

An Anthropometric Study on the Carrying Angle of Elbow among Young Adults of Various Ethnicities in Malaysia

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Abstract: Background and Objectives: Prediction of stature from incomplete and decomposing skeletal remains is vital in establishing the identity of an unknown individual. Variety of factors such as race, gender and nutrition play an important role in determining the carrying angle of an individual. There were no study done in Malaysia to find the relationship of the carrying angle with common anthropological parameters and for comparing carrying angle among various ethnic group such as Malay, Chinese and Indians. This study was useful in finding the relationship of the discussed parameters with carrying angle among both genders and comparing between ethnics group in Malaysia. **Materials and Methods:** A total of 201 participants between ages of 18-25 years were included in the study. The carrying angle was measured and compared among the genders and among ethnic groups and data analysis was done using SPSS version 22. **Results and Discussion:** The findings indicated significant differences in the carrying angle between the genders and between left and right arm. The variation in carrying angle was significant among the males and females of various ethnicities. **Conclusion:** The findings in this study will be useful for clinicians, anatomists, archaeologists, anthropologists and forensic scientists when such evidence provides the investigator the only opportunity to gauge that aspect of an individual's physical description which are of value in management of arm fractures, introduction of prosthesis, evolutionary studies and forensic assessments. [Anita Devi K NJIRM 2014; 5(6):20-23]

Key Words: Carrying angle, elbow, ethnic, goniometer, race

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Introduction: The carrying angle of the elbow is defined as the angle formed by the long axis of the arm and the long axis of the forearm in the frontal plane when the elbow is fully extended and the forearm is supinated ¹. In such a position, the forearm does not lie in one line with the arm, but it deviates lateral to the arm axis forming this angle. The evaluation of carrying angle value and its pathologic variations are important to identify the elbow deformities and in the diagnosis of diseases of the lateral and medial epicondyles ².

Studies have shown that there is a gradual increase in the carrying angle with skeletal maturation ³. The apparent difference in gender may be due to increased joint laxity in females permitting a greater degree of extension. The average carrying angle is normally greater in females than males as the medial lip of trochlea projects more distally than the lateral lip and the valgus tilt of the distal humeral articulation with respect to the longitudinal axis of humerus is more in females.

The carrying angle changes linearly with degree of flexion and extension of the elbow, being greatest

at full extension and decreasing as the elbow is flexed, and disappears in full flexion when the forearm and arm become closely aligned with the hand lying in front of the shoulder.

The carrying angle apparently develops in response to pronation of the forearm and keeps the swinging upper extremity away from the side of the pelvis during walking ⁴. Increasing the carrying angle may lead to elbow instability and pain during exercise or in throwing activities of sports ⁵. Wider carrying angle may reduce function of elbow flexion ⁶, predispose to risk of elbow dislocation ⁷. There is increased evidence of elbow fracture when falling on the outstretched hand and fracture of the distal humeral epiphysis ⁴ in subjects with wider carrying angle.

Variation in carrying angle among age groups, gender and race has been reported in literature. The average value of the carrying angle is 12.5 ±0.57 degrees in male and 15.26 ±0.45 degrees in females. Females had higher values than males except in 3-5yrs age group in whom the carrying angle is greater in males ^{8, 9}. Carrying angle

increases with age and is more on the dominant side (right) in both sexes (9). According to literature, the importance of evaluating the carrying angle is for handling and monitoring of traumatic lesions that affect the pediatric elbow¹⁰. Increased carrying angle may lead to elbow instability and pain during exercise or in throwing sports (eg. javelin throwing, discus throwing, hammer throwing and shot put) and may reduce elbow flexion^{6, 11, 12}. Dislocation, fracture when fall on outstretched hand and fracture of distal humeral epiphysis can lead to abnormal carrying angle. There are no reports in literature which has explored the correlation between carrying angle and the various ethnic groups in Malaysia. The most common abnormality of carrying angle is due to condylar fracture of the elbow joint^{3, 9}. In children, rare congenital disease can also lead to abnormalities of the carrying angle eg; Turner's syndrome, Cardiofaciocutaneous syndrome, Cohen's syndrome and Noonan's syndrome¹³. A study on the carrying angle has not been attempted so far as per literature and we embarked on this novel study to compare and correlate the carrying angle among Malaysian ethnic population with the relevant anthropometric measurements which may affect carrying angle.

Material and Methods: This study was aimed to measure and compare the carrying angle of elbow of both arms of an individual and to compare the carrying angle between males and females of the age group of 18-25 years. We also attempted to compare the carrying angle among the various races.

The present study was a cross-sectional study which included 201 (111 females & 90 males) healthy young adults participants within the age group of 18-25 years of age selected by convenient sampling. The age range was selected to minimize the confounding factor where carrying angle has been documented to alter with age. Eligible candidates with history of arm or elbow injury were excluded from the study. The carrying angles of the elbow of both hands were measured using a goniometer¹⁴. A comparison of carrying angle between males and females selected in the study was done to assess gender variation. A comparative study of racial variation among

Malays, Chinese, Indians and other minorities was done and the data was analysed using SPSS version 22. The values were further analysed using SPSS version 21.

Results: A total of 201 participants were enrolled in the study of which 90 were males and 111 were females (Figure 1). The mean ages of the study population are 21.07 years for males and 20.89 for females. Among the male and female participants, Chinese ethnic group was the largest followed by Malays and the Indians (Figure 2 and 3).

Figure 1: Pie Chart Showing the Total Number of Participants (N= 201)

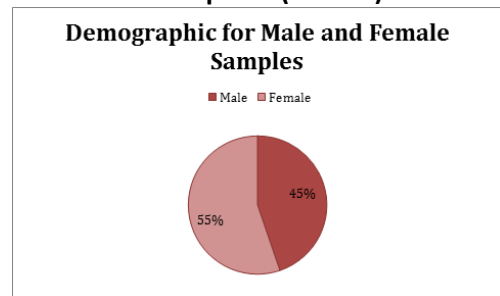


Figure 2: Pie Chart Showing the Ethnic Variation among the Male Participants

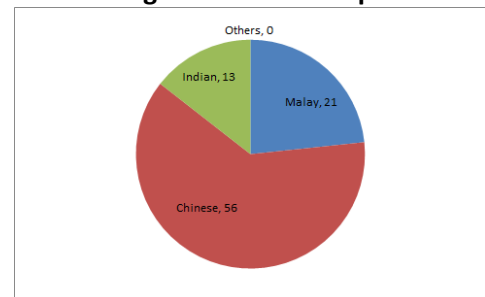
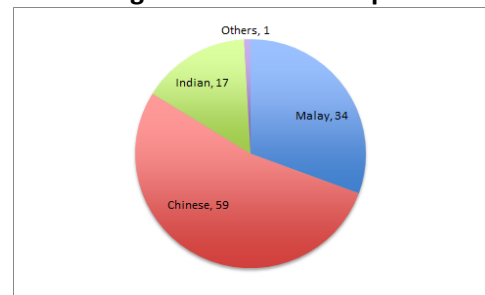


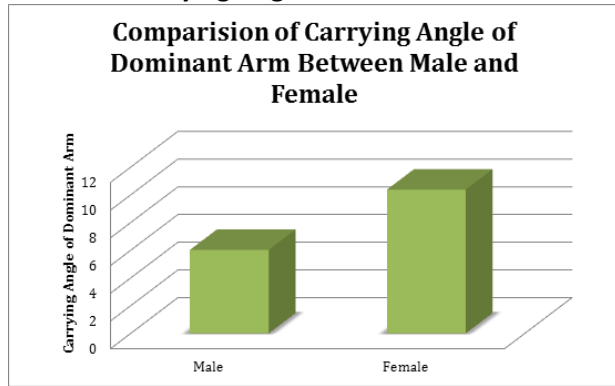
Figure 3: Pie Chart Showing the Ethnic Variation among the Female Participants



The study revealed that females have a greater carrying angle than males (Figure 4). The mean value of the carrying angle for female (10.3707)

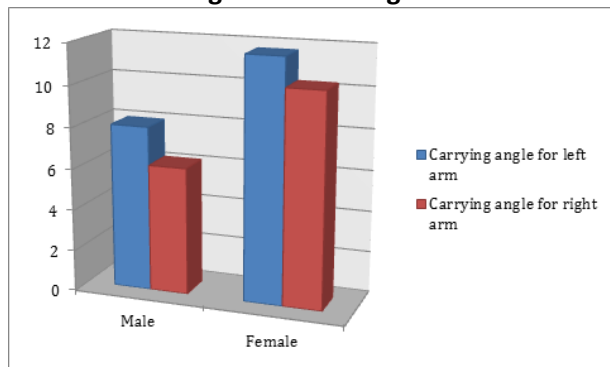
and male (6.022) were statistically significantly different with the p value of 0.00; hence there is significant difference between carrying angle among males and females.

Figure 4: Bar Chart Comparing The Male And Female Carrying Angle Of The Dominant Arm.



The study also revealed significant difference between the carrying angle of left and right arm among both males and females (Figure 5). The mean value for left arm carrying angle among males was 8.0033 while among females it was 11.700 and the right arm carrying angle in males was 6.1722 and in females 10.2982 respectively with the p-value of 0.00 which showed the left arm had wider carrying angle.

Figure 5: Bar Chart Comparing The Carrying Angle Of Left And Right Arm Among Both Genders.



Among the participants which included the ethnic groups of Malay, Chinese and Indian, we found that females have larger carrying angle than males among all the ethnicities. There was a significant difference between carrying angle among males and females. There are no past studies available in literature regarding variation among the ethnic groups of Malaysia. The mean value of carrying

angle and p value for all 3 ethnic groups are shown in the Table 1.

Table 1: Carrying Angle among the Various Ethnic Groups

Ethnic groups	Mean	p value
Malay	8.4909	0.311
Chinese	8.0922	0.117
Indian	9.5167	0.040

Discussion: The study revealed a wider carrying angle among females as compared to males which was statistically significant ($p < 0.05$). Previous studies also have found that the angle is significantly greater in females who have a shorter forearm/ulna than in males and this difference is considered as a secondary sexual characteristic¹⁵. The study also found that the left arm have greater carrying angle then the right arm in both genders which was also statistically significant ($p < 0.05$). This is a novel finding as most of previous studies show right arm have wider carrying angle then the left arm. It has been hypothesized that the difference between the carrying angles of the right and left sides may suggest ligamentous laxity at the medial elbow or asymmetrical bone growth⁴. Among the various ethnic Malaysian population, females in general had a wider carrying angle with non-significant variation among the races. Since the ethnic cohorts were small, further validation with a study based on a larger population is warranted. Incidentally, the authors found that the carrying angle in 3 participants who used both hands (meaning that they were not partial to either the right or left arm as the dominant) to do daily activities, were equal for both arms. Another incidental finding was a participant who had a “cubitusvarus” carrying angle. This observation is unique and need further assessment and data regarding the precipitating factors or genetic association.

Conclusion: This study which focused on the carrying angle found it wider in females as compared to males which is consistent with published literature^{8,9}. new observations regarding

the role of ethnicity affecting the carrying angle has been observed; further studies in a larger population would be ideal to corroborate them. More studies on the evolutionary anthropology would shed light on the role of environment and genetics in the listed findings.

References:

- JyothinathKothapalli, Pradeepkumar H. Murudkar, Lalitha Devi Seerla. The Carrying Angle Of Elbow: A Correlative and Comparative Study. *International Journal of Current Research and Review*, 2013; 5(7):71-76
- Maria L. Zampagni, Daniela Casino, Stefano Zaffagnini, Andre A. Visani, MaurilioMarcacci. Estimating the Elbow Carrying Angle With an Electrogoniometer: Acquisition of Data and Reliability of Measurements. *HealioOrthopedics*, 2008; 31
- Golden DW, Jhee JT, Gilpin SP, Sawyer JR. Elbow range of motion and clinical carrying angle in a healthy pediatric population. *J PediatrOrthop B*. 2007 Mar; 16(2):144-9.
- Khare GN, Goel SC, Saraf SK, Singh G, Mohanty C. New observations on carrying angle. *Indian J Med Sci*. 1999;53:61–67
- Cain EL Jr, Dugas JR, Wolf RS, Andrews JR. Elbow injuries in throwing athletes: a current concepts review. *Am J Sports Med*. 2003;31:621–63
- Van Roy P, Baeyens JP, Fauvart D, Lanssiers R, Clarijs JP. Arthro-kinematics of the elbow: study of the carrying angle. *Ergonomics*. 2005;48:1645–1656
- Habernek H, Ortner F. The influence of anatomic factors in elbow joint dislocation. *ClinOrthopRelat Res*. 1992;274:226–230
- Dey S, Mandal L, Kundu B, Mondal M, Sett TK. Carrying angle of the Elbow: It's Changes From Childhood to Adulthood :Morphometric Study in Eastern India; *Indian Journal of Basic & Applied Medical Research*; Sep 2013: Issue-8, Vol.-2, P. 823-830
- Koh KH et al. Clinical and radiographic results of lateral condylar fracture of distal humerus in children. *Journal J PediatrOrthop*. 2010 Jul-Aug; 30(5):425-9. doi: 10.1097/BPO.0b013e3181df1578. <http://www.ncbi.nlm.nih.gov/m/pubmed/20574257/>
- Balasubramanian P, Madhuri V, Muliylil J. Carrying angle in children: a normative study. *J PediatrOrthop B*. 2006;15:37- 40
- Hutchinson MR, Wynn S. Biomechanics and development of the elbow in the young throwing athlete. *Clin Sports Med*. 2004; 23:531–544;
- David C. Dugdale. Carrying angle of the elbow - excessive. A.D.A.M Medical Multimedia EncyclopediaMedlinePlus: US National Library of Medicine, National Institute of Health; 2011. <http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0002970/>
- Peter C. Amadio, James H. Dobyns. Congenital Abnormalities of the Elbow, Chapter 13. Morrey: *The Elbow and Its Disorders*, 4th ed. 2008 Saunders, Elsevier; 184-190.
- Chein-Wei Chang, MD, Yi-Chian Wang, MD, and Chang-Hung Chu, MD Increased Carrying Angle is a Risk Factor for Nontraumatic Ulnar Neuropathy at the Elbow <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2492992/#>
- Potter, H.P., 1895. The obliquity of the arm of the female in extension. The relation of the forearm with the upper arm in flexion. *J Anat. Physiol.*, 1985;29: 488-491.

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