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Anthropometric Measures and Zinc Status of Children with Sickle Cell Anaemia in Zaria

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Summary

Ogunrinde GO, Yakubu AM, Akinyanju OO. Anthropometric measures and zinc status of children with sickle cell anaemia in Zaria. *Nigerian Journal of Paediatrics 2000; 27: 64* One hundred and nineteen children aged 12 to 119 months with sickle cell anaemia (SCA) and 119 age- and sex-matched controls were studied to determine if there was any relationship between erythrocyte zinc concentration and anthropometric measurements. All SCA children were on steady state before recruitment into the study. The SCA subjects had significantly smaller anthropometric measurements with the deficits becoming more pronounced with advancing age. The mean (± 1SD) erythrocyte zinc concentration in SCA subjects was 31.9 ± 9.8 mg/g Hb and that in control subjects was 42.3 ± 16.2 mg/g Hb ($p = 0.0000001$). The difference in mean erythrocyte zinc concentration also became more pronounced with increasing age. Whereas height and erythrocyte zinc concentration have a positive and significant linear relationship in control subjects (partial regression coefficient = 0.56, $p = 0.0076$) no such relationship was detected in SCA subjects (partial regression coefficient = -0.04, $p = 0.954$). Other anthropometric measurements were not linearly correlated with erythrocyte zinc concentration in either SCA or control subjects. It is suggested that Nigerian studies be conducted to determine the significance of zinc deficiency in SCA subjects.

Introduction

IT is known that subjects with sickle cell anaemia (SCA) have retarded growth,[1-6] and that affectation of the pituitary gland may be partly responsible for the observed pattern.[7] Recently, zinc deficiency was reported to be a contributing factor.[8] Zinc supplementation was therefore suggested for SCA subjects by some earlier workers.[8-10] Zinc has been described as being essential for all forms of life since it participates in the synthesis and degradation of carbohydrates, lipids, proteins, and nucleic acids, and plays an essential role in polynucleotide transcription and translation.[11] The aim of this study was to describe the erythrocyte zinc status of SCA subjects in steady state and determine any relationship, if any, between zinc status and anthropometric data in these subjects. It was thought that the findings may contribute towards clarifying the controversy[12] surrounding the call for zinc supplementation in subjects with sickle cell anaemia.

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Materials and Methods

Random sampling technique was used to select 119 children with SCA attending the weekly paediatric haematology clinic of the Ahmadu Bello University Teaching Hospital, Zaria. All subjects had been in steady state (no crisis or hospital admission) for at least three months before recruitment into study. For each SCA subject, a sex-and age-matched control subject (who was not seriously sick and whose haemoglobin genotype was later confirmed to be either AA or AS) was selected from the paediatric out-

Table I

Mean anthropometric measurements in SCA and control subjects

Anthropometric measurement	*Mean (± 1 SD)*		*p value*
	SCA subjects n=119	*Control subjects n=119*	
Height (cm)	102.7 (16.1)	108.6 (17.7)	0.008
Weight (kg)	16.0 (4.6)	18.1 (5.4)	0.002
Left midarm circumference (cm)*	14.1 (1.5)	15.5) (1.2)	0.000001
Left tricipital skinfold thickness (mm)	6.3 (1.8)	6.7 (1.8)	NS
Left subscapular skinflold thickness (mm)	4.9 (1.4)	5.5 (1.7)	NS**

n = 52
** Wilcoxon matched pair test
NS = not significant

patient department of the same hospital within 24 hours of recruiting the SCA subject.

All data including anthropometry (weight, height, mid-upper arm circumference and skinfold thickness) for the subjects and their controls were recorded on a proforma. A beam balance weighing scale, regularly checked for accuracy by the use of a predetermined labelled 10kg weight, was used to weigh all subjects (to the nearest 0.1kg) when scantily dressed. Height (to the nearest 0.1cm) was measured with a stadiometer, the child standing upright with his/her heels, gluteal masses, scapulae, and occiput touching the vertical surface of the instrument. Occasionally, an infantometer was used to measure the recumbent height of children who were yet to stand without support. On such occasions, an assistant helped to place the soles of the feet firmly and perpendicularly on the footboard while the headpiece was used by one of the investigators (G.O.O) to take the reading. The mid-upper arm circumference (to the nearest 0.1 cm) was taken on the left upper arm, exactly midway between the acromion and olecranon processes using a flexible measuring tape regularly checked against a rigid measuring ruler. Skin calipers were used to measure the skinfold thickness to the nearest 0.1mm over the left triceps midway between the acromion and olecranon processes and over the tip of the left scapula. Blood specimen was taken, under very strict guidelines to prevent environmental zinc contamination, for erythrocyte zinc (EZ) concentration estimation by atomic absorption spectrophotometry.[13] Student's t test was used in statistical analysis of collected data, and Wilcoxon matched pair test where data were not normally distributed.

Results

One hundred and nineteen subjects with SCA and an equal number of controls were studied. The subjects and their controls were aged 12 months to 119 months, with a median age of 58 months in both groups. Fifty-seven (47.9 percent) of the subjects were females and 62 (52.1 percent) were males, giving a M:F ratio of 1.1:1.0. Since the subjects with SCA were matched for gender, the same gender distribution was observed in the controls. Of the 119 controls, 98 (82.4 percent) had haemoglobin genotype AA while the remaining 21 (17.6 percent) had genotype AS.

Anthropometric measurements were superior in controls compared to SCA subjects and the difference assumed statistical significance in height, weight and mid-arm circumference (Table I). There was a tendency for the differences in both height and weight to become more pronounced with advancing age as depicted in Figures 1 and 2. The overall mean EZ concentration in SCA subjects was 31.9±9.8 mg/g haemoglobin (range 13.2 – 58.1), and this was significantly smaller than the mean of 42.3±16.2 mg/g haemoglobin (range 5.1 – 99.2) obtained in control subject ($p = 0.0000001$).

As early as the third year of life, control subjects had a statistically significant higher mean EZ concentration than SCA subjects ($p = 0.0109$) with a trend towards statistical significance in the second year of life ($p = 0.077$). At all age intervals, control subjects had higher mean EZ concentration than SCA subjects did. The difference also became more pronounced with advancing age (Fig 3). The mean EZ

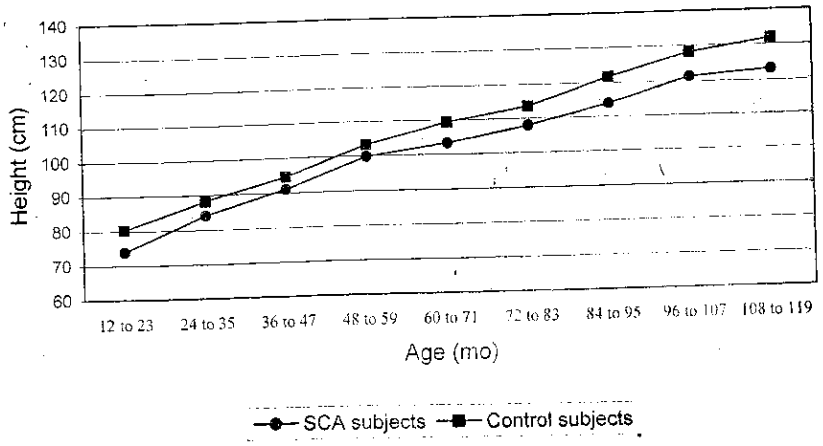

Figure 1. Mean height in SCA and control subjects

concentration in male SCA subjects was 31.9±9.8 mg/g haemoglobin and was lower but not significantly different from the mean value of 32.0±9.8 mg/g haemoglobin obtained for female SCA subjects. The corresponding figures for control males and females are 43.2±14.6 mg/g Hb and 41.4±17.8 mg/g Hb. respectively. The differences were however significant between male control and male SCA subjects ($p = 0.000001$) and between female control and female SCA subjects ($p = 0.000646$).

Among the SCA subjects there was a small but statistically significant positive linear correlation between EZ concentration and height ($r=0.26$, $p=0.0051$; $r^2 = 0.07$). This relationship was stronger among control subjects ($r=0.32$, $p = 0.00036$; $r^2 = 0.10$). Age was also found to be positively and significantly correlated with EZ concentration. In SCA subjects of preschool age the EZ concentration (29.03±9.88 mg/g Hb) was significantly smaller than the concentration in SCA subjects of school age (34.17±0.14 mg/g Hb; $p = 0.00039$). A similar pattern was observed between control subjects of preschool age (38.03±16.11 mg/g Hb) and school age controls (45.69±15.51 mg/g Hb; $p = 0.0098$). Because of these relationships multiple regression analysis of age and height on EZ concentration was performed. The following multiple regression equations were obtained:

a) $Y = 28.71 + 0.01x_1 - 0.04x_2$ (for SCA subjects)
b) $Y = -7.53 - 0.16x_1 + 0.56x_2$ (for control subjects)

Where Y is EZ concentration in mg/g Hb, x_1 is age in months and x_{2is} height in centimetres.

The regression equation for SCA subjects shows that when age is kept constant, EZ concentration (Y) and height (x_2) became inversely related but the partial regression coefficient (-0.04) was not statistically significant ($p = 0.954$). However, when age is kept constant in the control subjects, EZ concentration and height remained positively and significantly correlated (partial regression coefficient = 0.56, $p = 0.0076$).

The pattern of relationship between EZ concentration and weight in both SCA and control subjects

Table II

Linear relationship of anthropometric measurements to erythrocyte zinc SCA and control subjects

Anthropometric measurements	*SCA subjects* (n=119)		*Control subjects* (n=119)	
	r	*p-value*	*r*	*p-value*
Height (cm)	0.26	0.005	0.32	0.0004
Weight (kg)	0.23	0.012	0.30	0.001
Left midarm circumference (cm)*	0.21	0.138	0.22	0.113
Left tricipital skinfold thickness (mm)	-0.12	0.194	-0.10	0.292
Left subscapular skinfold thickness (mm)	-0.15	0.102	-0.09	0.327

*n=52

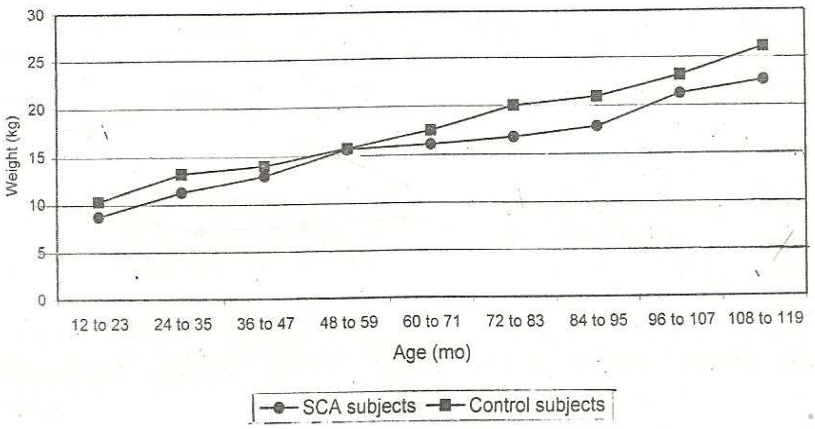

Figure 2. Mean weight in SCA and control subjects

was similar to that observed between EZ concentration and height. When age and weight were regressed on EZ concentration the following multiple regression equations were obtained:

a) $Y = 27.65 + 0.11x_1 - 0.20x_2$ (for SCA subjects)
b) $Y = 26.42 + 0.01x_1 + 0.85x_2$ (for control subjects)

Where Y is EZ concentration (mg/g Hb). x_1 is age in months and x_2 is weight (kg).

None of the partial regression coefficients was statistically significant. This means that with age kept constant, EZ concentration and weight were not significantly correlated, either in the SCA or control subjects. There were no statistically significant linear correlation between EZ concentration and other anthropometric measures in this study, i.e. left tricipital skinfold thickness, left subscapular skinfold thickness, and midarm circumference, in either SCA or control subjects (Table II).

Discussion

This study has demonstrated a significant reduction in height, weight and midarm circumference of sickle cell anaemia subjects when compared to normal control subjects with HbAA and HbAS. The differences in height and weight measurements between SCA and control subjects increased with advancing age. These patterns have been documented in earlier studies.[1,5,14-21] The differences in height and weight measurements were already evident by the second year of life as documented by other workers.[20-22] Unlike what was obtained in earlier studies,[22,23] skinfold thickness (left tricipital and subscapular) did not differ between SCA and control subjects in this study. However, skinfold thickness measurements may not be very reliable for comparing nutritional status given the marked individual differences in the distribution of body fat.[24]

Erythrocyte zinc estimation has not been sufficiently validated to permit its use as a diagnostic criterion for zinc deficiency.[11] However, zinc accumulates slowly in erythrocytes[25,26] and has been said to be reflective of long term zinc status.[27]

Since growth is also a long term physiological process it seems appropriate to study the effect of EZ on growth. In comparison to the control subjects, the SCA subjects in this study were zinc deficient because their mean EZ concentration was significantly lower than the mean for the control subjects. In addition zinc deficiency was detectable by the second year of life but only became statistically significant in the third year. However, because SCA subjects aged 12-23 months already had statistically significant lower anthropometric measurements, the statistically insignificant zinc deficiency noted at this age may actually be clinically significant. The low levels of EZ concentration obtained for SCA subjects in this study are similar to those reported earlier,[8,28] even though the subjects in later studies were either adults or older children.

As has been described earlier[8] age-related increases in EZ concentration were noted in both control and SCA subjects. In this study, SCA and control preschool subjects had significantly smaller EZ concentration than school aged subjects. Also, in each age group, control subjects had greater EZ concentration than SCA subjects with the difference in concentration becoming more pronounced with advancing age. However, it will be difficult to explain the growth retardation noted in the SCA subjects on the basis of zinc deficiency alone as this study has

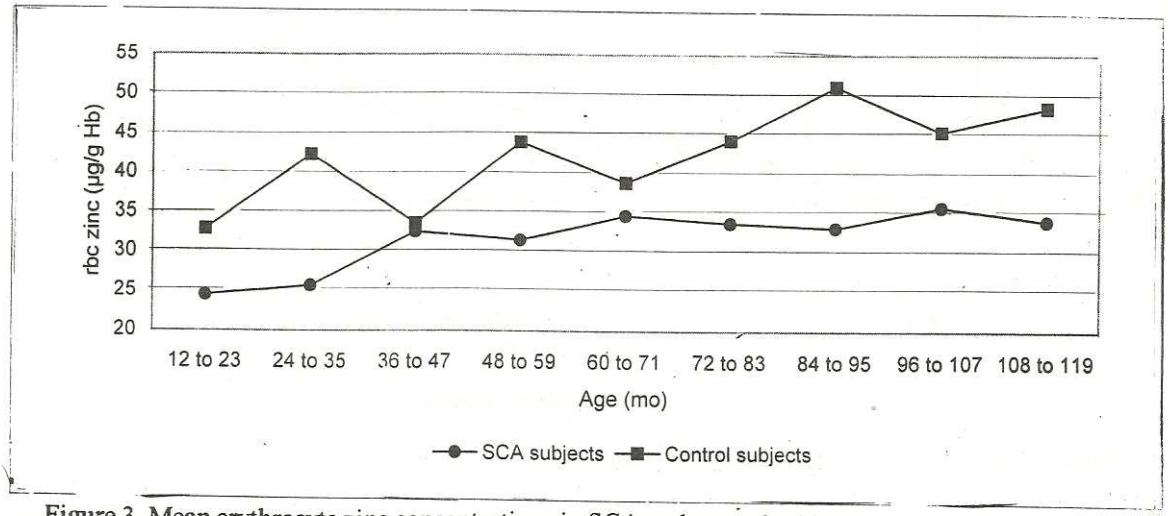

Figure 3. Mean erythrocyte zinc concentrations in SCA and control subjects

not demonstrated any significant linear correlation between EZ concentration and anthropometric measurements in SCA subjects. However, among control subjects there was a significant positive correlation between EZ concentration and height (partial regression coefficient = 0.56, F = 5.091, p = 0.0076). These patterns may suggest an increasingly defective zinc homeostasis in SCA subjects by way of a worsening zincuria or defective intestinal absorption.[8]

Though the significance of lowered EZ concentration in SCA subjects in this study is not clear, it has been shown in earlier studies that zinc supplementation resulted in improved growth patterns,[29-31] increased affinity of the sickle haemoglobin for oxygen without alteration of the Bohr effect,[32] improved androgen levels in patient with testicular failure,[10] healing of ulcers,[9] and reduced incidence of prematurity and improved birthweight.[33] In view of the uncommon occurrence of side effects of zinc supplementation[11] and the need to optimise the prophylactic care of children with SCA, it is recommended that further studies be carried out in Nigerian centres to determine the significance of zinc deficiency in sickle cell anaemia

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