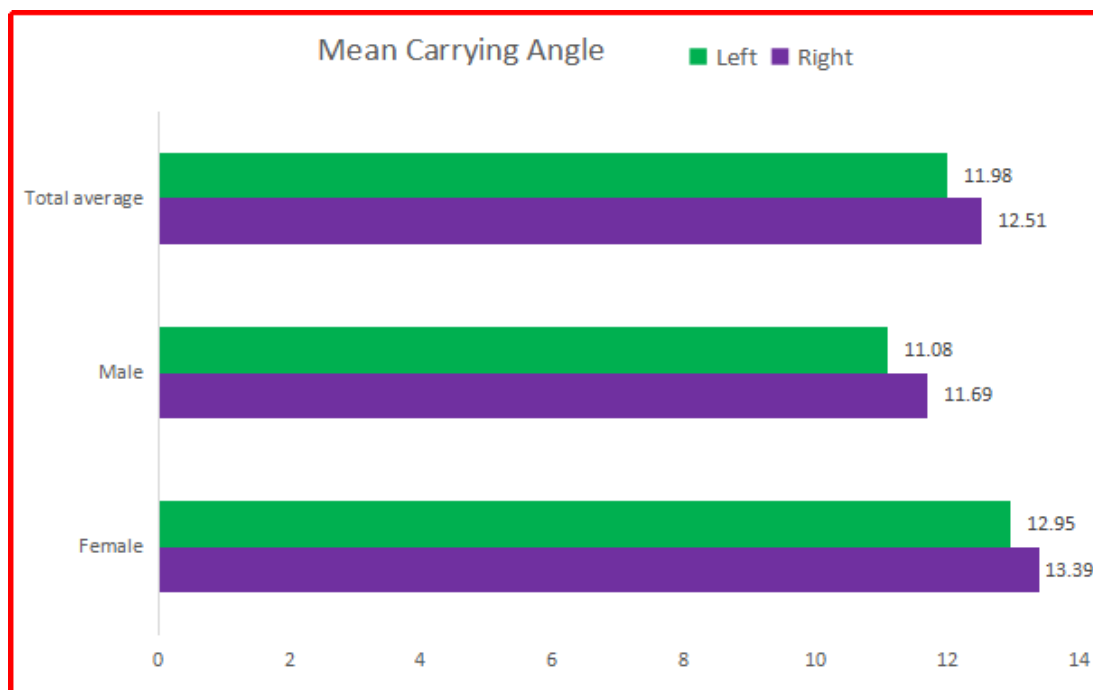


Figure 2: Mean Carrying Angle Comparison among participants (N= 300)

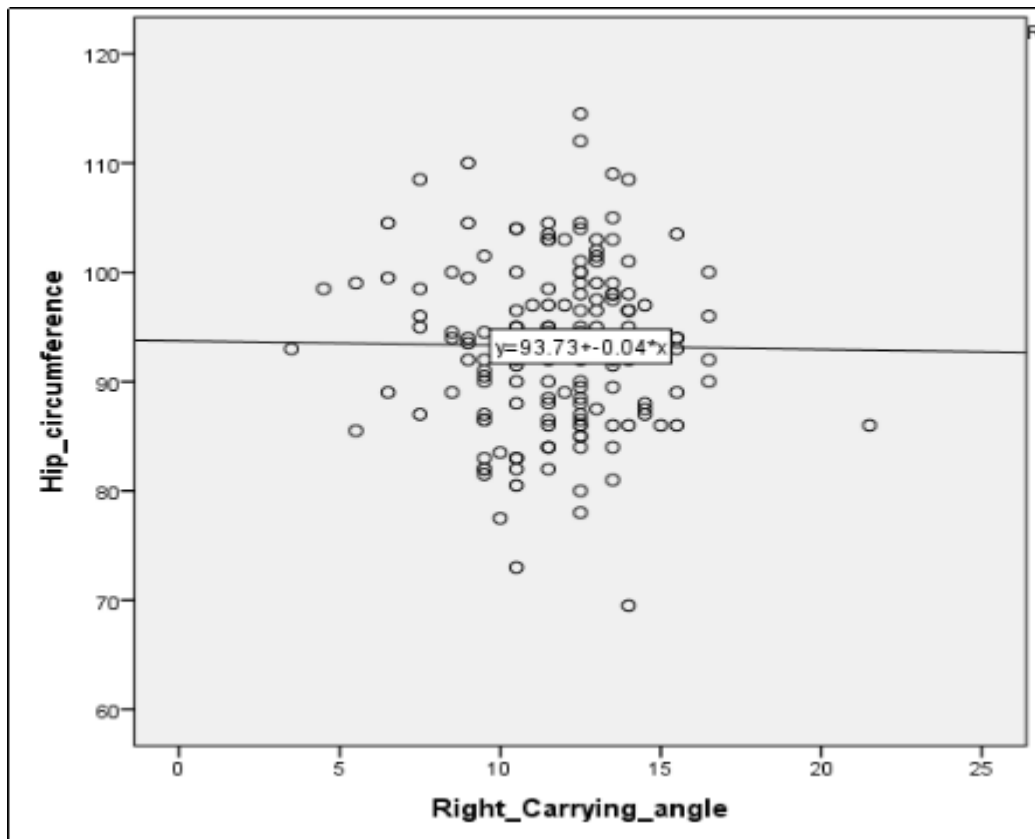


Figure 3: Correlation between Hip circumference and Right CA in Male.

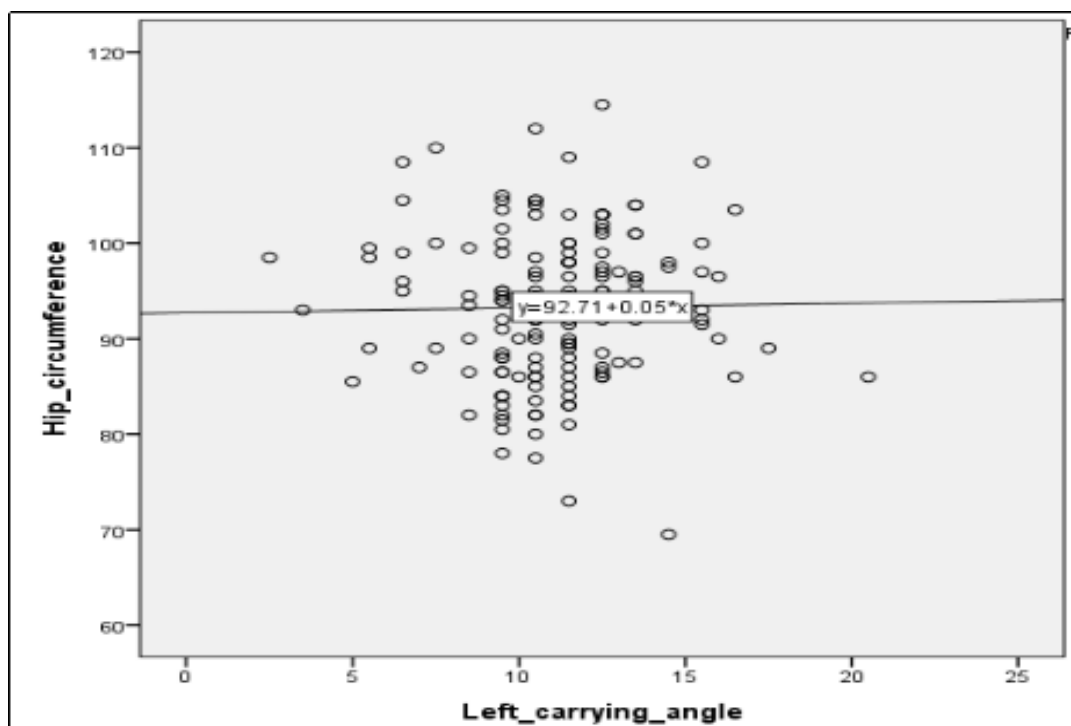


Figure 4: Correlation between Hip circumference and Left CA in Male

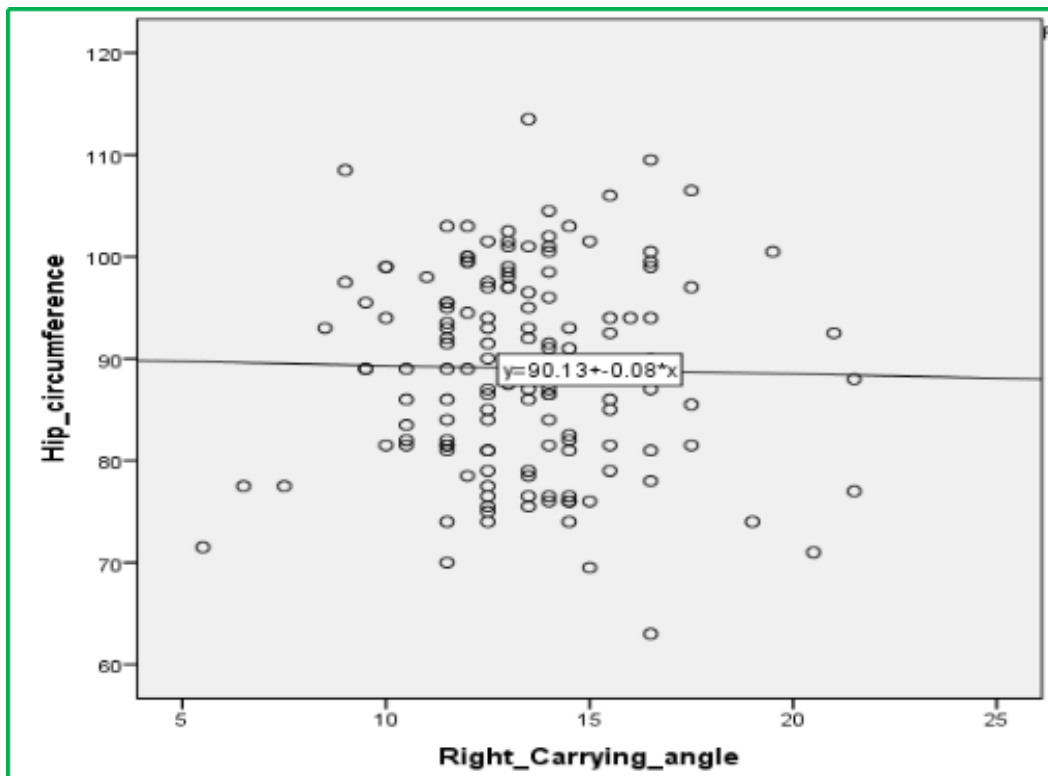


Figure 5: Correlation between Hip circumference and Right CA in Female

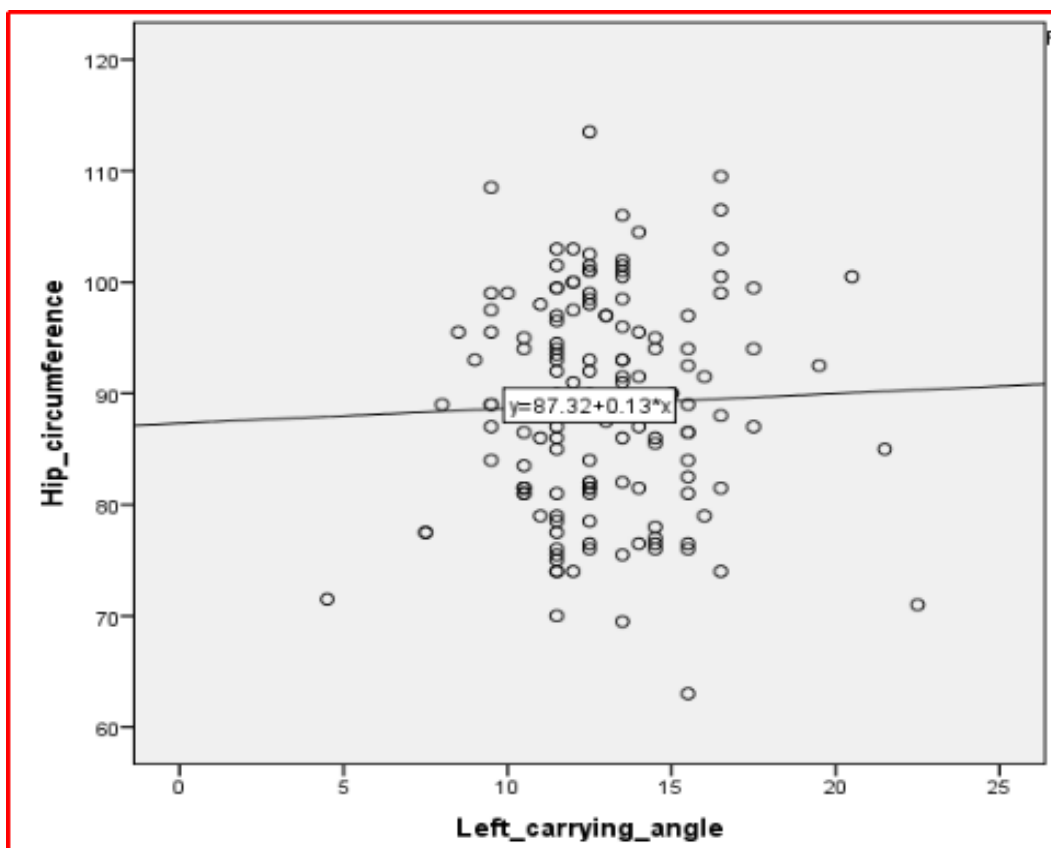


Figure 6: Correlation between Hip circumference and Left CA in Female

Table 1: Carrying Angle comparison (N= 300)

Carrying angle (mean ± SD)	Male	Female	Total / overall	P value
Right	11.69 ± 2.53	13.39 ± 2.62	12.51 ± 2.71	0.001
Left	11.08 ± 2.62	12.95 ± 2.62	11.98 ± 2.78	0.002
Mean difference	0.612			
P value	0.001		0.004	

Table 2: Hip circumference distribution of the participants

Hip circumference (Mean \pm SD)	91.24 \pm 9.03 cm
Male	89.05 \pm 9.87 cm (63 - 108)
Female	93.27 \pm 7.78 cm (73 - 115)
Mean differences	4.22 cm
P value	0.000

Table 3: Correlation between HC and Left CA in Male
p-value 0.833 (not significant > 0.05)

Correlation		Hip circumference	Left carrying angle
Hip circumference	Pearson Correlation	1	0.017
	Sig. (2-tailed)		0.833
	N	156	156
Left carrying angle	Pearson Correlation	0.017	1
	Sig. (2-tailed)	0.833	
	N	156	156

Table 4: Correlation between HC and Left CA in Female
p-value 0.673 (not significant > 0.05)

Correlation		Left carrying angle	Hip circumference
Left carrying angle	Pearson Correlation	1	0.035
	Sig. (2-tailed)		0.673
	N	144	144
Hip circumference	Pearson Correlation	0.035	1
	Sig. (2-tailed)	0.673	
	N	144	144

4. Discussion

In present study, it was found that mean value of Carrying angle were $11.38^\circ \pm 2.57^\circ$ & $13.17^\circ \pm 2.62^\circ$ in male and females respectively. Similar studies were conducted in the year 2018 by Acikgoz Ak et al. ⁽⁹⁾, were found that the mean value of carrying angle were $9.85^\circ \pm 2.95^\circ$ and $14.03^\circ \pm 4.08^\circ$

Another study conducted by the Shah PA et al. ⁽¹⁰⁾ it was found that the p value was > **0.05** on comparing CA with age which was non-significant and p was found **p < 0.05** on comparing with height and forearm length, which suggested significant co-relation whereas in my studies it was found that **p > 0.05** in between Hip-circumference and Carrying angle which suggested as significant co-relation between HC and CA.

The mean values of carrying angle were found that the $12.18^\circ \pm 2.62^\circ$ in males and $13.88^\circ \pm 3.46^\circ$ in females among 400 healthy, asymptomatic participants of age group of 21-25 years were examined in the Department of Orthopedics, Murshidabad MC, West Bengal studied by Bari W et al. ⁽¹¹⁾

A study was conducted by Rajesh B et al. ⁽¹²⁾ and found that the mean values of carrying angle were $6.7^\circ \pm 1.0^\circ$ and $13.3^\circ \pm 2.4^\circ$ in male and female respectively. A total number of 60 adolescents with ages varying from 17-20 years were included and here also similar with female participant result.

Terra BB et al. ⁽¹³⁾ conducted a study and it was found that a total 510 individuals participated with equal number sexes and their ages ranging from 1-18 years. The average of the elbow carrying angle was $11.20^\circ \pm 4.45^\circ$ in males and 12.78°

$\pm 5.35^\circ$ in females. In these studies, it was observed that male carrying angle almost similar with my present study result $11.38^\circ \pm 2.57^\circ$.

The mean carrying angle of female subjects was $10.65^\circ \pm 1.829^\circ$ whereas in males was $7.56 \pm 1.673^\circ$. This cross-sectional observational stud was done on 226 students (112 males and 94 females) of age group 17-21 years. It was also found that carrying angle was greater in females than males. The carrying angle was more on right side than the left side in both sexes. Carrying angle showed negative correlation with height and forearm length in both sexes stated by Kazi S et al. ⁽¹⁴⁾

Kothapalli J et al. ⁽¹⁵⁾ conducted a study included 220 healthy MBBS students from Karnataka age group of 18-22 years. It was found that in females there was a significant positive correlation (**p < 0.05**) of age with carrying angle of both sides, height was negatively correlated with carrying angle of both sides, no correlation between length of forearm with carrying angle. In males, Age and Height were not correlated with carrying angle but, the length of the forearm was significantly negatively correlated with carrying angle of both sides (**p < 0.05**). Greater carrying angle was found in females.

A study was conducted among the 150 healthy MBBS students of GMC, Jammu. The Carrying angle was more in females 15.2° than males 12.9° which was not statistically significant. No significant sexual dimorphism found though carrying angle was more in females and also on dominant side in both the sexes stated by Sharma AK et al. ⁽¹⁶⁾

Another descriptive cross-sectional study was conducted in the Department of Anatomy, Kathmandu by Manandhar B et al. ⁽¹⁷⁾ among 138 students with the age ranging from 18-23 years. It was found that Carrying Angle of right-hand male was $11.22^\circ \pm 1.25^\circ$ and female was $12.58^\circ \pm 1.60^\circ$.

It was observed that there was no statistical significance for carrying angle compared between sides and genders of both the ethnic groups (**p > 0.05**). The carrying angle was higher (**p < 0.05**) in Caucasians than in the Indian Americans, both over the right and left upper extremities. This was observed that in both genders. The comparison between genders showed that, carrying angle was higher in females (**p < 0.05**) than the males in both Caucasians and Indian Americans. This study was conducted among 200 students from the American population were belongs to 18-30 years age groups stated by Sadacharan CM et al. ⁽¹⁸⁾

Zampagni ML et al. ⁽¹⁹⁾ studied among the 28 adults (15 men and 13 women) with mean age 59 ± 10 years of age in both right and left arms. It was found that right arm dominant in all subjects which was almost my study results 98% and 2% was left dominant.

A study was conducted from the Madonna University, Nigeria among 200 subjects with age group of 16-25 years age. It was found that mean values of carrying angle was 9.31° in right and 8.99° in left sided arms of males while the females were found 9.75° and 9.58° in right and left respectively. It was revealed that mean values of RCA and

LCA lesser than my study results stated by Oladipo GS et al. (20)

Chakravarty M et al. (21) were conducted a study in the Department of Anatomy, Tezpur Medical College among 225 students. It was found that mean carrying angle males was $10.33^{\circ} \pm 1.56^{\circ}$ in the right limb and $12.11^{\circ} \pm 1.72^{\circ}$ in the left limb, in case of females were found $11.73^{\circ} \pm 2.73^{\circ}$ and $11.45^{\circ} \pm 3.26^{\circ}$ on the right & left side respectively. This study results showed that it was found that the almost my study findings.

5. Conclusion

In the present study, it can be concluded that there is a significant correlation between the carrying angles of the Elbow and the Hip circumference, especially in females, which reveals that increase Hip circumference and increase in carrying angles are directly related. Besides this, Obesity also have an impact those with an abnormal parameters are seen to have obesity.

Abbreviations:

CA-Carrying Angle
 HC-Hip Circumference
 R- Right
 L- Left
 SD- Standard Deviation
 cm- centimeter
 °- degrees

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Conflict of Interest:

The authors declare no conflict of interest.

References

- Stranding S. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 42nd ed. London: Churchill Livingstone Elsevier; 2023.p. 884, 936-41.
- Moore KL, Dalley AF. Clinically Oriented Anatomy. South Asian ed: Vol 1, Wolters Kluwer; 2018. p. 271-3.
- Santakke AY. Textbook of Human Anatomy, 1st ed. India: CBS Publishers & Distributors Pvt Ltd; 2021.p 156.
- Netter HF. The Netter Collection of Medical Illustrations: Section-2 Upper Limb & Elbow; Vol-6, 2nd ed.: Elsevier; 2013. p. 64-7.
- Singh V editor; Textbook of Anatomy: Upper Limb and Thorax, 3rd Ed.: Vol 1, Elsevier; 2019. p. 125.
- Garg K. BD Chaurasia's Human Anatomy: Regional and Applied, Vol-1. 8th Ed. Reprint, India: CBS Publishers and Distributors Pvt Ltd; 2022. p64-6.
- Mehta V, Suri RK; Snell's Clinical Anatomy by Regions; South Asian Edition, Wolters Kluwer; 2018. p. 464-6.
- Sinnatamby CS. Last's Anatomy: Regional and Applied. 11th Ed. London: Churchill Livingstone Elsevier; 2006. p. 64-6.
- Acikgoz, A.K. et al. Evaluation of the Elbow Carrying Angle in Healthy Individuals. Int. J. Morphol. 2018; 36(1): p. 135-9.
- Shah PA, Naqvi WM. Carrying Angle and its correlation with different parameters Height, Length of Forearm, and Age. Int J Physiother. 2020 Oct; Vol 7(5), p. 211-5.
- Bari W, Alam M, Omar S. Goniometry of Elbow Carrying Angle: A Comparative Clinical study on Sexual Dimorphism in Young Males and Females. Int J Res Med Sci. 2015 Dec; 3(12): p. 3482-4.
- Rajesh B et al. An Evaluation of the Carrying Angle of the Elbow Joint in Adolescents. Int J Med Biomed Res. 2013 Dec; 2(3): p. 221-5.
- Terra BB et al. Evolution of the carrying angle of the elbow: A Clinical and Radiographic study. Acta Ortop Bras. 2011; 19(2): p. 79-82.
- Kazi S et al. The Comparison and Evaluation of Carrying Angle of Elbow with Anthropometric Measurements in Both Sexes. Int J Anat Res 2017 Dec, Vol 5(4.3): p. 4686-90.
- Kothapalli J et al. The Carrying Angle of Elbow- A Correlative and Comparative Study. Int J Cur Res Rev, 2013 Apr; Vol 05(07): p. 72.
- Sharma AK et al. A Study of Carrying Angle Among Young Adults of Jammu & Kashmir. Jk Sci org. April-June 2019; Vol 21(2).
- Manandhar B et al. Dominance of Carrying angle in Right -hand among Dental Students of a Teaching Hospital: A Descriptive Cross-sectional Study. J Nepal Med Assoc 2022 March; 60(247): p. 282-5.
- Sadacharan CM et al. Carrying Angle of the Elbow Joint in Young Caucasian and Indian American Population: A Descriptive Cross-Sectional Study. Journal of the Anatomical Society of India Jan- Mar 2022; Vol 71(1).
- Zampagni ML et al. A protocol for clinical evaluation of the carrying angle of the elbow by anatomic landmarks. J Shoulder Elbow Surg Feb 2008; Vol 17(1).
- Oladipo GS et al. An examination of carrying angle of students in Madonna University, Elele, Port Harcourt, Rivers State, Nigeria. J Appl Biotechnol Bioeng. 2019 Mar Vol 6(2): p. 95-9.
- Chakravarty M, Bordaloi RR. Evaluation of the Carrying Angle in the Ethnic Assamese Community. J Evid Based Med Healthc. 2020 Dec; Vol 7(51).