Correlation of Carrying Angle of the Elbow in Full Extension and Hip-Circumference in Adolescents of Nnewi People in Anambra State.

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Abstract- The carrying Angle of the elbow is the measurement of varus-valgus angulation of the arm with the elbow fully supinated. This study was aimed at correlating the relationship between carrying angle, waist circumference and hip circumference and the relationship between that of the males and females carrying angle in adolescent Nnewi people. The carrying angles of 900 Nnewi adolescents were measured, 411 were females and 489 were males. The age range of the subjects was between the ages of 10 to 19 years. The carrying angle was measured on both upper limbs with goniometer. Hip and Waist circumference was measured using butterfly tape in inches. The result of this present study shows that right carrying angle and left carrying angle were significantly higher in females (right 13.82 ± 1.65 and left 12.55 ± 1.76) than that of the males (right 12.30 ± 1.88, left 10.99 ± 1.87). The carrying angle also increases with age. The waist-hip ratio of the male (0.82 ± 0.06) is significantly higher than that of the females (0.77 ± 0.06) at the level of 0.05. The right and the left carrying angles correlate significantly with the waist circumference in both gender while the right and left carrying angles correlate significantly with hip circumference in the males but do not correlate significantly in the females.

Index Terms- Carrying Angle, hip circumference, waist circumference, correlation, adolescent and Nnewi.

I. INTRODUCTION

1.1. BACKGROUND OF STUDY

The carrying angle of the elbow is the measurement of varus-valgus angulation of the arm with the elbow fully supinated (Erhan et al 2005). The intersection of the line along the mid-axis of the upper arm and the line along the mid-axis of the forearm defines this angle. The 'carrying angle' is caused partly by projection of the medial trochlear edge 6 mm beyond its lateral edge and partly by the obliquity of the superior articular surface of the coronoid, which is not orthogonal to the shaft of the ulna. Tilt of the humeral and ulnar articular surfaces is approximately equal; hence the carrying angle disappears in full flexion, the two bones reaching the same plane. When the adducted arm is flexed the little finger meets the clavicle, because of the position of the resting humerus; when the humerus is rotated laterally, the hand reaches the front of the shoulder (Standring et al 2005). Till date, the role of carrying angle in sex determination and its cause of formation is a long debated issue in Anatomy and Anthropology. Knowledge of the carrying angle helps in the management of pediatric elbow injuries (Balasubramanian et al 2006), for correction of albitus varus deformity occurring after malunited supracondylar fractures of the humerus (Ruparella et al 2010) and for elbow disorders that require reconstruction. Some workers have reported greater carrying angle for the dominant upper limb (Takenmez et al 2004) and established a relationship with the height of an individual and the intertrochanteric distance (Paraskevas et al 2004). While some other workers refute these facts (Balasubramanian et al 2006; Zampagni et al 2008). Khare et al 1999 argued that the carrying angle is not related to the width of the pelvis and is not a secondary sex character as previously believed. Subsequently, other researchers (Mall 1905 and Tukenmez et al 2004) have all shown the mean female carrying angle to be significantly greater than that of the male.

Anthropometric measurements are a set of non-invasive, quantitative techniques which are comparative in nature (Standring et al 2005), coined by the French naturalist George Cuvier (1769-1832) and were used by Physical Anthropologists in their study of human variability among human races and for comparison of Human to other Primates (Roberts 2006). Different Anthropometric measures or ways of taking Anthropometric measurements exist. These include; height, weight, length, head circumference, chest circumference, waist circumference, hip circumference, percentage of body fat etc. Anthropometric measurements are used in a remarkably wide variety of scientific and technical fields ranging from genetics and nutrition to forensics and industrial designs. Over the years engineers, designers, architects etc. have increasingly recognized the need for anthropometric measurements and have also incorporated it into their field of practice.

II. MATERIALS AND METHOD

2.1 Scope of study

This study was delimited to apparently healthy male and female in secondary schools adolescents aged 10 – 19 years in Nnewi with no history or current sign of musculoskeletal injuries in the upper limbs or hip. Cases of cubitus valgus and varus was noted. The parameters measured include; carrying angle, hip circumference and waist circumference.

2.2 Population of Study

The data were collected from Nnewi indigenes, who are males or female Adolescent (10 – 19 year) and whose father is an indigene of Nnewi. The study was carried out in St. Joseph's secondary school, St. Philip's secondary school, Nneoma memorial secondary school, Okongwu memorial secondary

school, Maria Regina secondary school and Nigeria Science and Technical secondary school all in Nnewi north local government area and in Ebenator village in Nnewi south local government area.

Nnewi is the second largest city in Anambra State in south eastern Nigeria. Nnewi as a metropolitan city encompasses two local government areas, Nnewi North and Nnewi South; Nnewi North is commonly referred to as Nnewi central, and comprises four autonomous quarters: Otolo, Uruagu, Umudim, and Nnewi-ichi. Nnewi North also includes Ichi, an autonomous neighbouring town.
As of 2006, Nnewi has an estimated population of 391,227 according to the Nigerian census. The city spans over 1,076.9 square miles (2,789 km^2) in Anambra State. Nnewi Metropolitan Area and its satellite towns is a home to nearly 2.5 million residents as of 2005. Dimensionally, Nnewi has an edge over all other units, being recognized by the 1953 figures as the largest inland town of all others in the Eastern states (Nigeria census 2006).

2.3 Sample size

This study was carried out on nine hundred (900) Nnewi adolescents. 489 males and 411 females of between 10 – 19 years of age.

2.4 Inclusion criteria

- Male and female adolescents between the age range 10 -19 year.
- Male and female adolescents who are indigenes of Nnewi and are willing to participate.
- Male and female adolescent without any congenital upper limb deformity or any obvious elbow deformity.
- Male and female participant without any loss of their upper extremities.

2.5 Exclusion criteria

- Participants that have lost one or both of their upper limbs.
- Pregnant, wheelchair bound and unstable participants.
- Participants with left limb dominance.

2.6 Research Instruments

 (i) A flexible tape rule (Butterfly brand, China): This instrument was used for measuring the participant's waist and hip circumference in inches.

 (ii) A universal goniometer: This instrument was used for measuring the Participants Carrying angle.

2.7 Procedures for data collection

Before the commencement of this study ethical approval was sought and obtained from the Ethical review committee of the Nnamdi Azikiwe University, Basic Medical Sciences, Nnewi. I then seek the informed consent of the principals of the selected schools as well as the parents or guardians of the participants I met in their homes.

The research procedure was explained to the participants, and all those unwilling to participate were free to decline.

i. **Waist circumference (inches):** This measurement was carried out with the subject standing erect, both feet together and abdomen relaxed. Ensuring that the participants shirt are not too thick and tight belts around the waist are loosened and He/ She is breathing normally, I then stood behind the participant, in order to locate the narrowest part of their trunk. I then place the measuring tape around the narrowest part of their trunk, in a horizontal plane around the body. I pull the tape measure lightly with the left hand until appropriate tension is achieved and then counter this movement with the right hand. With the tape measure in position between the lowest rib and the superior border of the iliac crest, in the mid axillary line, loose enough to let my finger pass between the rule and the participant's skin. The waist circumference was then read at the end of gentle exhaling and recorded to the nearest 0.1inch.

ii. **Hip circumference (inches):** This was measured over the maximal protrusion of the buttocks. I ensured that the participant was standing relaxed without bending with feet as close together as possible. I measured the hip circumference ensuring that it is horizontal and not too tight so as to compress or pinch the skin and took my reading around the trunk at the greatest protrusion of the buttocks to the nearest 0.1inches.

iii. **Measurement of Carrying Angle(degrees)**

- I asked the subject to stand up straight, roll his shoulders back and gently rotate his palms to face forward.
- I straightened the goniometer and move the two arms into a straight line so that the readout on the plate shows 0 or 180 degrees.
- I placed the goniometer's measurement plate at the fulcrum of one elbow and line one arm of the goniometer along the middle of the subject's upper arm then swing the goniometer's other arm along until it lines up along the middle of the subject's forearm.
- I recorded the angle from the readout on the measurement plate and subtract the measurement from 180 if your initial readout was 180 degrees. For example, if

the straight goniometer read 180 and it read 170 fitted to the subject's elbow, then the subject's carrying angle is 180 -170 = 10 degrees.

- I repeated the process with the other elbow and record the carrying angles for both elbows, recorded from which arm each measurement was taken.

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2.8 Method of Data Analysis

The data from this study was summarized with SPSS version 16.0 using descriptive statistics of mean and standard deviation, and analyzed using the Pearson's Correlation. Level of significance shall be set at 0.05.

III. RESULT

TABLE 1: MEAN±STANDARD DEVAITION OF THE MEASURED PARAMETER WITH RESPECT TO AGE.

AGE	No	Carrying Angle		Hip Circ (inches)	Waist Circ (inches)
		Right	Left		
10	17	11.06±1.64	9.76±1.437	28.22±2.73	23.54±0.80
11	31	12.00±2.03	10.71±2.224	31.54±3.70	25.58±2.80
12	67	12.28±2.10	10.91±2.109	31.26±3.18	25.33±1.99
13	132	12.99±1.89	11.58±1.985	31.90±3.52	25.86±2.03
14	140	12.97±1.99	11.76±2.020	33.38±3.28	26.58±2.42
15	108	13.05±1.82	11.82±1.923	33.65±3.38	26.79±2.23
16	149	13.18±1.81	11.81±1.897	34.68±3.43	27.13±2.29
17	121	13.23±1.92	11.84±1.761	34.98±3.09	27.15±2.39
18	94	13.33±1.78	12.18±1.843	35.81±3.26	27.97±2.67
19	41	13.54±1.91	12.39±1.986	36.10±3.55	28.35±3.07
Total	**900**	**12.99±1.93**	**11.70±1.978**	**33.68±3.72**	**26.71±2.51**

The table 1 above shows mean±standard deviation of Right and Left Carrying Angle, Hip Circumference, Waist Circumference, Weight and Height with respect to age (in years) and overall mean± standard deviation of each parameter.

For people aged 10 years, the total number measured was 17, their mean ± standard deviation of their (carrying angle was 11.06±1.64 for right and 9.76±1.437 for the left), hip circumference measured in inches was 28.22±2.73, waist circumference 23.54±0.80. For people aged 11 years, the total number was 31, their mean ± standard deviation of their (carrying angle was 12.00±2.03 for right and 10.71±2.224 for the left), hip circumference measured in inches was 31.54±3.70, waist circumference 25.58±2.80.

For people aged 12 years, the total number was 67, their mean ± standard deviation of their (carrying angle was 12.28±2.10 for right and 10.91±2.109 for the left), hip circumference measured in inches was 31.26±3.18, waist circumference 25.33±1.99.

For people aged 13 years, the total number was 132, their mean ± standard deviation of their (carrying angle was 12.99±1.89 for right and 11.58±1.985 for the left), hip circumference measured in inches was 31.90±3.52, waist circumference 25.86±2.03.

For people aged 14 years, the total number was 140, their mean ± standard deviation of their (carrying angle was 12.97±1.99 for right and 11.76±2.020 for the left), hip

circumference measured in inches was 33.38±3.28, waist circumference 26.58±2.42.

For people aged 15 years, the total number was 108, their mean ± standard deviation of their (carrying angle was 13.05±1.82 for right and 11.82±1.923 for the left), hip circumference measured in inches was 33.63±3.38, waist circumference 26.79±2.23.

For people aged 16 years, the total number was 149, their mean ± standard deviation of their (carrying angle was 13.18±1.81 for right and 11.81±1.897 for the left), hip circumference measured in inches was 34.68±3.43, waist circumference 27.13±2.29.

For people aged 17 years, the total number was 121, their mean ± standard deviation of their (carrying angle was

13.23±1.92 for right and 11.84±1.761 for the left), hip circumference measured in inches was 34.98±3.09, waist circumference27.15±2.39.

For people aged 18 years, the total number was 94, their mean ± standard deviation of their (carrying angle was 13.33±1.78 for right and 12.18±1.843 for the left), hip circumference measured in inches was 35.81±3.26, waist circumference 27.97±2.67.

For people aged 19 years, the total number was 41, their mean ± standard deviation of their (carrying angle was 13.54±1.91 for right and 12.39±1.986 for the left), hip circumference measured in inches was 36.10±3.55, waist circumference 28.35±3.07.

TABLE 2: CORRELATION BETWEEN THE PARAMETERS

CORRELATION	MALES		FEMALES	
	Coefficient	Sig	Coefficient	Sig
HC vs LCA	0.132[*]	0.003	0.049	0.319
HC vs RCA	0.097[*]	0.032	0.019	0.700
HC vs WC	0.691[**]	0.000	0.698[**]	0.000
WC vs LCA	0.168[**]	0.000	0.097[*]	0.049
WC vs RCA	0.136[**]	0.003	0.106[*]	0.032

* correlates significantly at the 0.05 level.
** correlates significantly at the 0.01 level.

The table 2 above and figures below shows the correlations of Carrying Angle (right and left) with other parameters such as; Hip Circumference and Waist Circumference in males and females respectively.

In males, the correlations of Hip Circumference versus Left Carrying Angle and Hip Circumference versus Right Carrying Angle are significantly positive at the 0.05 level. The correlations of Hip Circumference versus Waist circumference, Waist circumference versus left carrying angle, Waist circumference versus right carrying angle is significantly positive at the 0.01 level. The correlation of weight versus right carrying angle is significant.

In females, the correlations of Hip Circumference versus left carrying angle, of Hip Circumference versus right carrying angle is not significantly positive. The correlation of Hip Circumference versus waist circumference and height versus left

carrying angle are significantly positive at 0.01 level. The correlations of waist Circumference versus left carrying angle, Waist Circumference versus right carrying angle is significantly positive at 0.05 level.
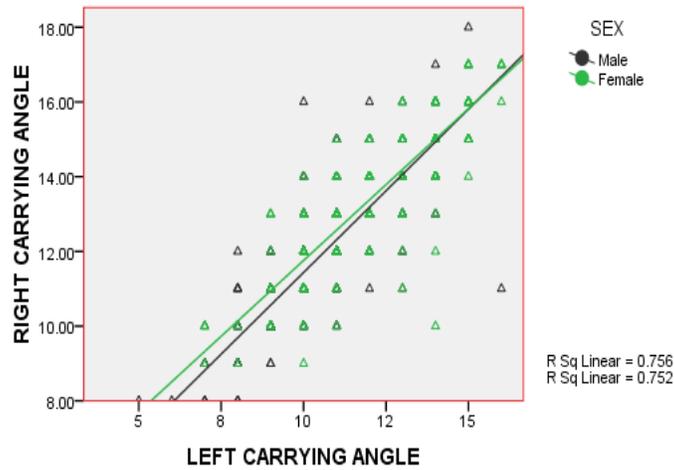
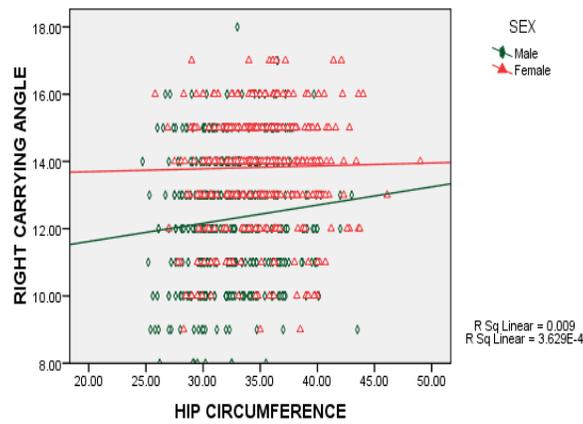**Fig 1: Correlation of right and left carrying angle for both males and females.**

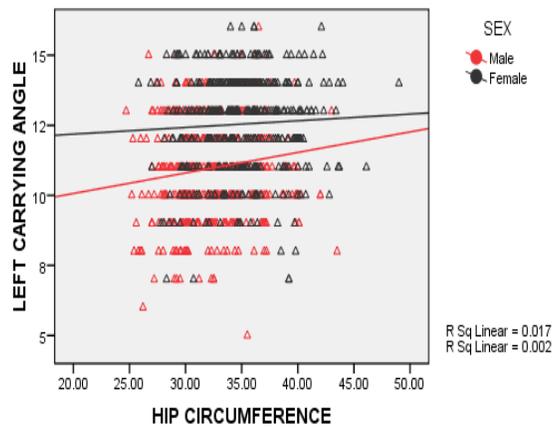**Fig.2: Correlation of right carrying angle hip circumference.**

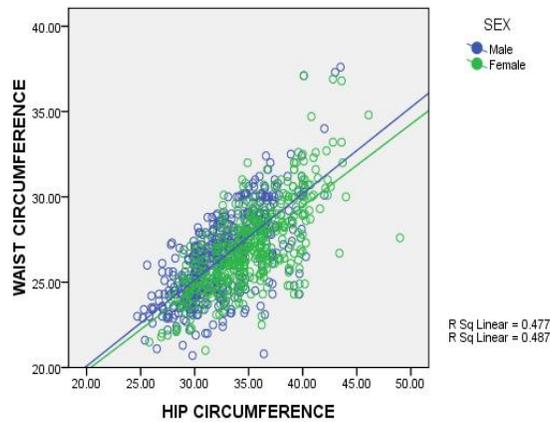**Fig.3: Correlation left carrying angle and hip circumference.**

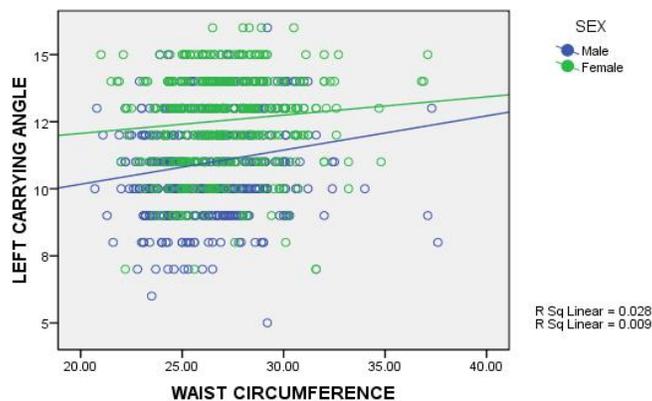**Fig.4: Correlation of waist and hip circumference.**

Fig. 5: Correlation of left carrying angle and waist circumference.

TABLE 3: Mean±Standard Deviation Carrying Angles, Hip Circumference, Waist Circumference, Waist-Hip Ratio, Body Mass Index and Age in Males and Females.

Independent Samples Test				
Parameters	Males (N=489)	Females (N=411)	t-value	Sig.
RTCA	12.30º ±1.88º	13.82º ±1.65º	-12.830	0.000
LFTCA	10.99º ±1.87º	12.55º ±1.76º	-12.803	0.000
HC(inches)	32.53±3.37	35.06±3.64	-10.802	0.000
WC(inches)	26.41±2.47	27.06±2.51	-3.905	0.000
WHR	0.82±0.06	0.77±0.06	10.164	0.000
AGE	14.92±2.22	15.15±2.16	-1.606	0.109

In table 3 above, the Right Carrying Angle (RTCA=12.30º ±1.88º), Left Carrying Angle (LFTCA10.99º ±1.87º), Hip Circumference (HC=32.53±3.37), Waist Circumference (WC=26.41±2.47). The waist-hip ratio (WHR=0.82±0.06) of the males is significantly higher than that of the females.

IV. DISCUSSION

4.1 DISCUSSION

The study of carrying angle and its relation to age, length of fore arm and sex have been carried out by many researchers. Most work done on carrying angle focused on it being a secondary sex determinant.

The present study is set at the statistical significant of ($P \leq 0.05$). My study shows that the males have mean carrying angle of 12.30º±1.88º for the right and 10.99º ±1.87º for the left, while the females have 13.82º ±1.65º for the right and 12.55º ±1.76º for the left respectively. These concur with the research done by other researchers which states that the female carrying angle is

greater than that of the males (Udoaka and Oghenenavwe 2009; Kumar et al 2010; potter 1895; Eliakim et al 2010; Chien Wei et al 2008; Bernardo et al 2011 and Tukenmez et al 2004), especially the work done by Keats et al (1966), which had a more similar result with the mean carrying angle of the males 11.0° and the females 13.0°.

The present study deals with the measurement of the carrying angles and its correlations with the hip circumference, waist circumference and with respect to the sex and age of an individual. Ruparelia et al (2010), reported that the greater value of female carrying angle is because they are shorter than the males but this study revealed that Adolescent males (with 1.5918±0.12 cm) in Nnewi had lower heights than their female (with 1.5919±0.20 cm) counterparts. This agrees with the findings of Rogol et al (2000), who proposed that female adolescents are slightly taller than their male counterparts at pubertal age. Yet the females still maintain a higher value of carrying angle.

Eliakim et al (2011), reported that carrying angles of the Igbos are 17.63±0.25 and 15.05±0.24 for right and left sides respectively in males and 18.67±0.35 and 16.64±0.33 for females. Their values are higher than that of the present study.

In table 2, it was shown that in males, the correlations of Hip Circumference versus Left Carrying Angle, Hip Circumference versus Right Carrying Angle and weight versus left Carrying Angle are significant at the 0.05 level. The correlations of Hip Circumference versus Waist circumference, Waist circumference versus left carrying angle, Waist circumference versus right carrying angle is significant at the 0.01 level. In females, the correlations of Hip Circumference versus left carrying angle, of Hip Circumference versus right carrying angle is not significant. The correlations of waist Circumference versus left carrying angle is significant at 0.05 level.

From the results in table 3, it was also shown that male adolescents in Nnewi also had a significantly lower waist circumference and hip circumference than the females, in concord with findings of Senbanjo et al (2009), which found that males had smaller hip circumference than the females.
Table 1 shows that the carrying angle, hip circumference and waist circumference increase with age in Nnewi adolescent.

4.2 CONCLUSION

According to this study carrying angle, hip circumference and waist circumference are higher in female adolescent of Nnewi than in their male counterpart. The waist and hip circumference directly proportional to the carrying angles and correlates significantly. There was also considerable increase of these parameters with age. Carrying angle and hip circumference may be considered a secondary sex characteristic.

4.3 RECOMMENDATIONS

In view to the result of this study, the following recommendations are made:

Future study should be done using a larger sample size and a large society.

Hip circumference should be correlated with other sex determinants.

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