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Correlation between serum zinc level and height of adolescent school girls in a Nigerian community

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Abstract *Background:* This study aims to asses the nutritional status among adolescent school girls using their serum zinc levels and to correlate it with their height.
Method: This is a cross-sectional study of adolescent girls attending public secondary schools in Oshimili local govt. area of Delta state in Midwestern Nigeria.
Results: The mean serum zinc level of the total population was 13.30mmol/l±5.82. Majority (58.3%) of the girls failed to attain the threshold value of 10.71mmol/l of serum zinc. The mean height of the population was 155.4cm with Standard Deviation Scores (SDS) score of -0.64±0.48, while the mean Body Mass Index (BMI) was 19.1kg/m^2 ±2.91 with an SDS score of -0.54±0.47. The mean serum zinc level of urban girls (11.05±4.66µmol/l) was significantly lower than that of rural girls (15.54±6.31µmol/l) (p = .009).
There was no correlation between the mean serum zinc levels with height SDS (p=0.28) and the BMI SDS (p=0.69).
Conclusion: Majority of the adolescent girls in Oshimili local Government Area of Delta State Mid western Nigeria have low serum zinc level when compared to threshold value, and there was no correlation of serum zinc with their height SDS or BMI SDS.

Key Words: Adolescent girls, Zinc level, Height, BMI , Correlation.

Introduction

Adolescence is a period of heightened nutritional requirement where a growing individual is passing through childhood to full adulthood[1]. Because zinc has been recognized to be essential for skeletal and muscular growth as well as for sexual maturation, it's need increases during adolescent growth spurt[2]. Girls who fail to attain their full growth potential and who are malnourished are at risk of having low birth weight babies and obstetric complications. The need for zinc increases during adolescent growth spurt. The essentiality of zinc in humans was noted dramatically in the 1960s by a syndrome of growth retardation and arrested sexual maturation in eight adolescent boys in the Middle East[3]. It was noted that this syndrome could be reversed by dietary supplementation with zinc. Average serum zinc status of a group of adolescent can give an average level of serum zinc in a locality.

The interest on zinc on growth was initiated when Ronaghy[3] in Iran demonstrated that stimulation of growth of pre pubertal school boys could be brought about by supplementation with zinc. Zinc is a co-enzyme in major metabolic pathways and has been shown to play physiological role as an activator in bone formation[4]. Specifically it enhances the anabolic effect of Insulin-like growth factor 1(IGF-I) which is a major mediator of growth hormone stimulated somatic growth .[4,5] Zinc supplementation has been found to improve the linear growth of stunted children .[6-10] In general the anabolic effect of IGF-I in osteoblastic MC3T3-EI cells is enhanced through modulation by zinc. The increase in growth velocity resulting from zinc supplementation was found to be associated with increased plasma IGF-1 concentrations[11] The total body content of zinc is estimated to be 2g.[4] however the total daily requirement of zinc in adolescent girls according to WHO expert panel is 107-184 unit (7-12mg)[4]. The recommended dietary allowance (RDA) in adolescent girls is 11mg/day[5]. Though there are no conventional store for zinc but skeletal muscle account for 60%, bone account for 30% and only 1% is found in plasma[4,]. The best dietary sources of zinc are generally animal products such as meat, seafood, and milk[5,12]. Although vegetable based diet may contain zinc but it's biological usefulness is impaired because of high fiber content found in vegetables[4,13] Zinc is absorbed from the jejenum and it's absorption is controlled by a homeostatic mechanism in the intestine.[2] Absorption of zinc is inhibited by the presence of phytates and fiber in the diet that bind to zinc[4].

Zinc status can be assessed by measurement of zinc in plasma, erythrocytes, neutrophils, lymphocytes, and hair[4] A single serum zinc estimation may not show a long term status of zinc. However average serum zinc status of a group of adolescents can give an average level of serum zinc in a locality[13]. Therefore Serum zinc estimation is used in this study because it is cheap, less cumbersome and can be performed with a relatively simple technique using Atomic absorption spectrophotometer (AAS). The National Center for Health Statistics and Nutrition Examination Survey (NHANES) used serum zinc level below 10.71mmol/l as a cut off value as indicative of zinc deficiency[14,15]

Since it has been established that adequate nutrition in girls is essential for maternal health and prevention of obstetric complications, therefore this study was done to assess their nutritional status using serum zinc as a tool. The micronutrient zinc and anthropometric parameters including Height standard deviation score (Height SDS) and Body Mass Index standard deviation score (BMI SDS) were measured. Weight SDS was not used because the WHO anthro version 3.2.2 does not have weight standard deviation values for children older than 10 years which formed the subjects of this study.

Subjects and methods

The study was carried out in the communities of Oshimili North and South Local Government Areas (LGA) of Delta State, Nigeria. Oshimili LGAs were chosen because they represent both urban and rural settings that were readily accessible. The definition of rural and urban has been predetermined by the Federal office of statistics.[16] Oshimili has a projected population of 143679 and is located on the West Bank of River Niger.[16] It shares borders with Ogwashiuku and Onitsha. The inhabitants are made up of both indigenous population and settlers from neighboring Eastern towns across the Niger. Their chief occupation is fishing. There are 15 public secondary schools in both LGAs. The survey involved adolescent girls aged 10-19 years in the 15 public secondary schools. Oshimili north LGA is predominantly urban and contain 8 schools while the remaining 7 schools are located in the Oshiimili south LGA and are predominantly rural. Out of these 15 schools, 6 are girls' schools only; 4 are boys' schools only while 5 are mixed schools. In this study girl only schools and mixed schools were selected. To achieve a reasonable measure of accuracy and increase the predictive power of the study 53%(8) of the schools were selected. Using a simple random sampling procedure, 8 schools were finally selected from the 15 schools in the LGAs.

The number of girls for the entire study was calculated using the statistical formula for the calculation of sample size.[17] Therefore a minimum sample size of 1067 girls was required in the 8 selected schools. Permission to carry out the research in the school was obtained from the State Ministry of Education, and also approval of the study protocol was obtained from the ethical committee of the University of Benin Teaching Hospital, Benin. The purpose and description of the study was explained to their parents by a hand bill distributed through the selected girls and informed consent was obtained from their parents.

Sampling frame was obtained by complete listing of the students' name, sex and age in all classes of the schools selected using the school register. With this sampling frame, the students were further arranged by the age cohorts in each schools as follows 10 -< 11, 11 - < 12, 12 - < 13,------- 19 - < 20. The sample size for each one year segment in each school was derived using the same formula for the calculation of sample size. Thus a stratified cluster (multistage) sampling technique was employed in the final subjects' selection.

A proportion of 1/10 of these for each school was studied for zinc to attain the population coverage for the study of micronutrient. A total of 151 girls were selected for analysis of serum zinc. Using a pre-tested health and life style questionnaire each recruited participant was interviewed. General examinations of the girls were done by the authors paying particular attention to pallor, oral hygiene, skin conditions and musculoskeletal systems. The randomly selected girls had no obvious physical defect or evidence of chronic illnesses

Anthropometry

Height measurements without shoes on as described by Janes[18] work were done using a field wooden minimeter attached to a straight wall calibrated to the nearest 0.5cm. A block was lowered in contact with the ruler to touch the head of the subject being measured who was standing erect with heels, buttocks and head touching the wall. The heels were together and the feet at an angle 45^{o}. The subject looked straight ahead. The heels were close together before measurement was done. Body weights without shoes, wearing only underwear were measured using a SECA standing scale calibrated to the nearest 100gm. All Height and Weight measurements were in triplicate and the mean was recorded on each occasion.

Serum Zinc Analysis

Serum zinc was analyzed using the atomic absorption spectrophotometer (AAS), [19] a Hitachi model 180 – 80 with a data processing unit model 180 – 0205. This was done at the Biochemistry Department of the University of Jos.

Data Analysis

Data was entered into a computer using the software SPSS version 16. The mean (x), standard deviation (SD) and the Z-scores were determined using the WHO Anthro version 3.2.2. Correlation between serum zinc and the height SDS and BMI SDS were done using Pearson correlation coefficient. Test of statistical significance was done using the student's t test and P values < 0.05 is regarded as significant

Results

A total of 1068 girls were selected for the study, of these 685(64%) and 383(36%) were from urban and rural areas respectively. Their mean age was 15.12yrs with a range of 10-18 years. The mean height of the study population was 155.4±10.74cm with a range of 122.5-179.2cm. The mean BMI was 19.1kg/m2 ±2.91 with an SDS score of -0.54±.47. The mean height of the rural girls was 155.3±10.2cm with a range of 122.5-179.2cm. The height range of urban girls was 129-179cm with a mean of 155.5±11.28cm. There was no significant difference between the mean height of the urban and rural girls (p=0.90).

The height SDS was -0.64±0.48 while the BMI SDS was -0.54±0.47. There was no difference between the height SDS of urban girls -0.64 ± 0.45 with that of rural girls -0.65 ± 0.51(t=0.06, p=0.95). The BMI SDS of urban girls -0.51± 0.52 was also not different from those of rural girls -0.57± 0.42 (t= 0.57, p= 0.57).

Table 1 shows the baseline characteristics of the subjects. There was no significant difference in age, weight, height, BMI, height SDS and BMI SDS between the girls in urban and rural areas.

Table1: Baseline characteristics of study subjects

	Urban	Rural	P-value
Mean age (yrs)	14.87	15.51	
Mean Height (cm)	155.5±11.28	155.3±10.2	0.90
Mean weight (kg)	46.1±11.33	45.2±9.84	0.64
Mean BMI (kg/m^2)	19.1±2.91	18.84±2.26	0.80
Height SDS	-0.64± 0.45	-0.65±0.51	0.95
BMI SDS	-0.51±0.52	-0.57±0.42	0.57

(p = <0.05 is statistically significant)
(Statistical test used= student t test)

Table 2 highlights the mean serum zinc levels of the urban and rural girls studied. One hundred and fifty one (15.6%) girls were analyzed for serum zinc level. The mean serum zinc level of the total population was 13.30µmol/l± 5.82. The urban girls had a mean serum zinc level of 11.05±4.66µmol/l while the mean serum zinc level for rural girls was 15.54±6.31µmol/l. The mean serum zinc level of the urban girls was significantly lower than that of the rural girls. (t= -2.75, p =0.01). The proportion of girls studied that did not attain the threshold value of 10.71µmol/l was 58.3% (88), out of which 89.8% (79) of them were from urban areas.

Table 2: Mean serum Zinc levels of Urban and Rural subjects

Serum zinc	Rural mmol/l	Urban mmol/l	Total mmol/l	p value
Mean	15.54(34)	11.09 (117)	13.30 (151)	.01
SD	6.31	4.66	5.82	
95%CI	14.03-20.17	8.70-11.09	10.37-12.85	

P=<0.0001 Figure in bracket ( ) represent total number studied
(Statistical test used= student t test)

Fig 1 shows that there was no correlation between the height SDS and serum zinc level of the subjects (p=0.28), and fig 2 highlights that there was also no correlation between the BMI SDS and serum zinc level (p=0.69). Among the urban girls however there was a correlation between their height SDS and their serum zinc level (p = 0.03), there was also a correlation between their BMI SDS and serum zinc level (p=0.04). There was no correlation among the rural girls between serum zinc level and either height SDS (p= 0.71) or BMI SDS (p= 0.99).

Fig 1

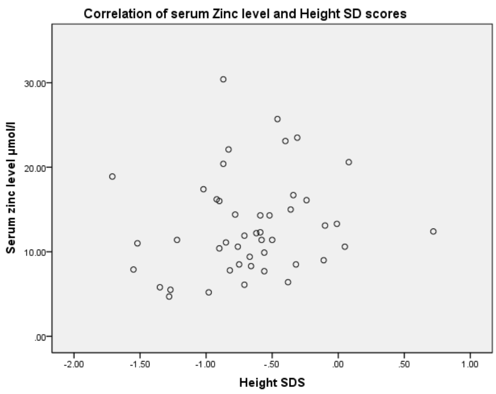
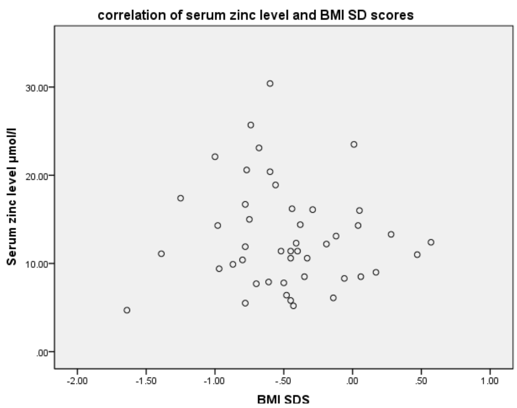


Fig 2



Discussion

In this study, the mean serum zinc was 13.30µmol/l with a range of 2.52-43.2µmol/l was within normal range. However, since as many as 58.3% of them failed to attain the threshold value of 10.71µmpl/l, it is therefore a direct pointer to the fact that the disaggregated data on zinc (urban/rural) is a better reflection of the state of

zinc in the local environment of the study.
The great disparity between urban and rural mean serum zinc could result from lower intake of zinc by the urban community, especially since these rural girls were mainly children of fishermen and thus have better assess to fish protein which is rich in zinc. It is also possible that the values of the rural girls may have been affected by the low sample size. Although the dietary intakes of these girls were not assessed the observed lower values of zinc might be a direct reflection of their inter-current intakes. It is also possible that these adolescent girls may have high phytate intake in their diets. It has been reported that serum zinc concentration was inversely correlated with dietary phytate.[13] Adolescent females are vulnerable to deficiency of zinc. This is because of the high requirement for growth, expanding blood volume and sexual maturation. It is also postulated that adolescents in Nigeria are under constant exposure and repeated attacks of malaria and other infection as a result will have higher demand for zinc. Zinc supplementation in childhood has also been shown to reduce infection rates such as seen in malaria infections.[7] This postulate might explain the observed low values of serum zinc in more than half of the study population.

Nakamura and Nishiyama[20] studied 21 prepubertal short Japanese children (11 boys) and found that they had very low serum zinc level of 9.9µmol/l. This boys gained height with zinc supplementation thus providing the basis for the direct effect of hypozincaemia on growth and puberty. This effect of hypozincaemia was however not manifest in this study; the rural girls with higher mean serum zinc level had lower height values, though this difference was not statistically significant

There was no correlation between the heights SDS of these adolescents and their serum zinc. This lack of relationship was also observed by Michealson[21]. The reason for this is not very clear, since there is a correlation between the heights SDS of urban girls with their serum zinc level. The absence of correlation can also imply the lack of an age dependent variation in the zinc level of the girls.

Mbofong and Atimo[22] discovered that the average daily dietary zinc intake of Nigerians was generally low and demanded increased intake in childhood, adolescence and pregnancy. This may explain the low serum zinc level in majority of the girls studied. Since zinc is found in animal products such as meat and fish, and if these girls do not consume adequate animal protein or are consuming large quantities of phytate containing foods in the presence of repeated infections and infestations; these may account for the observed deficiency in zinc.

The finding from this study is limited by the fact that it is not a longitudinal study and it was therefore not possible to incorporate increments and velocities of these girls growth over a time period. The other notable limitation is that serum zinc levels were assessed and this does not necessarily correlate to total body zinc. It is therefore recommended that a longitudinal study on the relationship between dietary zinc intakes and anthropometry could have a wider clinical application.

Conclusion

majority of the adolescent girls in Oshimili local Government area of Delta State, Mid western Nigeria had low serum zinc level when compared to threshold value. There was however no correlation of serum zinc level with their height SDS or BMI SDS. It is therefore recommended that there is need for nutritional intervention to augment zinc intake of adolescent girls in the area using public health education and school food supplementations.

Conflict of interest: None
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