Original Article

CORRELATION BETWEEN BMI AND CARRYING ANGLE AMONG YOUNG ADULTS OF MEDICAL COLLEGE IN LAHORE

Dania Javed[1], Saadia Perwaiz[2], Muhammad Mahmood Alam[3], Rimsha Touqeer [4], Lyba Javaid[5], Fatima Zafar[6]

ABSTRACT

Background: The carrying angle refers to the angle formed between the arm's long axis and the forearm at elbow joint, also referred to as cubital angle. Body Mass Index (BMI) is a metric used to evaluate a person's weight in proportion to their height. Carrying angle and other anthropometric measurements have been studied to explore differences in CA. The objective of the study was to analyze the correlation between BMI and Carrying angle among young adults in Lahore.

Materials and Methods: It was a cross-sectional study design. One-hundred & forty-six healthy young adults (18-25 years of age) were taken by non-probability convenience sampling, out of which 81 were females and 65 were males. Carrying Angle was measured using Goniometer. Weight was measured with a scale, height with a measuring tape, and pelvic circumference with a measuring tape. Correlation of BMI and Carrying Angle among young adult population was determined by using Pearson's Correlation Coefficient and shown with scatter diagram

Results: The carrying angle showed no correlation with BMI, pelvic circumference, or weight. There was significantly. The correlation between height and carrying angle of left side was -0.184 with p-value of 0.026 and at right side it was -0.189 with p- value of 0.023.

Conclusion: No significant correlation was identified between the carrying angle and BMI, pelvic circumference or weight. BMI correlated negatively with Height.

Key Words: Carrying angle, Body Mass Index, Young Adults, Goniometer

doi: https://doi.org/10.51127/JAMDCV07I01OA01

How to cite this:

Javed D, Perwaiz S, Alam MM, Touqeer R, Javaid L, Zafar F. Correlation Between BMI and Carrying Angle Among Young Adults of Medical College in Lahore. JAMDC,2025: 7(1):3-9 doi: https://doi.org/10.51127/JAMDCV07I01OA01

INTRODUCTION

Body Mass Index is a parameter that interprets fitness through a wide range varying from being underweight to obese in various age groups which is further marked by different biological and psychological changes.[1,2] There are various anatomical variations that exists with respect to BMI. These changes bring about biomechanical differences in execution of function. Some studies have found that the ranges of motion for elbow flexion, supination, hip extension, knee flexion, and ankle plantar flexion were notably smaller in the overweight and obese groups than in the normal-weight group.[3,4] Elbow is a complex hinge joint between the humerus and forearm bones (radius and ulna), allowing flexion, extension, and limited rotation, which is stabilized by ligaments and tendons, and protected by articular cartilage to reduce friction.[5, 6] The CA is the angle between the arm and forearm in the anatomical position, also known as Cubital Angle. It can be measured using a goniometer or X-ray images. The universal goniometer

[1,5,6] House Officer ASTH, Lahore
[2]Assitant Prof. ACRS, Lahore
[3]Professor of Physiotherapy ACRS, Lahore
[4,] Lahore
Date of Submission: 05-12-2024
Date of 1st Review: 15-12-2024
Date of 2nd Review: 24-12-2024
Date of Acceptance: 10-1-2025

shows high intra- and inter-rater reliability for measuring the elbow joint.[7] Studies show that the carrying angle is greater in women (13.6°) compared to men (6.7°), and it correlates with forearm length.[8] Variation in CA has been heeded with respect to gender and other anthropometric measures.[9] An increase or decrease in carrying angle is referred to as valgus and varus deformity, respectively. These deformities can lead to elbow instability, pain and other associated symptoms leading to disability.[10] BMI has been widely studied in various populations to study the variations of carrying angle. In most studies higher BMI is found to be associated with a greater carrying angle.[11] Tantawy SA et al., has explained a positive correlation between musculoskeletal disorders (MSDs), academic stress, and BMI.[12] Assessment of the elbow carrying angle in healthy individuals showed significant correlations with height ($r = 0.366$, $p < 0.001$) and arm length ($r = -0.273$, $p < 0.001$).[13] Patel MR et al., study, conducted on 200 young adults, investigated how changes in the carrying angle affect grip strength. A significant negative correlation between the carrying angle and grip strength of both hands was found, suggestion that smaller carrying angle leads to more grip strength, or vice versa.[14] There is a vast literature available that examines the relationship between carrying angle and various anthropometric factors in diverse populations of different age groups. The objective of this study was to assess the relationship between body mass index and carrying angle among young adults at a medical college in Lahore.

MATERIALS AND METHODS

The study was conducted at Akhtar Saeed Medical and Dental College in Lahore, with approval granted by the Institutional Review Board (IRB) under approval number M23/135/ - DPT, dated 29-08-2023. Using a cross-sectional study design, 146 medical students, both male and female, were selected through a non-probability convenience sampling method. The sample size was calculated using Taro Yamane formula having 95% confidence interval.[15] The study was completed in 6 months from June 2024 to November 2024. The main variables under study were BMI and carrying Angle of elbow joint. To calculate BMI was a composite variable which comprised of weight and height. Weight was measured by weight scale (in kg) and height was measured by measuring tape (in meters). The carrying angle of the elbow was assessed using a goniometer (measured in degrees). The person was positioned on their back, with the elbow straightened and rotated outward. The goniometer's hinge was aligned with the cubital area, with the ulna at the distal and the humerus at the proximal end, placed along the front of the upper limb. Equipment used were Goniometer, Weight Scale and Measuring Tape. The inclusion criteria were students of Akhtar Saeed medical & dental college, both males and females, within age group of 18-26 years. The individuals with congenital deformities of upper extremities, fractures or surgeries around the elbow joint & Paget's disease were excluded from the study. The data was analyzed using SPSS version 27. BMI, Carrying Angle and Pelvic circumference were presented using mean, standard deviation. Demographic variables of gender and hand dominancy were presented through frequency tables. Correlation of BMI and Carrying Angle among young adult population was obtained by using Pearson's Correlation Coefficient. The p-value of 0.05 or less was considered significant.

RESULTS

The results of this study showed that mean age of participants was 21.92 years, mean pelvic circumference of participants was 88.38cm and mean BMI of participants was 22.18 kg/m^2. It is depicted in table 1.

Majority of participants had right dominant hand. Out of 146, only 10 participants had

left dominant hand out of the sample taken from medical students, 81 were females and 65 were males as shown in table 2.

No significant correlation was found between the carrying angle of either elbow and the BMI or weight of the participants. A significant negative correlation, however, was noted between the carrying angles of the right and left elbows and the height of the participants, with a p-value of 0.05 or below indicating statistical significance. (Table no:3)

Table no. 1: Mean Age, Pelvic Circumference and BMI of Participants:

	N	Min	Max	Mean	Std. Deviation
Age (in years)	**146**	**18.00**	**26.00**	**21.92**	**1.57**
Pelvic Circumference (in cm)	**146**	**72.00**	**112.00**	**88.38**	**8.15**
BMI (kg/cm^2)	**146**	**15.20**	**33.50**	**22.18**	**3.64**
Carrying angle left (in degrees)	**146**	**3.00**	**21.00**	**12.67**	**3.96**
Carrying angle right (in degrees)	**146**	**4.00**	**23.00**	**14.69**	**3.87**

Table no. 2: Frequency of Dominant Hand and Gender of the Participants:

Dominant Hand		
	Frequency	**Percent (%)**
Left	**10**	**6.8**
Right	**136**	**93.2**
Total	**146**	**100.0**
Gender of the Participants		
	Frequency	**Percent (%)**
Male	**65**	**44.5**
Female	**81**	**55.5**
Total	**146**	**100.0**

Table no. 3: Correlation between Carrying Angle of Both Hands and Weight of Participants:

variables	Mean	Standard Deviation	N	r	p
BMI	22.18	3.64	146	0.002	.981
Carrying Angle (right)	14.69	3.87			
BMI	22.18	3.64	146	0.04	.633
Carrying Angle (left)	12.67	3.96			
Weight (kg)	62.02	12.66	146	-0.12	0.14
Carrying Angle (right)	14.69	3.87			
Weight (kg)	62.02	12.66	146	-0.07	0.43
Carrying Angle (left)	12.67	3.96			
Height	166.97	9.34	146	-0.184	0.026
Carrying Angle (right)	14.69	3.87			
Height (cm)	166.97	9.34	146	-0.189	0.023
Carrying Angle (left)	12.67	3.96			
Pelvic Circumference	88.37	8.15	146	-0.03	0.75
Carrying Angle (left)	12.67	3.96			
Pelvic Circumference	88.38	8.15	146	-0.07	0.41
Carrying Angle (right)	**14.69**	**3.87**			

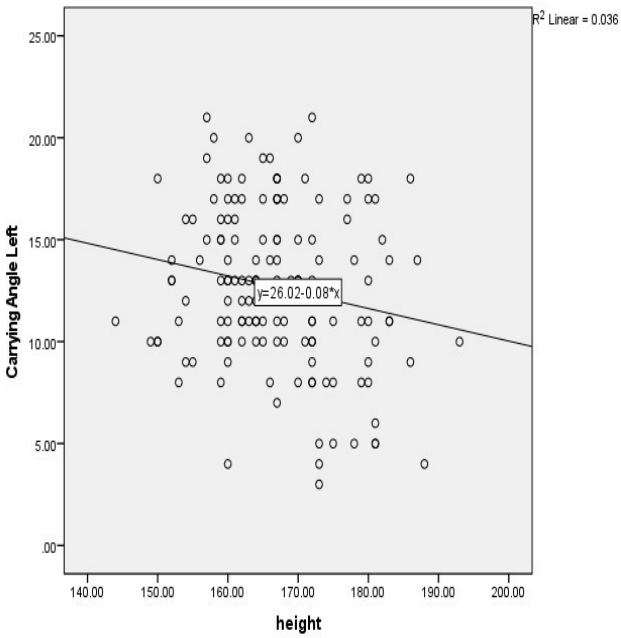

Figure no. 1: Correlation between Carrying Angle of Right Elbow and Height.

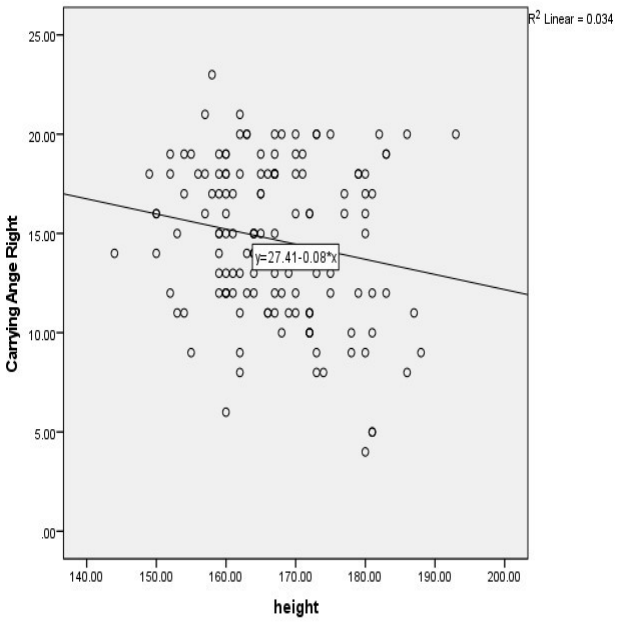

Figure no. 2: Correlation between Carrying Angle of Left Elbow and Height

DISCUSSION

A study conducted by Rajesh B et al., on evaluation of the CA of the elbow joint in the juvenile concluded that an average carrying angle of 13.6° in females and 6.7° in males. However, our study observed a mean carrying angle of 15.4° in females and 13.7° in males. The slight discrepancy warrants further exploration, particularly in terms of demographic differences between the two studies.[8] A similar study was conducted by Ahmed SK et al., on Determination of Carrying Angle of Elbow Among Adult Pakistani Population. The study with 500 participants from Indus Hospital, Karachi, found a mean carrying angle in females (14.4°) similar to this research. However, the mean carrying angle in males (9.5°) differed from this research.[16]

Another study performed by Sadacharan CM et al., on Carrying angle of the elbow joint in young Caucasian and Indian American population. A descriptive cross-sectional study performed on 200 students, concluded that females had larger CA than males similar to this research as shown in table 7.4. Both the studies have similar age groups consisting of young adults.[17]

An Anthropometric Study of Carrying Angle and other Parameters in Young Adults of Kathmandu, Nepal by Yadav SK et al., also showed that females had greater carrying angle values than in males. Both the method of measurement of carrying angle and age group of participants were same in both researches.[18]

Hypothesizing a gender-related carrying angle difference linked to pelvis width, our study found no correlation between carrying angle and pelvic circumference. In contrast, a study conducted by Chinweife KC et al., on Correlation of Carrying Angle of the Elbow in Full Extension and Hip-Circumference in Adolescents of Nnewi People in Anambra State reported a significant correlation between elbow CA and waist circumference in both genders. Both studies used the same measurement methods for CA and pelvic circumference.[19] In the present research height and carrying angle were negatively correlated similar to the study conducted by Nayak S et al., on relationship of carrying angle with grip strength and anthropometric measurements in young adults.[20]

Another study conducted by Verma V et al., on Correlation between morphometric measurements and carrying angle of human elbow showed a positive association between carrying angle and height, weight and other

morphometric measurements. No weight-carrying angle correlation was found in this study, in contrast to a negative height-carrying angle correlation. Unlike the previous research showing a negative correlation between carrying angle and BMI, this study found no such correlation. The data difference may be attributed to the age gap, as the previous research focused on children up to 15 years old.[21]

A study conducted by Nejat DR et al., on Kyphosis and Carrying Angle: Prevalence and correlation between anthropometric features showed carrying angle was positively associated with height and weight but in this research there was no correlation of CA with weight and an Inverse relationship between carrying angle and height. Both the studies were performed on young adults.[22]

A study conducted by Chakrabarti S et al., on Carrying angle and its correlation to height in young adult males and females showed that carrying angle was inversely proportional to height. The results were significant with this research that is carrying angle was negatively correlated to height. The only difference in both the studies is the age group, the former study was performed on age group 17 to 19 years.[23]

Existing literature on BMI and carrying angle shows inconclusive evidence-some studies report positive correlation, while others find no significant relationship. In our study, no correlation existed, in contrast to study conducted by Efe OJ et al., on Correlation between BMI and CA among adolescents in Abraka Nigeria, which showed a weak positive correlation. The studies differ in correlation results, sample size, and age group.[11]

Similar study performed on adolescents by Ansari MA et al., on Evaluation of the CA of the elbow joint in adolescents and its correlation with BMI, gender and dominant side showed significant positive correlation between BMI and CA of both sides. The findings are not consistent with present study, which found no correlation between CA and BMI.[24] In one of the study performed by Kabir MA et al., on Correlation Between BMI and CA Among Bangladeshi Adult Population concluded a negative association between BMI and carrying angle.

CONCLUSION

The findings of this study revealed no significant relationship between the carrying angle and BMI. However, a notable negative correlation was observed between the carrying angle and height. No significant correlation was found between the carrying angle and either weight or pelvic circumference.

LIMITATIONS

1. Hormonal factors might contribute to shaping the correlation between the carrying angle and the variables under study.
2. The impact of hand dominance on the carrying angle has not been explored in our investigations.

SOURCE OF FUNDING

None

CONFLICT OF INTEREST

None

AUTHOR'S CONTRIBUTION

DJ: Research Proposal, Manuscript, Data Collection, Result Writing

SP: Supervision of project, Guidance, Data Analysis and Result Writing

MMA: Review of Article, Guidance

RT: Guidance (Project)

LJ: Data Collection, Discussion Writing

FZ: Data Collection, Discussion Writing

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