

**Goniometry of Elbow Carrying angle: A Cross Sectional Study in Sohag University Students****Salwa M Ouies<sup>a</sup> and Walaa N Elsamman<sup>a\*</sup>**<sup>a</sup>Anatomy and Embryology Department, Faculty of Medicine, Sohag University, Sohag, Egypt**Abstract**

**Background:** Carrying angle is an acute angle formed medially at the elbow when the upper limb is in its anatomical position by the long axes of the humerus and ulna. Generally speaking, it is higher in girls than in males. When predicting a person's sex and race, forensic specialists and anthropologists can utilize carrying angle knowledge. Orthopedicians can use carrying angle knowledge to treat a variety of elbow diseases, and biomechanical engineers can use carrying angle knowledge to create elbow replacement prosthesis's.

**Objectives:** our work aimed to compare average values of the carrying angle of both sexes in Sohag university students.

**Subjects and methods:** A cross-sectional study was done among healthy 270 young adult participants (146 males and 124 females) with mean age in Sohag university students (average age =  $19.8 \pm 1.4$ ). Goniometer was used to measure carrying angle and statistics was done for data.

**Results:** The mean Carrying angle for right side was  $12.7^\circ \pm 3.4^\circ$  in males and  $13.9^\circ \pm 2.2^\circ$  in females. The mean left Carrying angle was found to be  $11.8^\circ \pm 3.7^\circ$  in males and  $13.6^\circ \pm 2.2^\circ$  in females. The mean Carrying angle for both sides were found to be greater in females than in males and this was highly significant statistically ( $p < 0.000$ ). In males, a significant difference was found between Rt angle and Lt with p value  $< 0.039$  while in females, a non-significant difference was found between both sides with p value  $< 0.22$ .

**Conclusion:** Carrying angle was significantly higher in females as compared to males. In males there was significant increase in the Rt angle in comparison to the Lt while in females there was non-significant difference between Rt and Lt angles.

**Keywords:** Carrying angle; Goniometer; Sohag.

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## Introduction

When the elbow joint is stretched and supinated at the radio-ulnar joints, a carrying angle is created between the long axes of both arm and forearm. This angle which opens laterally and become hidden when the elbow joint is fully flexed. Anatomically, the carrying angle in human adults is approximately 10° in men and 13° in women (Snell, 2004).

Cubitus varus (gunstock deformity) means that the carrying angle is decreased and complete loss of carrying angle is called cubitus rectus (Chakraborty et al., 2019).

The carrying angle maintains the swinging movement of upper limb away from the side of the pelvis during walking and appears to develop in response to forearm pronation (Kothapalli, 2013).

The superior part of the coronoid process of the ulna is positioned obliquely to the long axis of the bone, and the medial flange of the trochlear is 6mm deeper than the lateral flange, both of which contribute to the formation of the carrying angle (Garg, 2007).

When walking, swinging, and carrying objects, this angle is crucial. Due to forces acting on the elbow joint, the dominant hand has larger angle than non-dominant hand in both males and females. Greater carrying angle in the dominant hand may be due to ethnic and growth-related influences (Ruparelia et al., 2010).

Understanding carrying angle is crucial for anthropologists to distinguish between sexes in fragmented remains and to comprehend sexual dimorphism, which is more prevalent in bones, it is crucial for the differentiation between lateral and medial epicondyle illness and also following up traumatic lesions that affect the pediatric elbow is made easier by its use. (Manoranjitham et

al., 2015 ; Sharma et al., 2013 ; Lim et al., 2014).

Radiographs are used in clinical settings to examine the reduction of distal humerus or radial head fractures and epicondylar diseases by measuring the carrying angle of the elbow joint (Zampagni, 2008).

This study's primary objective was to determine the Goniometry of the carrying angle in Sohag university students and comparing the average values of the carrying angle in both sexes.

## Subjects and methods

**Study design:** A cross-sectional study was done in the Department of Anatomy, Sohag university 146 males and 124 females were participate in this study (from June 2023 to October 2023).

**Inclusion criteria:** Egyptians aged between 18 and 22 years (mean 19.8 ±1.4)

**Exclusion criteria:** Students with history of upper limb fractures (arm and /or forearm), upper extremity deformities, neuropathies, congenital anomalies, endocrinal disorders and athletes.

**Ethical considerations:** Institutional Ethical Committee approval was obtained from Scientific Research Ethics Committee of Sohag University (Sohag faculty of Medicine Ethical Committee under IRB registration, number: Soh-Med-23-06-16PD) prior to the study's start. The students were well informed about study's importance and advantages. The participants signed a written consent form after being given spoken information.

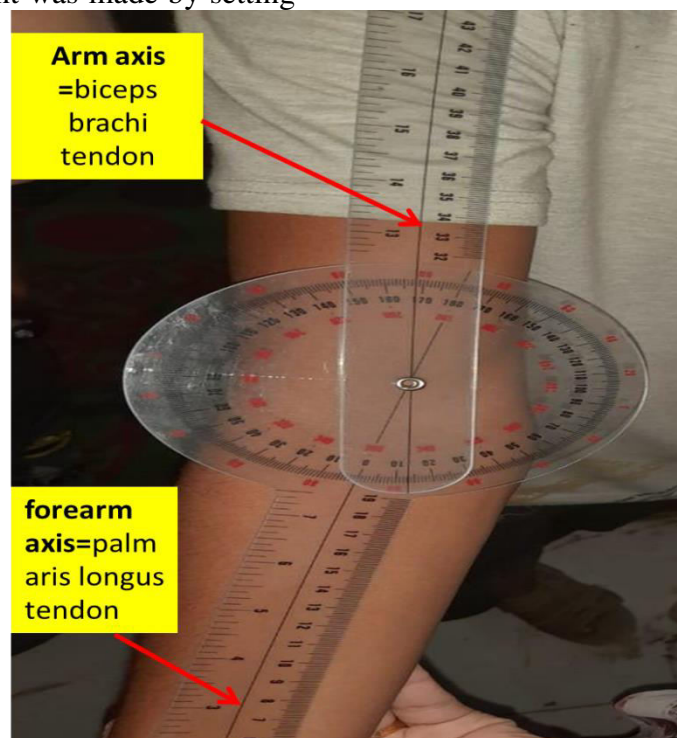
**Materials:** Goniometer, Marker

**Carrying angle measurement Procedure (Kazi et al., 2017; Manandhar et al., 2022):** Participants were made to stand in an anatomical position shoulder in 0° flexion and 0°

extension with their elbows fully extended and supinated.

A full circle goniometer made of flexible clear plastic with 30 cm long arms was used to measure the carrying angle of the elbows of both sides. The median axis of the forearm and arm were designated anatomically by the palpation of the palmaris longus tendon at the wrist and the insertion of the biceps brachii tendon, respectively. The measurement was made by setting

the measurement plate of the goniometer at the fulcrum of one elbow. The movable arm was set on the median axis of the forearm, while the fixed arm was positioned on the median axis of the upper arm. The angle was shown by the arrow on the goniometer measurement plate, the carrying angle was recorded and the same method was repeated on the other arm also (**Fig. 1**).



**Fig.1. Carrying angle measurement Procedure**

**Statistical analysis**

Measurements (mean value ± Standard deviation) were analyzed using SPSS 22.0 programme. Differences between dominant and non-dominant arm and between males and females were recorded and analyzed by independent sample t-test with  $p < 0.05$  was accepted.

**Results**

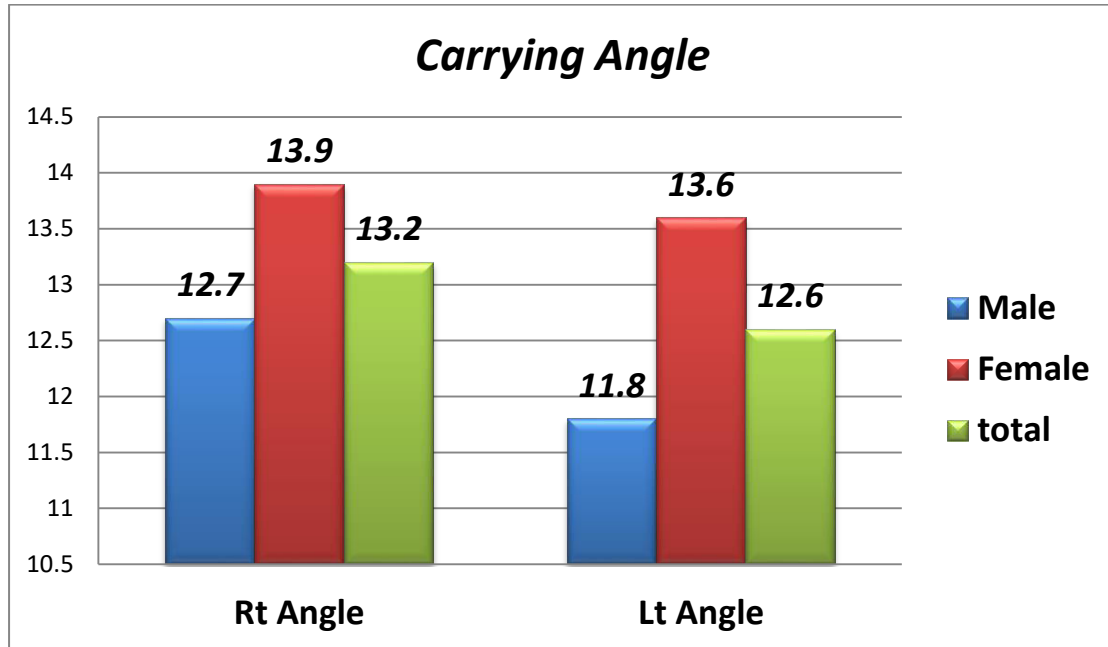
Measurements were obtained from 270 young adult participants (146 males and 124 females) with mean age =  $19.8 \pm 1.4$  years. In all participants the Right side was the dominant arm. The mean carrying angle was  $12.3^\circ \pm 3.6^\circ$  in males and  $13.8^\circ \pm 2.2^\circ$  in females with

significant difference between both sexes ( $p \text{ value} < 0.000$ )

In males there was significant increase in Rt angle (mean =  $12.7^\circ \pm 3.4^\circ$ ) in comparison to Lt ones (mean =  $11.8^\circ \pm 3.7^\circ$ ) with  $p \text{ value} < 0.039$ . In females there was non-significant difference between Rt (mean =  $13.9^\circ \pm 2.2^\circ$ ) and Lt (mean =  $13.6^\circ \pm 2.2^\circ$ ) with  $p \text{ value} = 0.22$ . Dominant arms angle was in a mean of  $13.2^\circ \pm 2.9^\circ$  which is significant increased in comparison with non-dominant arms (mean =  $12.6^\circ \pm 3.2^\circ$ ) ( $p \text{ value} < 0.02$ ), (**Table.1, Fig.2**).

**Table 1. Measurements of carrying angle in both sexes (mean±SD)**

Variables	Rt	Lt	Total	P value
Males	12.7 ±3.4	11.8 ±3.7	12.3 ±3.6	0.039
Females	13.9 ± 2.2	13.6 ±2.2	13.8 ±2.2	0.22
Total	13.2 ±2.9	12.6 ±3.2	12.9 ±3.1	0.02



**Fig.2. Carrying angle measurements in both sexes (mean± SD)**

**Discussion**

In our study the carrying angle at the elbow was measured by using a protractor goniometer to measure the axes from the surface margin of the arm and forearm while the elbow is fully extended.

In our study the mean carrying angle was 12.3° ±3.6° in males and 13.8° ±2.2° in females with significant increase in females compared to males. Same results were found by **Rana et al. in 2013** who made a study on Carrying angle in 60 person (30 males and 30 females) of age group 18-25 years in Nepal. They obtained the angle by two methods (Surface anatomical landmark method and radiological landmark method) and showed that it was greater in females than in males by both methods (**Rana et al., 2013**). Also **Alsubael and Hegazy (2010)** made a radiographic evaluation of carrying angle on 90 healthy adults (45 males and 45

females) aged 18 to 76 years in Saudi Arabia and revealed that the mean value of carrying angle was 9.29°±2.98° in males and 18.47°±4.12° in females .

Most older studies also confirm a greater carrying angle in females than in males (**Van Roy et al., 2005 ; Yilmaz et al., 2005 ; Paraskevas et al., 2004**), While on the other hand **Anibor et al. in 2016** who made a study on 384 adolescents (194 males and 190 females) of age group 10-19 years in Nigeria and found that no significant difference in carrying angle between both sexes .

In females, a larger angle may be considered as a secondary sexual feature as until adolescence there is no difference between the carrying angle of boys and girls, after that point it increases in girls, it might also possibly be because of their softer joints, which allow for more elbow extension and a higher carrying angle (**Ruparelia et**

al., 2010; Eliakim-Ikechukwu et al., 2012).

Variations in this angle in either sex are also caused by the general stature of males and females. Males typically have tapering hips and broad shoulders. As a result, this helps the arms remain straight, with the upper and lower arms' long axes in a straight line. The forearm axis instead splays out in females due to their narrow lower body and narrow shoulders (Allouh and Khasawneh, 2014 ; Chang et al., 2008; Thejeshwari et al., 2017), However, this theory was rejected later on because the forearm is pronated and slightly flexed during walking and the angle is formed only when the forearm is fully extended and supinated, and disappears in pronation and flexion of the forearm (Zampagni et al., 2008).

There are multiple causes that explain why the angle is more prominent in females than males like hormonal and genetic factors which may influence the angle in women (Balasubraman et al., 2006).

In the present study the dominant arm was observed to have a greater carrying angle than the non-dominant arm in males while in females there was non-significant difference between Rt and Lt angles. Most previous studies was found that the angle is larger in dominant arm in comparison to the non-dominant one in both males and females (Yilmaz et al., 2005 ; Paraskevas et al., 2004; Allouh and Khasawneh ,2014; Iftikhar et al., 2021).

This might be the result of recurrent stress and bone remodeling in the dominant arm from its more frequent use than the non-dominant arm which may imply more laxity of the ligament at the medial elbow or bony remodeling to adapt more stress in the dominant hand ( Dey et al.,2013).

**Conclusion:** The carrying angle is significantly greater in females than males and this difference has been considered to be one of the secondary sexual characteristics.

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