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An examination of carrying angle of students in Madonna University, Elele, Port Harcourt, Rivers State, Nigeria

Abstract

Background: The carrying angle is defined as the acute angle made by the median axis of arm and median axis of forearm in full extension and supination. This angle permits the forearms to clear the hips in swinging movements during walking and is important when carrying is a small degree of *Cubitus valgus*, formed between the axis of a radially deviated forearm and the axis of the humerus. This study was aimed at examining the carrying angle of male and female students of Madonna University Nigeria.

Materials and methods: The study comprised a total number of 200 subjects (100 male, 100 female), ages between 16 -25years. The carrying angle was measured using digital vernier caliper and compass while height, hip and waist circumference were measured using measuring tape.

Results: Age=21±2.59 years (Male), 20.37±3.00 years (Female); Hip Circumference=90.95±6.63cm (Male), 90.67±8.65cm (Female); Right Carrying Angle=9.31±1.67° (Male), 9.75±2.26° (Female); Left Carrying Angle=8.99±1.53° (Male), 9.58±2.10° (Female); Height=181.09±4.76cm (Male), 175.08±8.34; Waist Circumference=79.72±6.53cm (Male), 82.13±5.85cm (Female). In male subjects, Right Carrying angle can be predicted from other measured parameters as follows [H; RCA=0.1728 (H)-21.991] with a prediction accuracy of 24%; Left Carrying Angle [H; LCA=0.1023 (H)-9.5289] with a prediction accuracy of 10% while in females, Right Carrying Angle can be predicted from other parameters as follows [H; RCA=0.116 (H)-10.559] with a prediction accuracy of 18%; Left Carrying Angle [H LCA=0.1102 (H)-9.7203] with a prediction accuracy of 19%. Independent sample T-test was used to compare differences (sexual dimorphism) in the measured parameters indicated there were significant differences ($p<0.05$) in all the measured parameters.

Conclusion: The study of carrying angle in Madonna students have shown that the males have mean values (right 9.31° and left 8.99°) while the females (right 9.75° and left 9.58°). This has also proved that carrying angle is a useful tool in investigating gender variation in forensics and anthropological studies.

Keywords: carrying angle, hip circumference, waist circumference, height, age

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Introduction

The carrying angle is defined as the acute angle made by the median axis of arm and median axis of forearm in full extension and supination. This angle permits the forearms to clear the hips in swinging movements during walking and is important when carrying is a small degree of Cubitus valgus, formed between the axis of a radially deviated forearm and the axis of the humerus. It helps the arms to swing without hitting the hips while walking. Normally it is 5-15° away from the body or 165-175° towards the body. A decreased carrying angle can result in the forearm pointing towards the body, known as gunstock deformity or cubitus varus.[1–7] In Figures 1 & 2 below, the landmarks in the upper limbs and the axes of carrying angle are shown.

Brief anatomy of the elbow joint

The elbow is a complex synovial joint formed by the articulations of the humerus, the radius and the ulna. The elbow joint is made up of three articulations

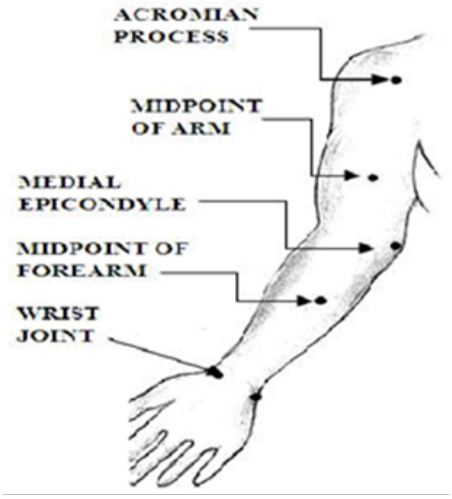

Figure 1 Indicating the landmarks in the upper limbs.[5]

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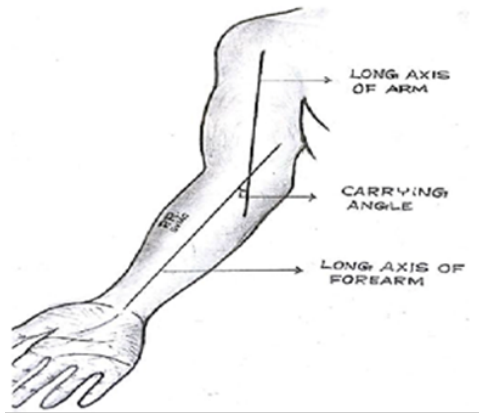

Figure 2 Indicating the landmarks in the the axes of carrying angle.[5]

Radiohumeral: capitellum of the humerus with the radial head

Ulnohumeral: trochlea of the humerus with the trochlear notch (with separate olecranon and coronoid process articular facets) of the ulna

Radioulnar: radial head with the radial notch of the ulna (proximal radioulnar joint)

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]

Movements

The elbow is a trochoginglymoid (combination hinge and pivot) joint.[8]

I. the hinge component (allowing flexion-extension) is formed by the ulnohumeral articulation

II. the pivot component (allowing pronation-supination) is formed by the radiohumeral articulation and the proximal radioulnar joint.[8]

Ligaments

1. medial (ulnar) collateral ligament complex
2. lateral (radial) collateral ligament complex
3. oblique cord: inconstant thickening of supinator muscle fascia and functionally insignificant, runs from tuberosity of the ulna to just distal to radial tuberosity[8]
4. quadrate ligament (of Denuce): thickening of the inferior aspect of the joint capsule and runs from just inferior to the radial notch of the ulna to insert to the medial surface of the radial neck.[8]

Joint capsule

I. The joint capsule has two layers, deep and superficial, and attaches proximally to the radial, coronoid and olecranon fossae. Distally, it attaches to the annular ligament of the radius and coronoid process of the ulna. The volume of the joint capsule is 24–30 mL.[9]

II. There are already works on carrying angle in varied populations.[9–20]

III. There is dearth of information on Nigerian indigenous populations on carrying angle. This study was aimed at examining the carrying angle of male and female students of Madonna University Nigeria.

IV. This study would find relevance in anthropology, forensics and will also serve to create a database for the indigenous populations.

Materials and methods

The study was descriptive and comprised a total number of 200 subjects (100 male, 100 female), ages between 16 -25years. All subjects used for this study were from Madonna University, Elele Rivers State, Nigeria. They were healthy individuals free of congenital or acquired abnormalities, and trauma. Ethical clearance was obtained from the Research Ethics Committee of the Madonna University, Elele, Port Harcourt, Rivers State, Nigeria.

A thorough clinical examination of the elbow region was done by following all the inclusion and exclusion criteria. The carrying angle (CA) was measured using clinical method on both upper limbs. Points were made 5cm above and below in line with the medial epicondyle in the front of arm and forearm. Width of the arm, forearm and wrist were measured with the help of the Digital Vernier Caliper, with the prongs of the caliper just touching the skin without giving any pressure to derive their midpoints. Two axes were drawn, one from acromian process meeting the midpoint in front of arm, another in forearm joining the midpoints in front of forearm and wrist. Both lines were extended so that they intersect nearly in front of the elbow joint and the angle thus formed in the medial aspect represents was measured using a compass.

Results

Distribution of carrying angle and other parameters was done using descriptive statistics, Independent sample T-test guided by Levene's test for Equality of Variance was used to evaluate sex based differences, while Paired sample T-test was used to determine side differences (left and right). Correlation and regression analysis was done, generating a regression equation for estimating the Height of subjects from their Hand parameters. Significance level was set at 95% confidence interval, hence $P< 0.05$ was considered significant. All these were carried out with the aid of the Statistical Package for the Social Sciences (SPSS IBM® ver 23.0) and MS Excel.

In Table 1, the descriptive statistics of hand dimensions were as follows (Age=21$\pm$2.59 years (Male), 20.37$\pm$3.00 years (Female); Hip Circumference=90.95$\pm$6.63cm (Male), 90.67$\pm$8.65cm (Female); Right Carrying Angle=9.31$\pm$1.67^0 (Male), 9.75$\pm$2.26^0 (Female); Left Carrying Angle=8.99$\pm$1.53^0 (Male), 9.58$\pm$2.10^0 (Female). In Table 2, Independent sample T-test was used to compared significant differences (sexual dimorphism) in the measured parameters. Significant differences were found in all the measured parameters. In Table 3, Side differences (left and right) were determined using paired sample T-test. Significant difference was found in male subjects between the right and left carrying angle (t=2.62, P=0.01), but not in female subjects (t=2.02, P=0.05) at $P< 0.05$. In Table 4, there was a strong correlation between carrying angles in males and females with Hip circumference, Waist circumference, Height. In Table 5, a summary of correlation and regression analysis was presented, with a regression equation for estimating the carrying angle of subjects from other parameters (Height, Hip Circumference, Waist Circumference and Age).

Citation: Oladipo GS, Paul JN, Amasiatu VC, et al. An examination of carrying angle of students in Madonna University, Elele, Port Harcourt, Rivers State, Nigeria. *J Appl Biotechnol Bioeng.* 2019;6(2):95–99. DOI: 10.15406/jabb.2019.06.00179

Table 1 Descriptive statistics of the carrying angle of the sampled students

Parameters	MALE (N = 100)				FEMALE (N = 100)				TOTAL (N = 200)			
	Min	Max	Mean	S.D	Min	Max	Mean	S.D	Min	Max	Mean	S.D
Age(years)	17.00	28.00	21.33	2.59	17.00	29.00	20.37	3.00	17.00	29.00	20.85	2.84
Hip Circumference (cm)	75.00	112.00	90.95	6.63	73.50	115.00	90.67	8.65	73.50	115.00	90.81	7.69
Right Carrying Angle (°)	5.00	12.00	9.31	1.67	5.00	17.00	9.75	2.26	5.00	17.00	9.53	1.99
Left Carrying Angle (°)	5.00	12.00	8.99	1.53	6.00	16.00	9.58	2.10	5.00	16.00	9.29	1.86
Height (cm)	170.00	193.00	181.09	4.76	155.00	188.00	175.08	8.34	155.00	193.00	178.09	7.41
Waist Circumference (cm)	60.00	99.00	79.72	6.53	62.00	93.00	82.13	5.85	60.00	99.00	80.93	6.30

N, sample size; Min, minimum; Max, maximum; SD, standard deviation.

Table 2 Determination of sex differences in the measured variables using Independent sample T-test

Parameters	Test for equality of variances			t-test for Equality of means				
		F-value	P-value	M.D	S.E.M.D	df	t-value	*P*-value
Age(years)	EVA	2.53	0.11	0.96	0.40	198	2.42	**0.02****
Hip Circumference (cm)	EVNA	5.98	**0.02****	0.28	1.09	198	0.26	0.80
Right Carrying Angle (°)	EVNA	6.17	**0.01****	-0.44	0.28	198	-1.57	0.12
Left Carrying Angle (°)	EVNA	10.50	**<0.01****	-0.59	0.26	198	-2.27	**0.02****
Height (cm)	EVNA	38.71	**<0.01****	6.01	0.96	198	6.26	**<0.01****
Waist Circumference (cm)	EVA	1.70	0.19	-2.41	0.88	198	-2.75	**0.01****

EVA, equal variance assumed; EVNA, equal variance not assumed; F-value, Fischer's value; P-value, probability value; M.D, mean difference; S.E.M.D, standard error of mean difference; df, degree of freedom; **, Significant; P < 0.05.

Table 3 Determination of side differences using paired sample T-test

Carrying Angle (°)	Sex	Paired Differences		Paired T-test			
		Mean diff	S.D	S.E.M.D	df	t-value	*P*-value
Right vs Left	Male	0.32	1.22	0.12	99	2.62	**0.01****
	Female	0.17	0.84	0.08	99	2.02	0.05

SD, standard deviation; SEMD, standard error of mean difference, diff, difference; df, degree of freedom; P-value, probability value; **, Significant; P < 0.05.

Table 4 Correlation between carrying angle and other parameters in male and female subjects

Parameters		MALE (N = 100)				FEMALE (N = 100)			
		Age(years)	HC (cm)	H (cm)	WC (cm)	Age(years)	HC (cm)	H (cm)	WC (cm)
Right CA (°)	*r*	0.29**	0.43**	0.49**	0.57**	0.39**	0.65**	0.43**	0.57**
	P-value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Left CA (°)	*r*	0.12	0.38**	0.32**	0.45**	0.36**	0.63**	0.44**	0.54**
	P-value	0.22	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

CA, carrying angle; N, number of subjects; HC, hip circumference; WC, waist circumference; H, height; r, pearson correlation; P-value, probability value; **, significant at P < 0.01.

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Table 5 Correlation analysis and regression equation for estimating carrying angle from other parameters

Parameters		Sex	Prediction model			
			r	R^2 (%)	*P*-value	Regression equation
Right CA	H (cm)	Male	0.49	24	<0.01	RCA = 0.1728 (H) - 21.991
		Female	0.43	18	"	RCA = 0.116 (H) - 10.559
	HC (cm)	Male	0.43	19	"	RCA = 0.1086 (HC) - 0.5645
		Female	0.65	43	"	RCA = 0.1708 (HC) - 5.7368
	WC (cm)	Male	0.57	32	"	RCA = 0.1453 (WC) - 2.2771
		Female	0.57	32	"	RCA = 0.2203 (WC) - 8.3467
	Age (years)	Male	0.29	8	0.22	RCA = 0.1869 (A) + 5.3227
		Female	0.39	15	<0.01	RCA = 0.2925 (A) + 3.7928
Left CA	H (cm)	Male	0.32	10	"	LCA = 0.1023 (H) - 9.5289
		Female	0.44	19	"	LCA = 0.1102 (H) - 9.7203
	HC (cm)	Male	0.38	14	"	RCA = 0.0867 (HC) + 1.103
		Female	0.63	39	"	LCA = 0.1526 (HC) - 4.2592
	WC (cm)	Male	0.45	20	"	LCA = 0.1053 (WC) + 0.5931
		Female	0.54	29	"	LCA = 0.193 (WC) - 6.2696
	Age (years)	Male	0.12	2	"	LCA = 0.073 (A) + 7.433
		Female	0.36	13	"	LCA = 0.2525 (A) + 4.437

CA, carrying angle; HC, hip circumference; WC, waist circumference; H, height; r, pearson correlation; R2, coefficient of determination; P-value, probability value

Discussions

The descriptive statistics of the carrying angle of the sampled students showed remarkable features that can be used as markers. Taking into cognizance the age, the mean age in the males was higher than the females. Hip circumference in the males was seen to be higher than the females which contradict the results reported by most researchers on hip circumference. Again, the right and left carrying angles indicated a higher mean value for the females than the males. This is consistent with the reports of several authors.[1,5,6] This difference could be a result of the difference in hormones in the sexes and quantity of adipose tissues in body. The males had higher mean values for height than the females. This again could be attributable to hormonal difference in both sexes. Waist circumference showed a remarkable difference in between the males and females with the females having a higher mean value.

The determination of gender differences using Independent sample t-test showed that there were statistically significant differences in all parameters investigated. This implies that any of these parameters i.e., age, hip circumference, carrying angles (right and left), height and waist circumference could be used to differentiate gender since there is a marked difference between males and females for all the parameters. These findings further buttress the fact that an examination of carrying angles in a forensic investigation, can aid in identifying or classifying victims into male and female were the gender is not initially known which can give a lead to solving the crime. These reports are consistent with the reports of previous authors who have worked on carrying angles.[9,13,16,19]

The regression analysis showed gave an equation for estimating the carrying angle of subjects from other parameters (Height, Hip Circumference, Waist Circumference and Age). In male subjects, Right Carrying angle can be predicted from other measured parameters as follows [H; RCA=0.1728 (H)-21.991] with a prediction accuracy of 24%; [HC; RCA=0.1086 (HC)-0.5645] with a prediction accuracy of 19%; [WC; RCA=0.1453 (WC)-2.2771] with a prediction accuracy of 32%; [Age; RCA=0.1869 (A)+5.3227] with a prediction accuracy of 8%, while for the Left Carrying Angle [H; LCA=0.1023 (H)-9.5289] with a prediction accuracy of 10%; [HC; RCA=0.0867 (HC) + 1.103] with a prediction accuracy of 14%; [WC; LCA=0.1053 (WC)+0.5931] with a prediction accuracy of 20%; [Age; LCA=0.073(A)+ 7.433] with a prediction accuracy of 2%.

The Carrying Angle for the females were also predicted from other parameters (Height, Hip Circumference, Waist Circumference and Age) as assessed. Hence Right Carrying Angle can be predicted from other parameters as follows [H; RCA=0.116 (H)-10.559] with a prediction accuracy of 18%; [HC; RCA=0.1708 (HC)-5.7368] with a prediction accuracy of 43%; [WC; RCA=0.2203 (WC)-8.3467] with a prediction accuracy of 32%; [Age; RCA=0.2925 (A)+3.7928] with a prediction accuracy of 15%, while for the Left Carrying Angle [H LCA=0.1102(H)-9.7203] with a prediction accuracy of 19%; [HC; LCA=0.1526 (HC)-4.2592] with a prediction accuracy of 39%;

[WC; LCA=0.193 (WC)-6.2696] with a prediction accuracy of 29%; [Age; LCA=0.2525 (A)+4.437] with a prediction accuracy of 13%. Therefore the model (regression equation) can predict the carrying of subjects but at a moderate level of accuracy (%), with the highest prediction accuracy [R^2(%)] being 43% (moderate).

Conclusion

The study of the carrying angle in Madonna students have shown that the males have mean values (right 9.31^0 and left 8.99^0) while the females (right 9.75^0 and left 9.58^0). This has also proved that carrying angle is a useful tool in investigating gender variation in forensics and anthropological studies.

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Author's contribution

We write to state that all authors have contributed significantly, and that all authors are in agreement with the contents of the manuscript. 'Author A' (Gabriel S. Oladipo) designed the study and protocol, 'Author B' (John Nwolim Paul) reviewed the design, protocol and examined the intellectual content, Author C' (Valentine C. Amasiatu and Ade Stephen Alabi) wrote the first draft of the manuscript and managed the literature search, 'Author D' (Paulinus Nmereni Amadi) managed the analyses of the study. All authors read and approved the final manuscript.

Conflicts of interest

We write to state that there is no conflicts of interest.

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