Nigerian Journal of Biochemistry and Molecular Biology
23 (2): 30 - 34, 2008. ISSN 0189-4757
Available online at http://www.njbmb.researchjournals.org

Changes in Alkaline Phosphatase Activity During Adolescence in an Urban and Suburban Localities in Abia State, Nigeria

*Ifeoma I. Ijeh and D. Orieke.
Dept of Biochemistry, Michael Okpara University of Agriculture,
Umudike, Umuahia, Abia State, Nigeria
Corresponding Author Email: ijehirene@yahoo.com

ABSTRACT

The study investigated variations in alkaline phosphatase activity during adolescence in Ohafia and Umuahia (suburban and urban localities respectively) in Abia State, South Eastern Nigeria. Males (123) and females (112) aged between 9 and 16 years were recruited for the study. Peak alkaline phosphatase activities (68.59±26.31 IU/L and 57.33 ± 26.55 IU/L for males and females respectively) were observed at 14yrs of age in the suburban locality studied. In the urban locality peak alkaline phosphatase activity (79.28 ± 9.63 IU/L) was observed at 15yrs of age in males while their female counterparts had peak alkaline phosphatase activity (68.21±16.29 IU/L) at 12yrs. Mean heights at which peak alkaline phosphatase activities were observed in the suburban locality were 1.46±0.10 and 1.57±0.05m for males and females respectively, while in the urban locality studied peak heights were 1.56±0.05 and 1.48±0.05 for males and females respectively. Alkaline phosphatase activity was significantly ($P \leq 0.05$) higher in urban males at ages 10 and 15 than in their suburban counterparts. Among the females alkaline phosphatase activities were significantly ($P \leq 0.05$) higher at 10, 12, 13 and 16 years of age in urban residents relative those resident in the suburban locality. Our findings are indicative that using peak alkaline phoshatase activity (a biochemical index of growth spurt in adolescents) males and females in Ohafia had peak growth spurt at age 14yrs. Females in Umuahia had peak growth spurt at age 12yrs, while their male counterparts had theirs at age 15yrs. The paper discusses the implications of these findings *vis a vis* adolescent nutrition and lifestyle in the two localities studied.

Key words: Adolescents, alkaline phosphatase, growth spurt.

INTRODUCTION

Adolescent growth spurt accounts for approximately 25% of adult height and 50% of adult weight and peak bone mass achieved at this period depends on both genetic and environmental factors.(Matkovic, 1992). Adolescent growth spurt has been reported by several workers to occur approximately 2years later in boys than in girls (Zemel and Jenkins 1989). Growth is not a continuous process but proceeds as a series of small growth spurts that vary in amplitudes and frequency. (Lamp and Johnson, 1996).

Alkaline posphatase is present in all tissues of the body but occurs at particularly high levels in the intestinal epithelium, kidney tubules, bone (osteoblasts), liver and placenta. It is closely associated with the calcification process in bone. The relative contributions of bone and liver isoenzymes to the total activity of alkaline phosphatase is markedly age- dependent. There is also a significant difference in activity at some ages.

In growing children a high fraction of alkaline phosphatase activity originates from metabolically active chronoblasts in the calcifying matrix vesicles and in mature osteoblasts. Increased serum alkaline phosphatase activity in children reflects not only bone growth but also growth of connecting tissues (Fleisher et al., 1977). Normal alkaline phosphatase activity is age dependent and is elevated during periods of active bone growth. The optimal range for alkaline phosphatase activity is also age dependent (Crofton et al., 1996). Growing adolescents have much higher alkaline phosphatase activity than a full grown adult because the osteoblasts are laying down bone very rapidly. A decreased alkaline phosphatase activity may be seen in zinc deficiency, vitamin C deficiency excess intake of Vitamin D, hypothyroidism and some disease conditions.

The present study is aimed at identifying the peak age of adolescent growth spurt in an urban and suburban locality in Abia State Nigeria using alkaline phosphatase activity as a biochemical marker.

MATERIALS AND METHODS

Location and subjects.

The study was carried out in Ohafia and Umuahia (suburban and urban) localities in Abia State South East of Nigeria. Two hundred and thirty five children aged between 9 and 16 years were selected from two primary and two secondary

schools in Ohafia and Umuahia. Questionnaires ministered after obtaining written permission from school authorities and the Parents Teachers Association of the schools involved. Consent letters were also obtained from parents of individual pupils willing to be involved in the study.

A total of seventy eight pupils (78) from Amaetiti primary school and fifty-six from Coronata Secondary School in Asaga, Ohafia were used for the suburban locality study while twenty seven (27) from World Bank Primary School and seventy five from Ibeku High School Umuahia were recruited for the urban locality study.

Anthropometric measurements

Body weights (kg) was measured (to the nearest 0.2kg) in light clothing without sandals , shoes or bags on the volunteers using a portable bathroom scale(HANSON model) as described by Jellife, 1996. Standing height was measured using a constructed vertical wooden rod affixed with graduated fibre glass tape. Subjects stood bare footed and readings were taken to the nearest 0.1cm (Iohman et al., 1991).

Blood sampling and analysis

Venous blood sample was collected from each volunteer by venepuncture using sterile non-toxic pyrogen -free plastic syringes into heparinized sterile containers.

The plasma fraction was separated by centrifugation at 1000g for 5 minutes using a Bench-top centrifuge. It was stored in a deep freezer before enzyme assay which was done within 48hrs of sample collection.

Plasma Alkaline Phosphatase activity

Alkaline phosphatase activity was determined using commercial kits supplied by TECO Diagnostics, USA. The principle of the method used is based on the action of alkaline phosphatase on the AMP buffered –Sodium phenolphthalein monophosphate (Bowers *et al*., 1977)

Statistical Analysis of Data

Data obtained was analyzed using version 11 of SPSS for windows. The methods used for analysis included descriptive statistics, One-way analysis of variance (ANOVA), and Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Our results as shown in Fig 1 show that males in Umuahia (urban) had peak alkaline phospatase activity at ages 10 and 15 yrs while their counterparts in Ohafia (a suburban locality) had peak alkaline phosphatase activity at ages 11 and 14yrs. Alkaline phosphatase activity at each of these peaks was higher in the males in the urban locality than in their suburban counterparts. Peak alkaline phosphatase activity was observed at ages 12 and 14yrs in females living in Umuahia an urban locality while the their counterparts living in Ohafia a suburban locality had peak alkaline phosphatase activity at ages 11 and 15yrs. Alkaline phosphatase activity at these peaks was significantly ($P \leq 0.05$) higher in males living in the urban areas when compared to their counterparts in the suburban area.

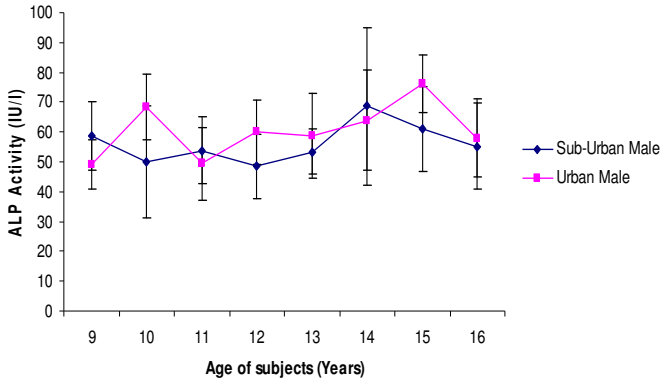

Fig 1: Variation in plasma alkaline phosphatase activity of urban and sub-urban male subjects

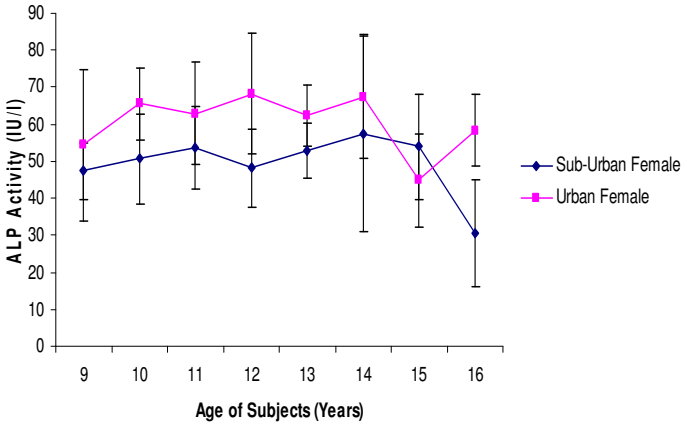

Fig 2: Variation in plasma alkaline phosphatase activity of urban and sub-urban female subjects.

There is sufficient scientific evidence to indicate that peak alkaline phosphatase activity could be used as a biochemical index of growth spurt in the absence of diseases that could lead to its elevation (Crofton *et al*., 1996). *Bacillus cereus* has been reported to express maximal activity of alkaline phosphatase during the exponential phase

Table 1: Variation in Mean Heights (M) and Weights (Kg) of Male Subjects.

Age in yrs (n)	Height (m)		Weight (kg)	
	Urban Male (n)	Suburban Male (n)	Urban Male (n)	Suburban Male (n)
9	1.33±0.06(5)	1.27±0.04(5)	25.08±2.39(7)	24.43±2.58(7)
10	1.36±0.03(5)	1.34±0.04(5)	28.60±1.14(7)	27.71±1.60(7)
11	1.37±0.01(4)	1.38±0.04 (4)	29.50±2.08(15)	30.00±2.17(15)
12	1.47±0.10(4)	1.38±0.07(4)	37.50±7.94(12)	29.50±3.71(12)
13	1.55±0.07(8)	1.47±0.05(8)	42.309±5.40(8)	36.50±3.86(8)
14	1.57±0.08(10)	1.46±0.10(10)	44.60±5.74(9)	36.79±7.34(9)
15	1.56±0.05(10)	1.55±0.08(10)	40.70±3.47(6)	39.00±6.99(6)
16	1.65±0.07(5)	1.59±0.05(5)	52.20±7.19(8)	42.88±5.59(8)

and suburban settings of our study may be due to environmental factors. It is possible that the nutritional values of the food eaten by adolescents in both localities studied were the same as seen from our survey with questionnaire, but stress and lifestyle in both settings could differ. The adolescents in the suburban locality are exposed to more farm work, long distance trekking and other hard labour compared to their urban counterparts (personal communication). This could explain why there was a delay in the peak alkaline phosphatase activity of suburban male and female adolescents compared to their urban counterparts. Though, the socioeconomic status was not considered a factor in selecting our subjects for study, it is possible that our subjects were from families whose economic status was low, since the study was carried out in public schools. Quality of life is generally improved in the urban localities due to factors like basic amenities hence urban adolescents do less physically exerting exercise than their rural counterparts.

Our findings showed that the peak alkaline phosphatase activity was at 15years with weight of 40.7± 3.5kg for males in the urban setting and 14years with average weight of 36.8± 7.9kg for males in the rural settings. This may be due to less stress and better nutrition for the males in the urban setting. Our survey through questionnaire shows that the predominant food nutrient in the menu of school children in the rural setting is carbohydrate while in the urban setting proteins and vitamins from beverages are held at high esteem in the adolescents' nutrition. This may account for the higher alkaline phosphatase activity in urban subjects which is a reflection of higher protein synthesis. Marjorie *et al.,* 2004, confirmed this fact by suggesting that nutritional intake has to support growth by providing not only enough energy but also the proper balance of protein, carbohydrate, fats, vitamins and minerals. Majorie and his colleagues suggested that nutritional recommendations should be viewed as general guidelines and should be adjusted for special conditions such as a significant growth spurt; athletic participation, major stress, or chronic illnesses.

The female adolescent may grow faster in the urban setting compared to rural setting. The female adolescents in the urban setting are kept at home during and after puberty to help care for their siblings and do homework. They also may be better fed by their parents and guardians who are supposedly more informed and better equipped with knowledge of nutrition. Conversely, female adolescents in the rural setting are exposed to more stress and hard labour in that they are deeply involved in long trekking distances to farm lands since these constitutes the major occupation in the rural South Eastern Nigerian locality. This may be the reason why in our study, the rural female adolescents had a two year delay in their peak plasma alkaline phosphatase activity compared to their urban counterparts.

Generally, in both localities we discovered that the males had significantly higher ($P<0.05$) plasma alkaline phosphatase activity compared to their female counterparts. These values started to fall after 14 and 15years except for urban females. This finding is in agreement with the work of Cooke *et al* .(1973) who studied serum alkaline phosphatase activity among 569 school chil-

Table 2: Variation in Mean Heights (M) and Weights (Kg) of Female Subjects.

Age in yrs	Height (m)		Weight (kg)	
	Urban Female(n)	Suburban Female(n)	Urban Female(n)	Suburban Female(n)
9	1.35±0.06(5)	1.30±0.04(5)	26.40±5.13(5)	26.80±3.03(5)
10	1.41±0.03(5)	1.35±0.05(5)	32.20±2.28(10)	25.90±1.37(10)
11	1.40±0.03(4)	1.38±0.09(4)	31.50±2.38(8)	30.25±3.01(8)
12	1.48±0.03(8)	1.42±0.07(8)	36.87±4.09(11)	33.46±2.42(11)
13	1.52±0.09(8)	1.50±0.04(8)	42.25±6.86(8)	39.25±3.77(8)
14	1.55±0.03(7)	1.57±0.05(7)	48.49±6.11(6)	44.50±3.27(6)
15	1.53±0.06(8)	1.54±0.05(8)	46.13±6.75(5)	41.40±3.85(5)
16	1.57±0.05(5)	1.60±0.06(5)	49.60±2.70(4)	48.50±2.52(4)

dren (386 boys and 183 girls) aged between 14 and 17years with a finding that mean values were significantly greater in boys than girls and both showed a fall in mean values with increasing age. Their findings are consistent with ours.

From the result of our study the peak alkaline phosphatase activity in the rural locality and urban females lies between 12 and 14 years, while the male adolescents in the urban locality had theirs at 15years.

Our findings provide the mean age of growth spurt in apparently healthy urban and suburban south eastern Nigerian adolescents. The age at which the peak plasma alkaline phosphatase activity occurred was lower by 2years in the rural female adolescents compared to their urban counterparts, while in males the mean plasma alkaline phosphatase activity was significantly higher ($P<0.05$) in the urban compared to rural adolescents. There was a delay in the mean growth spurt in the rural male and female adolescents compared to their urban counterparts.

REFERENCES

Bowers GN, McComb RB and Kelley ML, (1977). Measurement of total alkaline phosphatase activity in human serum: Selected Methods of Clinical Chemistry, G.R. Coopors, ED, Am. Asso. Clinical Chem., Washington, Vol.8,

Cooke, W. T., Swan, C. H. J., Asquith, P., Melikian,V. and McFeely, W.E. (1973) Serum Alkaline Phosphatase and Rickets in Urban School Children. B. M. J. 1: 324 – 327.

Crofton P.M., Stirling H.F and Kelnar C.J(1995) Bone alkaline phosphatase and height velocity in short normal children undergoing growth promoting treatments: longitudinal study. Clin. Chem. 41:672-678

promoting treatments: longitudinal study. Clin. Chem. 41:672-678

Crofton P.M., Stirling, H.F., Schonau E, and Kelnar, C. J. H. (1996). Bone alkaline phosphatase and collagen markers as predictors of height velocity response to growth-promoting treatments in short normal children. Clin. Endocrinol. 44(4):394 – 0(385).

Demir, A., Voutilainea, R. and Juul, A. (1996) Increase in first morning voided urine luteinizing hormone levels precedes the physical onset of puberty. J. Clin. Endocrinol Metab. 81:2963-2967

Fleisher, G.S., Eickelberg, E.S and ELveback, L.R (1977) Alkaline Phosphatse activity in the plasma of children and adolescents. Clin. Chem. 23(3):469-472

Iohman T., Roche A and Martorell R (1991). Anthropometric standardization refence manual. Human kinetics, Champagne, USA.

Jellife D.B (1996). The assessment of the nutritional status of the community, Geneva. WHO

Lamp M and Johnson M.L(1993) A case study of daily growth during adolescence: a single spurt or changes in salutatory growth? Ann. Human Biol. 20 :593-603

Marjorie E., Koplan S., Elyse S and Vaugha I. R. (2004). Nutrition and Eating disorders in adolescents. The Mount Sinai J. Med. 71(3):155-161.

Matkovic, V. (1992) Calcium and Peak bone mass. J. Intern Med. 231:151-60Moss, D.W., Henderson, A.R. (1994) Enzymes In: Tietz Textbook of clinical chemistry, 2nd Edition,. Burtis,C.A,, Edward R. and Ashwood(Eds) W. B. Saunders. Philadelphia Pp. 735-896.

Mitamura, R., Yano, K and Suzuki, N. (1999). Diurnal rhythms of luteinizing hormone, folli-

cle stimulating hormone and testosterone secretion before the onset of male puberty J. Clin. Endocrinol Metab. 84:29-27

Vinter V., Smid F and Smrckova(1987) Factors influencing alkaline phosphatase during growth and sporulation of *Bacillus cereus*. Folia Microbiologica32(2):89-95

Zemel, D.S and Jenkins C (1989) Dietary Change and adolescent growth among the Bundi (Gende-speaking) people of Papua New Guinea. Ann Hum. Biol. 1:709-718.