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Somatotype Characteristics of the Igala Adolescents' from Kogi State, North-Central Nigeria

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Abstract

Adolescence is a life's most critical periods that are marked with rapid changes in body size, composition, and shape. These changes can be better explored through an investigation of somatotype. This paper was aimed at investigating the somatotype characteristics of adolescent Igala ethnic group of Kogi State in the context of sex- and age- related variations. A total number of 405 apparently healthy adolescent subjects comprising 203 males and 202 females were randomly selected and somatotyped. Standiometer and precision weighing scale were used to measure height and weight respectively, Luftin flexible tape to measure girths (arm and calf), Harpenden skin fold calliper to measure skin folds and Small sliding calliper to measure bone breadths. The study protocol was approved by the Ethical Committee on Human Research of Ahmadu Bello University, Zaria. The somatotype component ratings, the somatotype attitudinal distance (SAD) and somatocharts were computed using the somatotype calculation and analysis software. A somatotype analysis of variance (SANOVA) which compares the somatotype of each group by using the somatotype attitudinal

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distances within and between the groups was used to test the significance of gender differences. A MANOVA analysis was used to assess the significance of age differences in somatotypes. The mean somatotype for the males was 2.06-4.55-3.03 (ectomorphic-mesomorph) while that of the females was 3.88-4.10-2.34 (endomorphic mesomorph) and they were significantly different (F=122.85, p<0.001). The one-way MANOVA analysis indicated a significant effect of age on mean somatotypes in boys, as well as in girls. There were notable sex differences in the somatotypes of adolescents, with girls being significantly more endomorphic and boys being more mesomorphic and ectomorphic. In both sexes, the somatotype did not show significant changes from early adolescence to late adolescence. More studies, especially longitudinal ones, are necessary to better understanding of somatotype variations during adolescence.

Keywords: Adolescents, Kogi State, Somatotype, Somatotype Software.

INTRODUCTION

Adolescence is defined as the period between 10 and 19 years (WHO, 2015) and is a life's most critical periods that are marked with rapid changes in body size, composition, and shape (Tanner, 1970). These changes in body size, composition and shape can be better explored through an investigation of somatotype. A somatotype is basically a three number descriptor of the size-dissociated shape of an individualrepresenting the components of endomorphy (fatness), mesomorphy (musculoskeletal development) and ectomorphy (leanness). The concept of somatotype was originally given by Sheldon and coworkers (Sheldon *et al*., 1940). Initially developed as a photoscopic technique, somatotyping as a method has undergone several modifications (Carter and Heath, 1990). The Heath and Carter anthropometric somatotype technique has higher reliability and feasibility and has now become the most widely applied methods in the world for estimating somatotype (Heath and Carter, 1967; Reis *et al*., 2007; Choi *et al*., 2013; Liiv *et al*., 2013). Because of its simplicity and uniqueness, somatotyping has attracted the attention of researchers from a wide variety of disciplines such as human biology, physical anthropology, sports sciences, medicine, psychology, etc.

Somatotyping technique has been used to study and contrast the body types of different sports men at various competition levels (Battista *et al*., 2007). It has also been used to describe physique changes during growth (Gaur *et al*., 2008, 2014), pathological conditions (William *et al*., 2000; Koleva *et al*., 2002; Eiben *et al*., 2004; Kalichman *et al*., 2004; Buffa *et al*., 2007; Yadav *et al*., 2007), ageing (Gakhar and Malik, 2002; Bhasin and Jain, 2007), as well as in relation to nutrition (Bolonchuk *et al*., 2000; Koleva *et al*., 2000; Chakrabarty *et al*., 2008), physical activity (Ozener and Duyar, 2008),sex (Buffa *et al*., 2005; Chandel and Malik, 2012; Gaur *et al*., 2014), socioeconomic differences (Rahmawati *et al*., 2004; Singh, 2011).

It is essential to study age related changes among children, particularly during the pubertal phase. Previous studies have reported that somatotype changes in children can provide important information for understanding their growth patterns, the timing, and rate of sexual maturation (Toselli *et al*., 1997; Claessens *et al*., 2000).Growth studies in adolescents can also provide information regarding adult physique variation and can be used to compare and contrast physique patterns in a different population (Malina *et al*., 2004). Kalichman *et al*. (2005) have also reported that there is a possible clinical benefit in studying the association between somatotype, health conditions and nutritional status.

In a large and multiethnic country like Nigeria, body shape is likely to vary from region to region and from population to population. Studies treating the somatotype characteristics of children or adolescents in Nigeria are generally sparse. Goon *et al*. (2013) have reported the somatotypes of rural children and adolescents of Andibila, Benue State, Nigeria. However, no information to the best of our knowledge is available on the somatotypes of adolescent Igala ethnic group of Kogi State. This article is aimed at investigating the somatotype characteristics of adolescent Igala ethnic group of Kogi State, North Central Nigeria in the context of sex- and age- related variations.

METHODOLOGY

Study area

Igala is one of the ethnic groups in Kogi state and the natives are specifically located east of the Benue confluence and river Niger and Benue confluence and straddling the Niger in Lokoja, with Idah as its headquarters. The area coverage is approximately 13665 sq.km and lies between longitude 6° 30 and 7° 40 east and latitude 6° 30 and 8° 40 north. Their population has been shown to be over 2 million. The Igala can also be found in Anambra, Delta, Edo and Enugu states of Nigeria. Their economic life revolves around agriculture, tapping of palm wine for sells and consumption and fishing especially amongst the riverine Idah people. Staple diets of the people include rice, yam, cassava, plantain, and seasonal vegetables. Public servants, schoolteachers, and merchants comprise the population. The people's social life is characterized by traditional ceremonies such as burials, births, coronation and marriages and other festivities alike. Health and social amenities are available.

Data collection

This cross sectional-study consisted of 405 Igala adolescents (202 girls and 203 boys) aged 13 -19 years. Only the apparently healthy subjects present in the school at the time of the research in March 2017 were recruited for the study. Informed consent was obtained from the children's parents or guardians as the case may be and permission was obtained from the various school's concerned. The Ethics Committee on Human Research, Ahmadu Bello University Zaria endorsed the study protocol.

Data for the present investigation were collected from five secondary schools of three distinct Local Government Area (LGA): Dekina, Anyigba, and Ankpa of Kogi State, Nigeria. Information about the dates of birth of the subjects was obtained from the school records and the subjects were grouped into seven age groups, of one year each, using age mid-points as shown in table 1. In each case, the following parameters were measured - height, weight, biepicondylar breadth of the humerus and femur, contracted arm girth and calf girths, and skinfolds thickness (triceps, subscapular, medial calf and supraspinal). Standard anthropometric tools following the procedures as outlined by the International Society for the advancement of kinanthropometry (2001) was employed for the data collection. Standiometer and precision weighing scale were used to measure height and weight respectively, Luftin flexible tape to measure girths (arm and calf girths), Harpenden skin fold calliper to measure skin folds (tricep, subscapular, supraspinal and medial calf skin folds), and Small sliding calliper to measure bone breadths (biepcondylar breath of humerus and femur).

Statistical analysis

The somatotype component ratings, the somatotype attitudinal distance (SAD) and somatocharts were computed using the somatotype calculation and analysis software (Carter, 2002). Descriptive statistics were calculated for height, weight, the three somatotype components, viz. endomorphy, mesomorphy, and ectomorphy. A somatotype analysis of variance (SANOVA) which compares the somatotype of each group by using the somatotype attitudinal distances (SAD) within and between the groups was used to test the significance of gender differences. Chi-square test was used to check for associations between somatotype categories based on sex. The significance of age differences in somatotypes was assessed with the help of MANOVA analysis that used Wilk's Lambda as test statistics (Cressie *et al*., 1986) with Scheffe's Post Hoc. All statistical analyses were performed with Statistical Product and Service Solutions (SPSS) version 23.0 and the significance level was set at $p<0.05$.

RESULTS

Table 1 and 2 displays the statistical details of height, weight, endomorphy, mesomorphy and ectomorphy for the adolescent Igala boys and girls of Kogi State, North Central, Nigeria. It can be seen from the tables and figure 1 (A) and f2 (A) figure hat height and weight showed a general increase with age. The maximum increase in height was noted from 13 to 14 years (7 cm) in girls and from 13 to 14 years in boys (6 cm). In weight, the maximum gain was recorded from 13 to 14 years (7 kg) in boys and from 13 to 14 years in girls (8 kg).

Table 1: Descriptive statistics for height, weight and somatotype components of the male subjects

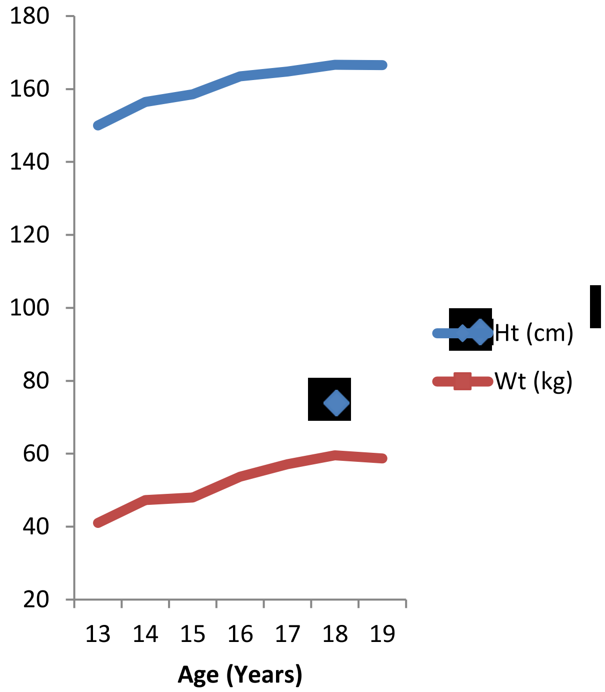
Age Group		Height (cm)		Weight (kg)		Endomorphy		Mesomorphy		Ectomorphy	
	N	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
13	10	150	2.89	41	8.46	2.05	0.425	4.27	0.86	3.38	1.53
14	8	156	2.61	47	8.94	2.39	0.636	4.21	1.46	3.25	1.63
15	25	158	2.29	48	7.01	1.94	0.395	4.27	1.01	3.44	1.14
16	40	163	2.25	53	6.12	1.94	0.410	4.60	0.96	3.20	0.95
17	70	164	2.21	57	7.93	2.09	0.712	4.70	1.12	2.87	1.05
18	29	167	1.83	60	5.28	2.18	0.791	4.71	0.18	2.73	1.20
19	21	167	1.77	59	6.38	2.05	0.483	4.74	0.80	2.89	1.18

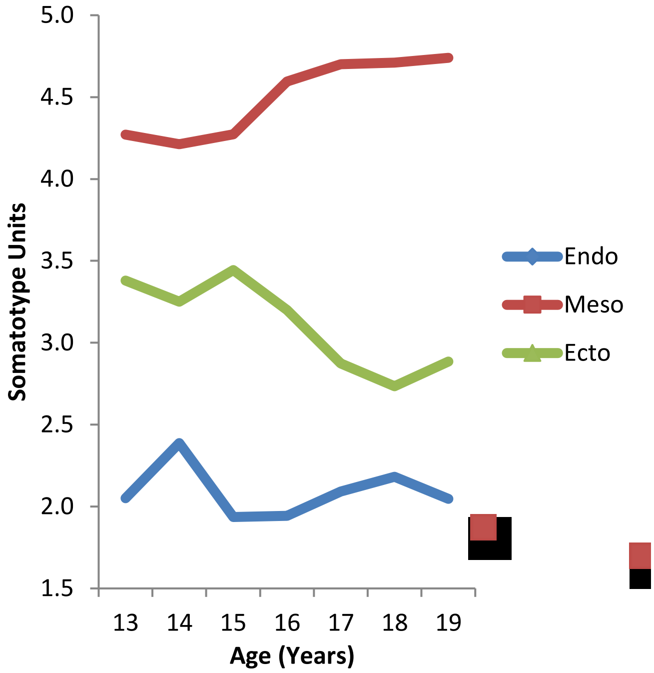
N: Frequency; SD: Standard deviation

Table 2: Descriptive statistics for height, weight and somatotype components of the female subjects

Age Group		Height (cm)		Weight (kg)		Endomorphy		Mesomorphy		Ectomorphy	
	N	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
13	24	151	16.32	44	6.32	3.45	6.32	3.72	0.95	2.89	2.89
14	27	157	3.96	51	3.96	3.81	3.96	3.94	1.12	2.61	2.61
15	45	157	6.24	53	6.24	3.87	6.24	4.02	1.19	2.29	2.29
16	52	159	5.88	55	5.88	3.98	5.88	4.14	1.40	2.25	2.25
17	36	159	6.76	55	6.76	4.01	6.76	4.25	1.16	2.21	2.21
18	12	157	7.14	56	7.14	4.09	7.14	4.73	1.08	1.83	1.83
19	6	158	4.10	56	4.10	4.10	4.10	4.52	0.96	1.77	1.77

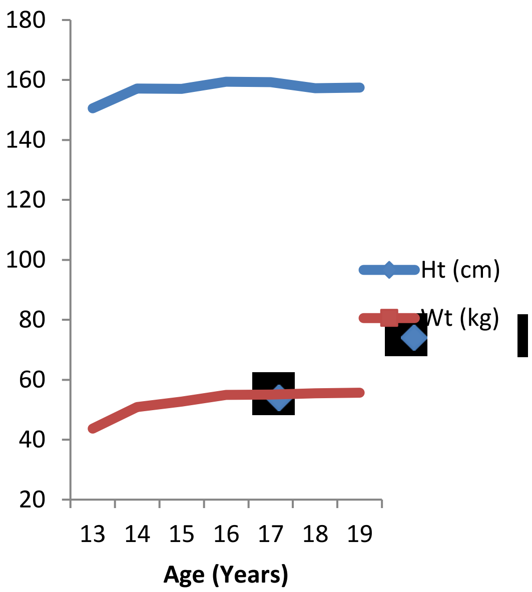
N: Frequency; SD: Standard deviation

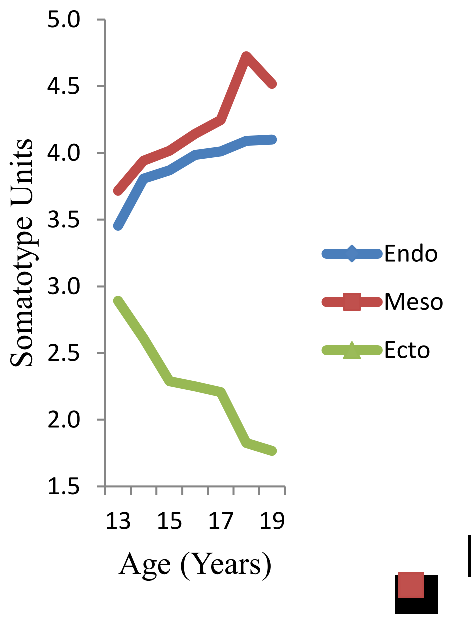




A **B**

Figure 1: (A) Age trends in mean height (Ht)* and weight (Wt)* of the male subjects
(B) Age trends in mean endomorphy (Endo), mesomorphy (Meso) and ectomorphy (Ecto)* of the male subjects (*p<0.05)





A **B**

Figure 2: (A) Age trends in mean height (Ht)* and weight (Wt)* of the female subjects (B) Age trends in mean endomorphy (Endo), mesomorphy (Meso) and ectomorphy (Ecto) of the female subjects (*p<0.05)

Figures 1 (B) and figure 2 (B) shows the age trends of the three somatotype components. As is evident from tables 1 and 2, the age trends of various somatotype components were variable, in both sexes. From 14 to 18 years, the mean endomorphy among boys showed a marginal decrease of 0.21 units. On the other hand, in females, there was a general trend towards an increase in mean endomorphy with the advancement of age. In females, the mean endomorphy increased from 3.45 units at 13 years to 4.10 units at 19 years, thus recording a total gain of 0.65 units.

In boys, there was a general trend towards an increase in mean mesomorphy with the advancement of age. The mean mesomorphy increased from 4.27 units at 13 years to 4.74 units at 19 years, thus recording a total gain of 0.47 units. In females, the mean mesomorphy, in general, increased up to 18 years and decreased thereafter. From 13 to 18 years, the girls showed an overall gain of 1.01 units in mean mesomorphy. Ectomorphy in boys declined from 13 years up to 18 years and increased thereafter. From 18 to 19 years, the boys showed an overall gain of 0.16 units in mean ectomorphy. In girls, there was a clear trend towards a decrease in ectomorphy with age increase. From 13 to 19 years, the ectomorphy registered a total decline of 1.04 units in girls.

Figure 3 is a somatochart presenting the somatotype distribution of both male and female subjects respectively. In the somatochart of the males, the bulk of the somatotypes means clustered on the North Axis with few in the North East and South East Axis of the boundary of the somatochart. Also, On the Somatochart, is the profile marker inside an empty circle which represents the mean somatotype for all the profiles in the document. Thus, the mean somatotype for all the male profiles was ectomorphic-mesomorph (2.1-4.6-3.03). For the females, the majority of the somatotype means clustered on the North Western Axis with few on the South Western Axis of the boundary of the somatochart. Hence the mean somatotype for all the female profiles was endomorphic-mesomorph (3.88-4.10-2.34).

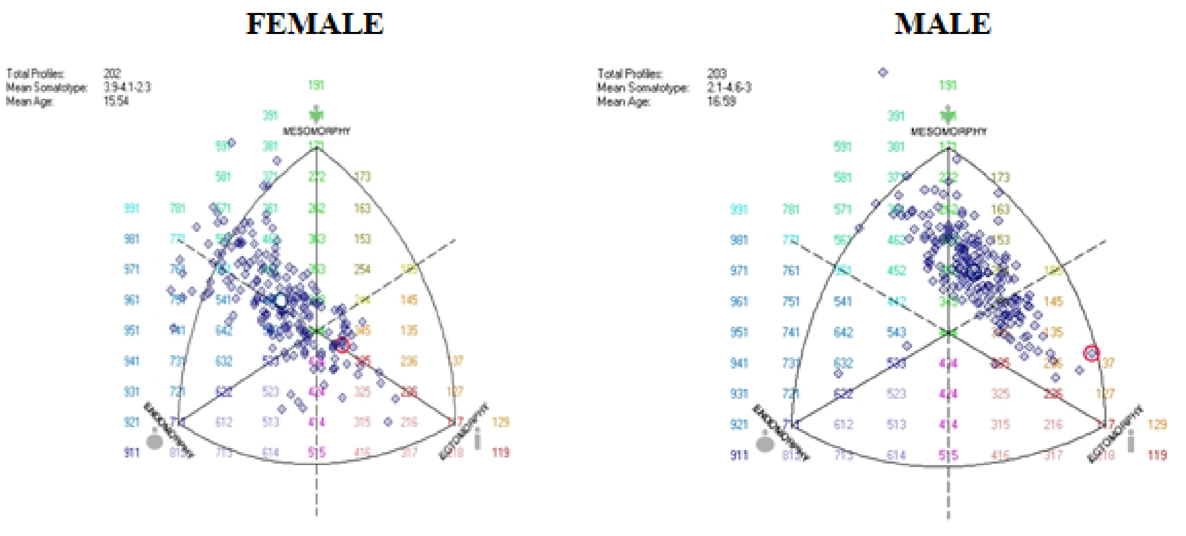


Figure 4: Somatotype distribution of the female and male subjects

The somatotype analysis of variance (SANOVA) table for the overall population which compares the somatotype of each group by using the somatotype attitudinal distances (SAD) within and between the groups is presented in table 4. The females had a moderate endomorphic rating of 3.88, while males had a low rating (2.06). The males, on the other hand, had moderate mesomorphic (4.55) and ectomorphic ratings (3.03) which were greater than the ones in females (mesomorphic=4.10 and ectomorphic 2.34). There was a statistically significant difference in the somatotypes of both male and female subjects (F= 122.85, p< 0.001).

Table 3: Somatotype analysis of variance (SANOVA) for the female and male subjects

Group	Frequency	Mean	Standard Deviation
Female	202	3.88-4.10-2.34	0.90-1.20-1.24
Male	203	2.06-4.55-3.03	0.61-1.06-1.14
ANOVA	F=122.85	P< 0.001	

ANOVA: Analysis of variance

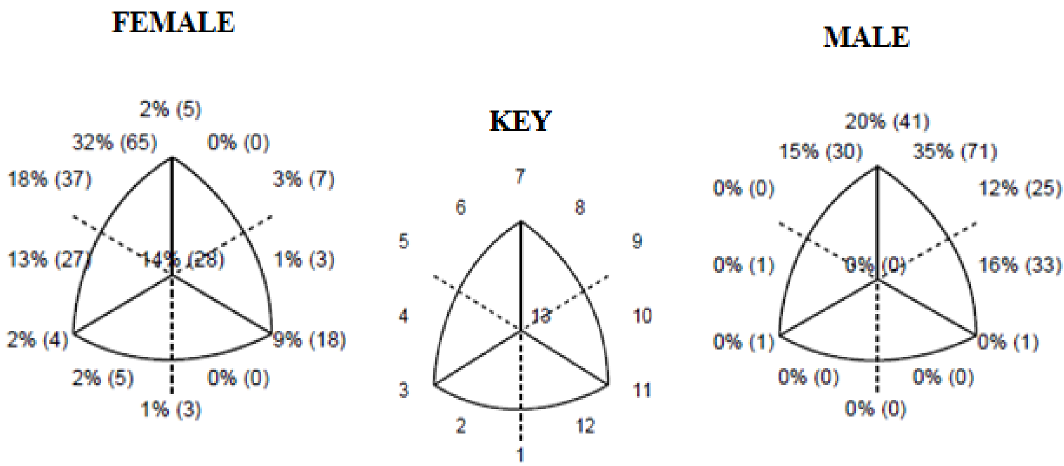


Figure 4 is category chart showing the percentage/frequency profile of the major somatotype categories. Eight major somatotype categories for the males: balanced-endomorph (1), mesomorphic endomorph (1), endomorphic-mesomorph (30), balanced-mesomorph (41), ectomorphic-mesomorph (71), mesomorph-ectomorph (25), mesomorphic-ectomorph (33) and balanced ectomorph (1). Females, on the other hand, had eleven categories: endomorph-ectomorph (3), ectomorphic endomorph (5), balanced endomorph (4), mesomorphic endomorph (27), mesomorph-endomorph (37), endomorphic mesomorph (65), balanced mesomorph (5), mesomorph-ectomorph (7), mesomorphic ectomorph (3), balanced ectomorph (18) and central (28).

Comparison of somatotype categories according to sex presented in figure 5. There was a statistically significant association between male and female subjects based on the somatotype categories (*$\chi^2 = 261.346$, $p < 0.001$).*

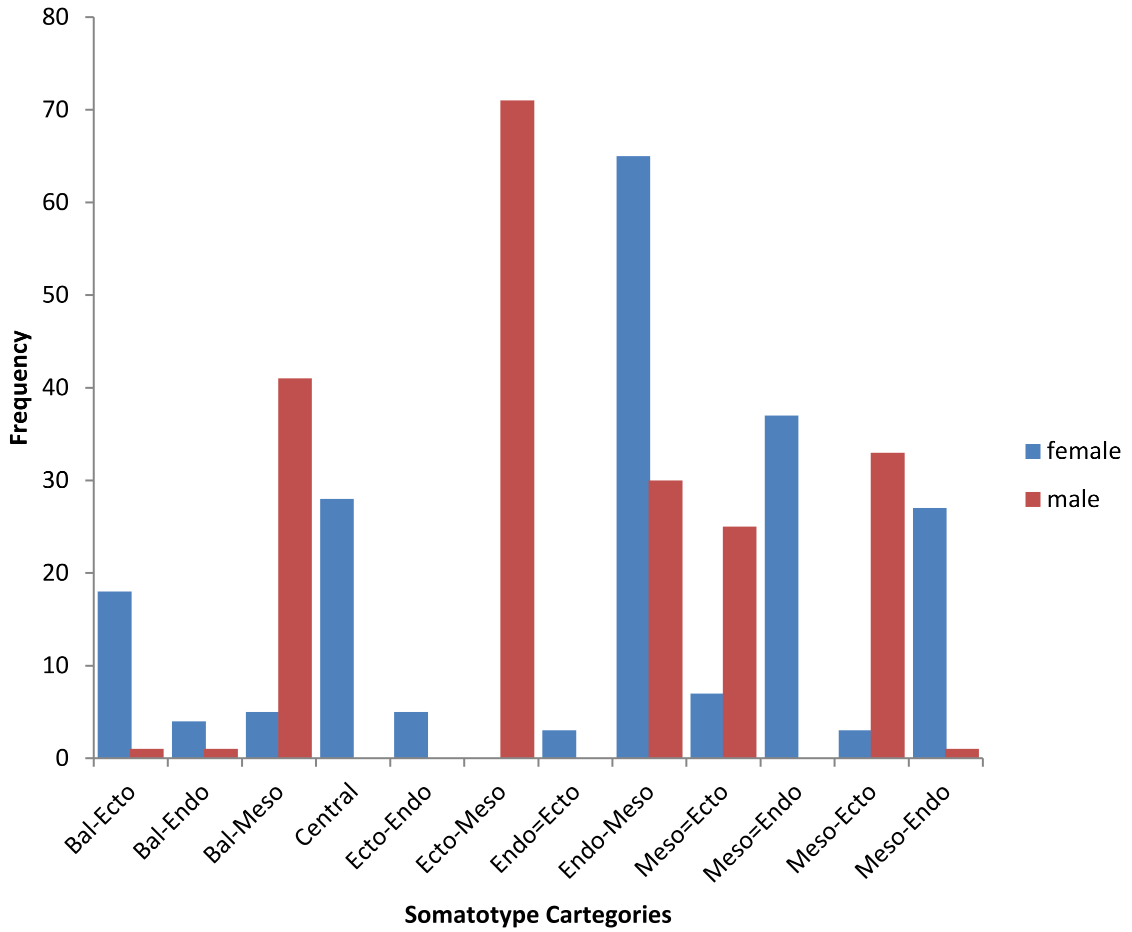


Figure 5: Comparison of somatotype categories according to sex (χ^2 = *261.346,* * $p < 0.001$

To see the effect of age, according to sex, on various parameters, a MANOVA analysis with Scheffe's Post Hoc procedure was done. Table 4 and 5 contains the results of the analysis. In the case of boys, the F-value (F 30, 766) for the test (Wilk's Lambda = 0.593) was 3.586 and partial eta squared= 0.099 which was highly significant (P<0.05). In girls also, the F-value of the test (F 30, 766) for the test (Wilk's Lambda = 0.681) was 2.571 and partial eta squared= 0.074 which was highly significant (P<0.05). Hence the MANOVA analysis has proven the significant effect of age on various parameters in boys, as well as in girls. The table also displays the F-values for the effect of age on various dependent variables. In the case of boys and girls, the F-values for endomorphy, mesomorphy, and ectomorphy were not significant (P>0.05), indicating the least effect of age. Height and weight, however, showed significant F-values (P<0.05) in both sexes. Scheffe's Post Hoc tests for multiple comparisons did not reveal significant differences between various age groups for endomorphy, mesomorphy and ectomorphy among boys and girls. However, in boys as well as in girls, the differences were significant (P<0.05) for height and weight for the majority of age groups.

Table 4: Effects of age on height, weight, somatotype components among male Igala adolescents

Dependent variable	Wilks' Lambda	F	Df	Sig.	Partial eta squared
Overall	0.593	3.586*	30, 770	0.001*	0.099
Height (cm)	-	9.098*	6, 196	0.001*	0.218
Weight (cm)	-	16.418*	6, 196	0.001*	0.334
Endomorphy	-	1.047	6, 196	0.396	0.031
Mesomorphy	-	.965	6, 196	0.450	0.029
Ectomorphy	-	1.543	6, 196	0.166	0.045

*$P < 0.05$; F: analysis of variance; Df: Degree of freedom; Sig: Significant level

Table 5: Effects of age on height, weight, somatotype components among female Igala adolescents

Dependent variable	Wilks' Lambda	F	Df	Sig.	Partial eta squared
Overall	0.681	2.571*	30, 766	0.001*	0.074
Height (cm)	-	6.803*	6, 195	0.001*	0.173
Weight (cm)	-	9.413*	6, 195	0.001*	0.225
Endomorphy	-	1.295	6, 195	0.261	0.038
Mesomorphy	-	1.296	6, 195	0.261	0.038
Ectomorphy	-	1.724	6, 195	0.117	0.050

*$P < 0.05$; F: analysis of variance; Df: Degree of freedom; Sig: Significant level

DISCUSSION

The mean somatotype of the adolescent Igala ethnic group of Kogi State was ectomorphic-mesomorph (2.1-4.6-3.03) for males and endomorphic mesomorph for females (3.88-4.10-2.34). When compared with age-matched samples of Andibila males and females of Benue State by Goon *et al*. (2013), whose mean somatotypes for male and female werefound to be mesomorph-ectomorph (1.20-2.41-2.58) and mesomorph-ectomorph (1.36-2.16-2.67) respectively, adolescent Igala are more endomorphic, mesomorphic and ectomorphic. Similarly, Gaur*et al*. (2014) on the somatotype of Rajput adolescents in India found the mean somatotypes as a whole to be 3.45-2.48-4.63 (endomorphic-ectomorph) for girls and 1.61-3.20-4.38 (mesomorphic-ectomorph) for boys and these are dissimilar with the present studies. Also, Malcom (1970) on Manus boys and girls of New Guinea found their mean somatotypes to be ectomorphic mesomorph and balanced mesomorph respectively. The somatotype of Chinese boys and girls was found to be ectomorphic mesomorph and central respectively (Jiand Oshawa, 1996). The morphological variations seen may be attributable to some measure of genetic factors, nutrition, geographical location, physical activities, hormonal and other sociocultural or environmental factors.

In the present studies, the female Igala adolescents had a moderate endomorphic rating i.e., obese physique with large deposits of subcutaneous fat while the males, on the other hand, had a low ratings which implies marked lean physique with minimum subcutaneous fat. This findings is consistent with the general understanding that females of the human species have more fatness than males (Forbes, 1987; Frisancho, 1981; Malina *et al.*,1988; Pavlovsky and Kobyliansky, 1997; Kalichman and Kobyliansky, 2006). Girls tend to have more subcutaneous fat at all ages and the differences in fatness between boys and girls become more pronounced during adolescence (Roemmich and Rogel, 1995; Rolland-Cachera, 1995; Jurimae and Jurimae, 2001; Gaur *et al*., 2014). The traditionally stereotypical roles played by females though not empirical should not be discarded as it might be associated with their nutrition and physical activities. The girls while they remain at home to perform domestic chores which are less physically demanding, might have a propensity to eat more than the boys, thus increasing their endomorphic components. The males had moderate mesomorphic ratings significantly greater than their female counter parts and this denotes moderate bone mass plus moderate bone diameters relative to stature. This is in keeping with the general pattern of boys having greater average muscle mass at all ages than girls (Roemmich and Rogel, 1995; Rolland-Cachera, 1995; Gaur *et al*., 2008; Arce *et al.,* 2012). The boys are more involved in physically demanding jobs such as cutting firewood, farming and helping to rear domestic animals, these may tend to account for the high mesomorphy in them.

Similarly, the ectomorphic ratings in males were a moderate one as compared with their female counterpart (low rating). This characterizes the males as having little mass relative to stature plus relatively elongated limb segments while the females as having greater mass relative to stature. In contrast with these finding Carter and Heath (1990) and several other researchers (Rebato *et al*., 1996; Kalichman and Kobyliansky, 2006; Goon *et al*., 2013; Gaur *et al.,* 2014) did not find a significant difference in ectomorphy between boys and girls. The disparity observed could stem from ethnic differences, genetics, nutrition, hormonal and environmental influence, type of study and methodological inconsistencies.

Thus, sex differences in somatotype relate to its three basic components: endomorphy, mesomorphy, and ectomorphy. Generally, males are more mesomorphic and ectomorphic, and less endomorphic than females, from preschool ages through to young adulthood (Malina *et al*., 2004). Variations in different components during adolescence can be translated in terms of growth and development in humans that characterize changes in size and shape relative to time (Cameron, 2012).

The one-way MANOVA analysis indicated a significant effect of age on mean somatotypes in boys, as well as in girls. However, F-test did not show significant age differences in the dominant somatotype components from 13 to 19 years in both sexes. In congruent with the present finding, several other researchers have also reported no significant changes in component dominance during growth (Claessens *et al*., 1986; Bhasin and Singh, 1991; Singh and Singh, 1991). Contrastingly, some studies have shown significant changes in component dominance during growth from early to late adolescence (Singh and Sidhu, 1980; Eiben, 1985; Rebato *et al*., 1996; Tamazo-Ravnik, 1996). In a recent longitudinal study on Belgian children and adolescents, Hebbelinck *et al*. (2005) demonstrated the instability of somatotype. Thus the evidence is still inconclusive and needs further exploration.

CONCLUSION AND RECOMMENDATION

There were notable sex differences in the somatotypes of adolescents, with girls being significantly more endomorphic and boys being more mesomorphic and ectomorphic. In both sexes, the somatotype did not show significant changes from early adolescence to late adolescence. More studies, especially longitudinal ones, are necessary to better understand somatotype variations during adolescence.

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