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Effects of Carrying Angle on Hand Grip Strength Among Undergraduate Students of the Sarhad Institute of Allied Health Sciences, Sarhad University of Science and Information Technology, Peshawar: An Analytical Cross Sectional Study

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Carrying angle, hand grip strength, hand span, forearm diameter, universal goniometer, dynamometer, measuring tape

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ABSTRACT

The Carrying Angle (CA), also known as acute angle or cubital angle, is the angle between the humerus and the forearm. Carrying angle maintains a distance between the forearm and the pelvis during arm movement while walking, as well as plays an important role in grasping and holding objects securely. CA determines the normal anatomical and biomechanical alignment of the elbow. Males have an average CA ranging from 5-10 degrees, while females tend to have slightly greater CA, falling between 10-15 degrees. Hand Grip Strength (HGS) is the total strength exerted by the flexor muscles in the palmer, thenar and hypothenar regions of the hand. The CA and HGS hold significant importance in assessing upper extremity, shoulder and forearm function. HGS not only indicates hand functions but also guides treatment plans, requiring coordination among fingers, wrist, forearm, pre-scapular and shoulder muscles for optimal performance and functional outcomes. An analytical cross sectional study was conducted in Peshawar, Pakistan. This study included undergraduate students at Sarhad University, Peshawar, ages between 18-30 years. The sampling technique used was non-probability convenience sampling. The sample size was determined using an online calculator Rao Soft and sample size was 332. The data was collected through a self-generated questionnaire and physical assessment. Hand grip strength was evaluated using a hand-held dynamometer and the carrying angle was measured using a universal goniometer. Additional parameters, such as hand span, forearm length and forearm diameter, were assessed using a measuring tape to determine their relationship with carrying angle. The findings revealed a significant negative association (R-value=-0.492) between hand grip strength and carrying angle, indicating that hand grip strength decreased as the carrying angle increased. Additionally, a negative correlation (R-value=-.336,) was also seen between carrying angle and hand span, as well as a negative correlation (R-value=-.209,) between carrying angle and forearm diameter. Our research study concludes that there was negative correlation between carrying angle with hand grip strength, hand span and forearm diameter in the undergraduate students of SIAHS. Whereas carrying angle had no significant effect on forearm length.

INTRODUCTION

The upper limb is crucial for daily activities like reaching, grasping, lifting and manipulating objects, ranging from self-care tasks to complex activities such as typing or participating in sports. The elbow joint, a complex synovial joint, connects the hand, wrist and shoulder, facilitating gripping and fine motor[1]. It is primarily a hinge joint formed by the humerus, radius and ulna, allowing only flexion and extension[2].

Carrying Angle (CA): The carrying angle (CA) is formed between the longitudinal axis of the humerus and the deviated forearm when the elbow is extended and supinated[9,10]. It is typically 5-10 degrees in males and 10-15 degrees in females[18]. Changes in CA can lead to complications like cubitus valgus (over 15 degrees) or cubitus varus (below 5 degrees)[6]. Larger CAs are associated with a reduction in grip strength and a higher risk of ulnar nerve entrapment and instability during physical activities[22].

Hand Grip Strength (HGS): HGS is the total strength generated by the hand muscles, indicating upper extremity function. It involves coordination among fingers, wrist, forearm and shoulder muscles[17]. Grip strength typically declines after midlife and varies by gender, with men having higher HGS compared to women[3-5]. It is often used as a marker for health conditions like frailty, cardiovascular diseases, and sarcopenia. Lower HGS is linked to diabetes, hypertension and mortality, as well as social and behavioral factors such as depression and insomnia[25].

Clinical Relevance: CA and HGS play vital roles in evaluating upper extremity function and can guide treatment strategies in clinical settings.

Literature Review: In May 2023, a correlational descriptive study was conducted by Subhasmita Nayak and team in India to determine the relationship between carrying angle with hand grip strength. 203 participants (female 121 and male 82) aged between 18 and 30 years, both genders years, were included as per the inclusion and exclusion criteria. Carrying angle was measured by goniometer and grip strength was measured by handheld dynamometer[8]. Anthropometric data like forearm length and hand span were measured by the measuring tape respectively and Statistical analysis was performed using IBM Statistical Package for Social Sciences (SPSS) version 26. Spearman's correlation test showed that carrying angle was negatively correlated with grip strength (r=-0.18., <0.05) and forearm length (r=-0.14.,p<0.05) on the left side but no significant correlation on the right side. Body height and carrying angle have negative correlation on the right (r=-0.20, p<0.05) and left sides (r=- 0.23, p<0.05). As the carrying angle increases, grip strength decreases. The height and length of the forearm were inversely related to the carrying angle. Grip strength was directly proportional with forearm length and hand span[18]. This study was conducted by Lavanya K, Swapnali Shamkuwar, Vasudha Kulkarni Akash in 2023 Institute of Medical Sciences and Research Center, Bangalore, India. In this cross-sectional study involving 80 participants aged 18 to 30 years, the carrying angle, grip strength and subcutaneous fat percentage were measured using a goniometer, dynamometer and skin fold calipers, respectively[11,13-16]. Mean and standard deviation for each parameter were calculated based on gender, laterality and age and comparisons were made using T tests. ANOVA was employed to establish correlations between variables, with a significance level set at p<0.05. The results revealed an inverse relationship between carrying angle, subcutaneous body fat percentage and hand grip strength. The study concludes that cubitus valgus was associated with various conditions, including elbow ligament injuries, fractures, osteoarthritis and neuromuscular disorders[24]. A descriptive study was conducted in Egypt. The main objective of this study was to investigate the relation between the carrying angle and hand grip strength in normal healthy children. 370 Normal Healthy Children of both sexes with mean of age 15-18 years examined in different schools[19,20,21]. The Carrying angle was assessed by Digital goniometer on both sides (Dominant and non-Dominant) and hand grip strength was assessed by a Hand Held Dynamometer, forearm length and forearm diameter were measured by tape measurement. For data analysis SPSS 19 was utilized. The results showed that there was a statistical significant negative correlation between carrying angle and hand grip strength in dominant and non-dominant sides and negative correlation between carrying angle and forearm length and that there is no relation between carrying angle and forearm diameter in boys[11].

MATERIALS AND METHODS

Study Design: Analytical cross-sectional study.

Study Setting: Data collection for this research was done among the undergraduate students of Allied Health Sciences, Sarhad University of Science and Information Technology, Peshawar.

Study Population: Undergraduate students of Sarhad Institute of Allied Health Sciences.

Study Duration: The study was conducted over a period of 6 months (February 2024 - August 2024).

Sample Size: The sample size was calculated using the Raosoft software. The total population of SIAHS was

2390 and the calculated sample size was 332. The sample size collected was 332 (Fig.1).

Fig.1: Small Size Showing by Raosoft Software

Sampling Technique: sNon-probability convenience sampling technique.

Sample Selection: Participants were enrolled in the study based on the following criteria:

Inclusion Criteria:

- Both male and female.
- Age between 18-30 years.
- Undergraduate students of SIAHS.

Exclusion Criteria:

- All the staff members of SIAHS.
- Age below 18 and above 30 years.
- Students with musculoskeletal disorders, amputation, nerve palsy, fracture of upper limb, or cervical radiculopathy.
- Recent road traffic accident affecting the upper limb.

Assessment Tools:

- Universal Goniometer.
- Hand Held Dynamometer.
- Measuring Tape.

Data-Collection-Procedure: After obtaining approval from the research committee of our institute (Sarhad University, Peshawar). Afterwards Permission was taken from director of concern department and the class teacher to collect data. Once our inclusion criteria were met we distributed a consent form and self-generated questionnaire to the students, which included 2 different sections. A Demographic section, which included name, age, gender, height, weight, dominant hand as well as past injury to the dominant limb and the physical assessment section included measurements of Carrying Angle, Hand Grip Strength, Hand Span, Forearm Diameter and Forearm Length. Once the consent form and the demographic data was completed we continued with the physical assessment.

Data-Analysis-Procedure: The collected data was analyzed using SPSS (Statistical Package for the Social Sciences). Correlation and descriptive statistics, including associations, frequencies, means and standard deviations, was used to represent the data, along with graphs to display the distribution of the participants and their age.

RESULTS AND DISCUSSIONS

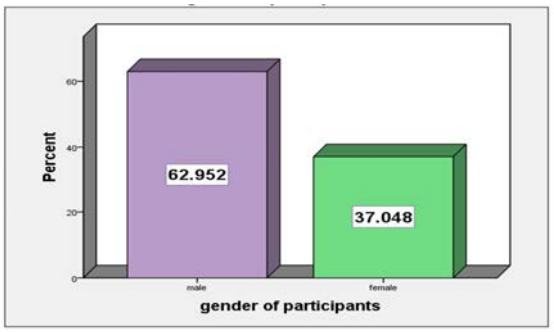

Fig. 2: Gender of Participants

This bar graph shows the total number of participants divided by gender. From the sample of 332, 62.9% were males while females where 37.04%. Total number of males was 208 and total number of females was 123 (Fig. 2).

Table 1: Age of Participants

	Frequency	Percent	Cumulative	Percent
Valid	18-23 years	297	89.5	89.5
	24-30 years	35	10.5	100.0
	Total	332	100.0	

Age groups were divided on the basis of class boundary. We saw that among 332 participants, 297 were falling in the age group between 18-23 years. While only 35 individuals were falling in the age group of 24-30 years (Table 1).

Table 2: Correlation Between Carrying Angle and Hand grip Strength

		carrying angle	hand grip strength in kgs
carrying angle	Pearson Correlation	1	-.492**
	Sig. (1-tailed)		.000
	N	332	332
hand grip strength in kgs	Pearson Correlation	-.492**	1
	Sig. (1-tailed)	.000	
	N	332	332

Pearson correlation was used and the p value came up to be 0.000 which is less than level of significance of 0.05. This indicates that there is a correlation present between carrying angle and hand grip strength (Table 2).

Table 3: Correlation between Carrying Angle and Hand Span

		carrying angle	hand span in inches
carrying angle	Pearson Correlation	1	-.336**
	Sig. (1-tailed)		.000
	N	332	332
hand span in inches	Pearson Correlation	-.336**	1
	Sig. (1-tailed)	.000	
	N	332	332

Pearson correlation was used and the p value came up to be 0.000 which is less than level of significance of 0.05. This indicates that there is a correlation present between carrying angle and hand span (Table 3).

Table 4: Correlation between Carrying Angle and Forearm Length

		carrying angle	forearm length in inches
carrying angle	Pearson Correlation	1	-.066
	Sig. (1-tailed)		.116
	N	332	332
forearm length in inches	Pearson Correlation	-.066	1
	Sig. (1-tailed)	.116	
	N	332	332

Pearson correlation was used and the p value came up to be 0.116 which is greater than level of significance of 0.05. This indicates that there is no significant correlation present between carrying angle and forearm length (Table 4).

Table 5: Correlation Between Carrying Angle and Forearm Diameter

		carrying angle	forearm diameter in inches
carrying angle	Pearson Correlation	1	-.209**
	Sig. (1-tailed)		.000
	N	332	332
forearm diameter in inches	Pearson Correlation	-.209**	1
	Sig. (1-tailed)	.000	
	N	332	332

Pearson correlation was used and the p value came up to be 0.000 which is less than level of significance of 0.05. This indicates that there is a correlation present between carrying angle and forearm diameter (Table 5).

Supporting Study: Our research included 332 participants, we discovered a significant negative correlation between carrying angle and hand grip strength among undergraduate students at the Sarhad Institute of Allied Health Sciences (SIAHS) in Peshawar. In May 2023, a correlational descriptive study was conducted by Subhasmita Nayak and team in India to determine the relationship between carrying angle with hand grip strength. 203 participants aged between 18 and 30 years. The results showed that carrying angle was negatively correlated with grip strength, as the carrying angle increases, grip strength decreases[23].

Contradicting Study: Our research included 332 participants., we discovered that there was no correlation between carrying angle and forearm length among undergraduate students of SIAHS. In September 2021, a descriptive study was conducted by Mohamed N. Eldein Hassan and team in Egypt. 370 Normal Healthy Children, of age 15-18 years examined in different schools through digital Goniometer. The results show negative correlation between carrying angle with forearm length in both genders[26-28]. The contradiction was the change in population and Assessment tools used.

CONCLUSION

Our research study concludes that there is a negative correlation between carrying angle with hand grip strength, with hand span and with forearm diameter in the undergraduate students of SIAHS. Whereas carrying angle has no significant effect on forearm length. No correlation was seen in age and carrying angle. These findings have important implications for understanding how anatomical variations influence physical performance and could be valuable in fields such as ergonomics, sports science and physical therapy.

Limitations:

- Due to limited resources and time we opted for an analytical cross-sectional study.
- It was a Single setup study.
- Non availability of the tools that were needed for data collection.
- There was a lack of cooperation from teachers and participants during data collection.

Recommendations:

- Future researchers should carry out a Longitudinal study on this topic.
- In the future, a multiple set up should be carried out
- The availability of advanced and updated equipment should be ensured.
- Awareness programs should be held to maintain the ideal carrying angle, through different exercises.

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