Sociodemographic Determinants of Nutritional Status in Children with Sickle Cell Anaemia in Benin City Edo State, Nigeria

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Abstract: *Background*: Nigeria has the highest burden of sickle cell anaemia (SCA) in Africa. Patients with SCA present with life-long complications in addition to growth failure. With comprehensive care, patients with SCA have improved survival and well-being, with some studies reporting overnutrition. This study aims to assess nutritional status and sociodemographic determinants in children with SCA.

Methods: A descriptive cross-sectional study was carried out among children aged 1-16years attending the paediatric SCA clinics and their sex and age-matched controls. Anthropometric measurements were carried out to determine their nutritional status, and the data obtained were analyzed using SPSS software. The sociodemographic and relevant clinical information was obtained using a semi-structured questionnaire.

Results: The majority (86%) of the children with SCA had normal height and weight, but the mean weight, weight for age z-score (WAZ), body mass index z-score (BMIZ) and height for age z-score (HAZ) were significantly lower than the HbAA controls. The mean WAZ was significantly higher in children from high socioeconomic class (SEC) and those whose mothers had tertiary education than those from lower educational statuses. Similarly, the mean HAZ was significantly higher in children from high SEC, tertiary maternal education and younger children.

Conclusion: Most children with SCA have normal nutritional status despite significantly lower nutritional indicators compared to children with HbAA genotype. Higher educational status of mothers and SEC were associated with a significantly higher nutritional status among the subjects.

Keywords: Sickle cell anaemia, nutritional status, determinants, children.

INTRODUCTION

Sickle cell anaemia (SCA) is a genetic disorder characterized by the presence of two mutant haemoglobins (HbSS). It is an autosomal recessive disorder and the most common form of sickle cell disease. Globally, the birth prevalence of SCA is 111 per 100,000, while Africa, the continent with the highest burden, has 1125 per 100,000 [1]. Nigeria has the highest burden, with a prevalence of 1.3% in children aged 6-59months and an estimated national average birth prevalence of 1.21% [2]. Patients with sickle cell anaemia experience life-long complications, which include anaemia, infections, stroke, acute painful episodes, tissue damage, organ failure and early death [3]. Poor growth has been reported in children with sickle cell anaemia compared to Haemoglobin AA children. The causes of growth failure in children with SCA are multiple and complex. Higher resting energy expenditure, repeated infections, endocrine dysfunction, micronutrient deficiencies and chronic anaemia have been attributed to the high prevalence of stunting and wasting observed in children with sickle cell anaemia [4]. Increased resting energy expenditure

has been attributed to increased erythroid activity resulting from increased haemolysis in children with sickle cell anaemia. Anorexia leading to inadequate food intake has been reported to occur in the absence of infections, and this usually precedes painful crises by days or weeks [4]. Improved care, including genetic counselling, vaccination against pneumococcal organisms, blood transfusions, dietary advice, and hydroxyurea and folic acid, have improved the survival and well-being of patients with SCA. Provision of such services may depend on the health facility's support and the family's socioeconomic status, which may ultimately reflect on the nutritional status of patients with SCA.

Assessing the nutritional status of children, especially those at risk of malnutrition, gives information on their dietary intake and well-being. Methods used to assess nutritional status can be categorized into dietary assessment, use of anthropometric parameters, and clinical and bio-chemical assessment. Measurement and interpretation of different anthropometric parameters are very reliable in the assessment of nutritional status in children.

Several nutritional studies on sickle cell children have shown varying results. A comparative study of the

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nutritional status of SCA patients in Northern Nigeria and a cohort from high-income countries using anthropometric measurements showed a statistically lower BMI in the Nigerian cohort [5]. In the United States, a higher prevalence of overweight/obesity was reported in a study of children with SCA [6]. A high prevalence of overweight/obesity was also reported in another study in Nigeria [7], while other Nigerian studies have reported a higher prevalence of undernutrition [8-10]. The contribution of the possible socioeconomic factors associated with the nutritional status of these children was not emphasized.

This study aims to assess the nutritional status of children with SCA and the associated sociodemographic factors in Benin City.

METHODS

This is a descriptive cross-sectional study carried out in the paediatric sickle cell clinic of the University of Benin Teaching Hospital and the Sickle Cell Centre Benin.

Study Subjects and Controls

Subjects are SCA children aged 1 to 16 who were being followed up for SCA. They were recruited consecutively from two sickle cell centres for the study. The centres were the Paediatric Sickle cell clinic of the University of Benin Teaching Hospital and the Sickle cell centre, both in Benin City, Nigeria. Controls consisted of age and sex-matched children with Hb AA genotype who accompanied their siblings to the hospital and well children on follow-up in the paediatric outpatient clinic. Information on clinic attendance, the number of vaso-occlusive crises and packed cell volume over the past six months were obtained from the caregivers using an interviewer-administered questionnaire. Information obtained was confirmed using the patient's case notes. The socioeconomic class of the parents was assessed using the mother's educational status and the father's occupation according to the method described by Olusanya *et al*. [11].

The researchers examined the participants while the weight was obtained using a Seca$^®$ scale (Secagmbh & co, Germany) with a sensitivity of 0.1kg. The scale was calibrated after use daily using a known weight. Children less than two years old were weighed naked (on a Bassinet scale), while older children were weighed wearing light clothing.

Standing barefoot, legs together, upright and gazing straight ahead, the height was taken to the nearest centimetre. Recumbent length was taken in children less than two years using an infant measuring board placed on a flat surface. The BMI was calculated using the formula: [Weight (kg)/ (Length/Height)^2(m^2)]. Weight for age Z-score (WAZ), height for age Z-score (HAZ,)) and Body Mass Index Z- score were calculated using 2005 WHO anthro-calculator in comparison with the National Centre for Health Statistics (NCHS) standard population. Malnutrition (stunting, underweight and wasting) was defined as HAZ ≤ -2, WAZ ≤ -2 and BMI ≤ -2, respectively.

Blood samples were obtained from any peripheral vein on the upper limb to estimate the packed cell volume and haemoglobin electrophoresis (for the controls alone).

The Statistical Package for Scientific Solutions (SPSS) version 21.0 (IBM SPSS version 21.0) was used for data analysis. Student t-test was used to compare means of continuous variables while differences in means between three or more groups were analysed using the analysis of variance (ANOVA) test. Continuous variables were summarised using means± (SD), while categorical variables were presented as frequencies and percentages.

A Chi-square statistical significance test was carried out where applicable for categorical variables. The level of significance was set at $p<0.05$ and the confidence level at 95%.

Ethics Approval

Ethical clearance was obtained from the Ethics and Research Committee of the University of Benin Teaching Hospital **(ADM/E22/A/VOL.VII/1270)** and the Ethics Committee of the Hospital Management Board, Ministry of Health, Edo State **(HM.1208/146)**. Written consent was obtained from the caregivers of the participants.

RESULTS

A total of 72 HbSS subjects and 72 HbAA controls were recruited for this study. Forty-five males (62.5%) and 27 females (37.5%) with an M:F ratio of 1.7:1 participated in the study. The mean age of the subjects and controls was 7.29 ± 4.46 years (range 1-16 years) and 7.25 ± 4.45 years (range 1 – 16 years), respectively. There was no statistical difference between their mean ages (t = 0.58 *p* = 0.954).

Table 1: Characteristics of the Study Population

Parameters	Subjects (n = 72)	Controls (n = 72)
Age (years)		
Mean (SD)	7.29 ± 4.46	7.25 ± 4.45
Age distribution (years)		
<5, n(%)	26 (36)	26 (36)
5 – 9, n(%)	21 (29.2)	21 (29.2)
10 – 14, n(%)	21 (29.2)	21 (29.2)
≥15, n(%)	4 (5.6)	4 (5.6)
Gender		
Male, n(%)	45 (62.5)	45 (62.5)
Female, n(%)	27 (37.5)	27 (37.5)
Socioeconomic class		
Upper, n(%)	18 (25)	16 (22.2)
Middle, n(%)	24 (33.3)	29 (40.3)
Lower, n(%)	30 (41.7)	27 (37.5)
Haematocrit		
Mean (SD)(range)*	24.3(4.2)(14 -34)	35.4(3.25)(27 – 42)

*p <0.5.

A higher proportion (41.7%) of the subjects belonged to the low socioeconomic class (SEC) as opposed to the control group, where the highest proportion (40.3%) belonged to the middle SEC. There was, however, no statistically significant difference in the SEC of the subjects and controls (x^2= 0.747, p=0.690). The sociodemographic characteristics of the subjects and control are shown in Table **1**. The age group of fewer than five years had the highest proportion (36.1%) while the least was in the age group of 15 – 16 years which constituted 5.6% of the total.

The mean haematocrit (24.3±4.2) of the subjects was significantly lower ((t= -17.672, p< 0.0001) than that of the controls (35.4±3.25).

The anthropometric measurements of the subjects and controls are shown in Table **2**. The mean weight, height, WAZ, HAZ and BMIZ of the subjects were lower than that of the controls, and the difference was statistically significant except for the height.

The nutritional status of the subjects and controls is depicted in Table **3**. Most (86.1%) of the subjects had normal weight for age and height for age z scores. Similarly, about three-quarters had normal body mass index z-score. The proportion of subjects with severe underweight and underweight were 8.3% and 5.6%, respectively, while that of the HbAA children was 0.0% and 2.8%, respectively, and the difference was statistically significant. The HAZ equally showed a significantly higher rate of severe stunting/stunting

Table 2: Anthropometric Measurements and Indicators of the Subjects (HbSS) and Controls (HbAA)

Characteristics	Subjects (mean±S.D.)	Controls (mean±S.D.)	t	p-value
Weight (kg)	23.25 ± 11.88	28.27 ± 15.61	-2.15	0.035*
Height (cm)	119.76 ± 24.77	125.48 ± 26.25	-1.42	0.159
WAZ	-0.65 ± 1.45	0.61 ± 1.39	-5.20	<0.0001*
HAZ	0.13 ± 1.88	1.41 ± 1.96	-4.25	<0.0001*
BMIZ	-0.98 ± 1.36	-0.32 ± 1.93	-2.35	0.021*

*p<0.05.
Kg – Kilograms cm – Centimetres WAZ –Weight for Age Z-score, HAZ – Height for Age Z-score, BMIZ – Body Mass Index Z-score.

Table 3:   Nutritional Status of the Study Subjects and Controls

Nutritional Status	Subjects n (%)	Controls n (%)	χ^2	p-value
WAZ				
Severely underweight	6(8.3)	0(0.0)	7.152	0.028*
Underweight	4(5.6)	2(2.8)		
Normal weight	62(86.1)	70(97.2)		
HAZ				
Severely stunted	3(4.2)	0(0.0)	8.109	0.017*
Stunted	7(9.7)	1(1.4)		
Normal	62(86.1)	71(98.6)		
BMIZ				
Severely thin	1(1.4)	3(4.2)		
Thin	16(22.2)	5(6.9)	12.320	0.015*
Normal	53(73.6)	58(80.6)		
Overweight	2(2.8)	1(1.4)		
Obese	0(0.0)	5(6.9)		

*p= <0.05.

Table 4:   Mean WAZ of Subjects (HbSS) by Sociodemographic Characteristics

Characteristics	Mean WAZ (SD)	n= 72	F	p-value
Sex				
Male	–0.734(1.381)	45	[†]–0.633	0.529
Female	–0.510(1.563)	27		
Age group (years)				
< 5	–0.259(1.375)	26		
5 – 9	–0.447(1.114)	21	2.273	0.088
10 – 14	–1.170(1.611)	21		
>14	–1.518(1.898)	4		
Socioeconomic class				
Low	–1.302(1.562)	30	8.121	0.001*
Middle	–0.521(0.970)	24		
High	0.266(1.275)	18		
Maternal Education				
Primary	–1.501(1.516)	15	8.830	<0.001*
Secondary	–0.918(1.370)	31		
Tertiary	0.162(1.089)	26		

*$p < 0.05$, [†]t = –0.633.

among the HBSS children in comparison with the HbAA controls. There were more severely thin children in the control group, but the prevalence of thin subjects was in the group of children with SCA. About 7% of the controls were obese, but none of the subjects was.

The mean WAZ was significantly different among the subjects across the socioeconomic and maternal educational status divide. The mean WAZ was highest in the subjects whose mothers had a tertiary level of education and decreased progressively with a lower

Table 5:   Mean HAZ of Subjects (HbSS) by Sociodemographic Characteristics

Characteristics	Mean HAZ (SD)	n= 72	F	p-value
Sex				
Male	−0.132(1.861)	45	−1.568[†]	0.121
Female	0.576(1.849)	27		
Age group (years)				
< 5	1.178(1.845)	26		
5 − 9	−0.351(1.451)	21	4.965	0.004*
10 − 14	−0.568(1.740)	21		
>14	−0.428(2.387)	4		
Socioeconomic class				
Low	−0.619(1.729)	30	10.243	<0.001*
Middle	−0.038(1.396)	24		
High	1.615(1.895)	18		
Maternal Education				
Primary	−1.275(1.555)	15	14.542	<0.001*
Secondary	−0.229(1.527)	31		
Tertiary	1.378(1.696)	26		

*$p < 0.05$, [†]t = −1.568.

Table 6:   Mean BMIZ of Subjects by Sociodemographic Characteristics

Characteristics	Mean BMIZ (SD)	n= 72	F	p-value
Sex				
Male	−0.905(1.373)	45	0.743*	0.460
Female	−1.152(1.354)	27		
Age group (years)				
< 5	− 1.405(1.210)	26		
5 − 9	−0.381(1.399)	21	2.395	0.076
10 − 14	−0.1.113(1.418)	21		
>14	−0.985(1.020)	4		
Socioeconomic class				
Low	−1.309(1.101)	30	1.383	0,258
Middle	−0.734(1.568)	24		
High	− 0.831(1.433)	18		
Maternal Education				
Primary	−1.083(1.410)	15	0.353	0.704
Secondary	−1.108(1.492)	31		
Tertiary	−0.817(1.196)	26		

*t = 0.743.

level of education. The same trend was observed when the mean WAZ was assessed in the various socioeconomic classes with the highest values in subjects whose parents belonged to the high socioeconomic class. There was a trend in the mean WAZ across the various age groups, with the lowest

values in the older subjects. This difference was, however, not statistically significant (p = 0.088). These findings are shown in Table **4**.

The association between the mean HAZ of the subjects and some sociodemographic characteristics are as shown in Table **5**. The mean HAZ in the under-five age group was significantly higher than that of the older age groups. The mean HAZ of children from low SEC and those whose mothers had lower educational status were significantly lower than those with higher SEC and maternal educational status.

The mean BMIZ of the subjects across different sociodemographic characteristics is represented in Table **6**. There was no statistically significant difference in the mean BMIZ among the various age groups, socioeconomic class and maternal educational status.

DISCUSSION

The anthropometric indices of the children with sickle cell anaemia obtained from this study were lower when compared with healthy controls. This is in consonant with previous studies [9,12]. Poor physical growth has been ascribed mainly to increased resting energy expenditure and poor food intake [13]. Children with SCA due to the hyperactivity of the bone marrow following the chronic anaemic state have increased resting energy expenditure in the range of 6 – 22% [13]. This implies that children with SCA will have less weight and height when compared with children without the disease, even if they are offered the same diet. Another major explanation is the reduced intake of food resulting from anorexia. Caloric intake may be reduced to about 80% of normal in a steady state and about 39% of normal during a painful crisis [13]. There is evidence of a rapid and sustained increase in growth when growth retarded children with SCA were given supplements by the nasogastric route [4]. A poor nutritional state may predispose affected children to infections and diseases, which may further worsen their nutritional state by increasing their metabolic demands and reducing food intake. Other factors attributed to their poor growth include endocrine dysfunction, poor nutrient absorption, and the presence of micronutrient deficiencies. In this study, although the mean weight and mean height were lower in the children with SCA, the difference was not statistically significant with the mean height. This finding suggests that weight was more affected than height in the subjects. Similar findings were reported by some authors of studies reviewed by Al-Saqladi *et al*. [4]. The proffered reason

was that children with SCA might experience a delay in epiphyseal fusion, which might result in a variable height depending on the degree of the delay.

The finding of a high proportion of the children with SCA having a normal weight and height indicates improvement in their nutritional status despite the apparent lag when compared to children with HbAA. This finding might be ascribed to the improved care offered to patients with SCA compared to previous years. The care includes genetic counselling, vaccination against pneumococcal organisms, blood transfusions, dietary advice, use of hydroxyurea and folic acid and antimalarial prophylaxis.

The 13.9% prevalence of underweight in the current study is similar to the 13.5% reported in Iraq by Fadhil *et al.* [14]. It was, however, lower than reports from a National Survey in Nigeria [10] and studies conducted in Enugu, Nigeria [15], Sudan [16] and Ghana [17,18].

The prevalence of stunting in this study is 13.9% and is comparable to that reported in other Nigerian studies conducted in Lagos [8] and Enugu [19] and a study from Brazil [20]. A lower prevalence was reported by Islam *et al*. [10] in Nigeria and from other studies from Ghana [17,18], Iraq [14] and Yemen [4].

Using the BMIZ scores, wasting was seen in 23.6 % of the subjects in this study. This is similar to that reported in other Nigerian studies [8,19] but higher than that reported in Brazil [20] and Iraq [14]. A lower prevalence was, however, reported by Islam *et al*. [10] in Nigeria. The varied prevalence of nutritional status reported from the various studies in children with sickle cell anaemia can be attributed to the diverse aetiological factors affecting nutrition in this group of children. In a meta-analysis of articles by dos Santos *et al*. [21] on the nutritional status of children and adolescents with SCA, the prevalence of underweight varied from 3.7% - 100%, while stunting varied from 8.2% - 34.9%. The factors associated with growth deficit from these studies included an increase in resting energy expenditure, low mineral bone density, reduced plasma concentration of micronutrients, low haemoglobin concentration, low dietary intake, hormonal alterations, vaso-occlusive crises and increased need for blood transfusion [21]. The extent to which these factors are present greatly contributes to the varied prevalence of nutritional deficiency.

Being overweight is an emerging nutritional problem in children with sickle cell anaemia, a disease where

historically, many children and adolescents were largely underweight [6]. Indeed before 2011, the presence of obesity and overweight was not observed in any article [21]. The current study found a 2.8% prevalence of overweight and 0% of obesity. This is comparable with the findings of Esezobor *et al*. in Lagos, Nigeria [8]. A higher prevalence was reported by Eke *et al*. in Enugu, Nigeria [7]. The study by Eke *et al*. was conducted among children aged 1-5years, an age where children are still actively fed by parents, unlike older children. In addition, that study was conducted in a state in Nigeria that has the lowest record of stunting nationally. A much higher prevalence of obesity was recorded in the USA and Brazil by Chawla *et al*. [6] and Bortelho *et al*. [22], respectively.

Poor socioeconomic status was significantly associated with underweight and stunting but not wasting. This finding is comparable with the findings of other researchers who found a significant association between either wasting or stunting or both with low socioeconomic class [8,15,23]. Sickle cell anaemia is predominantly a disorder of the low/middle socioeconomic class, which has implications for care and management [24]. The provision of a nutritious diet to meet the recommended daily allowance of nutrient needs, prompt treatment of infections, cost of transportation to the health facility for review and treatment, vaccination, and other care needs of children with SCA will most assuredly be provided more readily by caregivers belonging to the high socioeconomic status. This will ultimately contribute to the nutritional status of the affected children. This finding indicates that socioeconomic status and sickle cell disorder contribute to the children's nutritional status. The nutritional indices were better in the controls than those of the subjects despite a non-significant difference in their socioeconomic status, which suggests that the difference in the nutritional status may be attributed to the disorder in addition to the low socioeconomic status.

The lower nutritional status observed in the older subjects in this study is consonant with other studies in Lagos [8,23], Enugu [16] and Sudan [15]. The complications of the disorder tend to increase with age which may lead to an increase in resting energy expenditure with a negative impact on nutritional status. Another possible reason is inadequate dietary intake in the older age group which has been reported to be less likely to meet the nutritional recommendations for energy and micro-nutrients [17]. Reduced intake of nutrients may be due to anorexia

associated with vaso-occlusive episodes and unhealthy eating habits (skipping meals, food selection), which often occur in adolescents [4,25].

Maternal education has been widely known to positively affect children's general health and nutrition. High maternal education may translate to an attitude of positive health-seeking behaviour, immunization of children, preparation and feeding of a high-quality diet, and administration of prescribed medications, all of which translate to better health for children. Higher educational status was reported to significantly impact positively on HAZ in children without sickle cell disorder [26]. This observation was corroborated by the findings of this study in which the mean WAZ and HAZ in the subjects whose mothers had tertiary level of education were significantly higher than those with lower educational status. The association of maternal education to the nutritional status of SCA has not been studied to the best of the researchers' knowledge.

There was no significant association between nutritional status and gender in children with SCA in this study which is comparable with the findings of Kazadi *et al*. [12], Boadu *et al*. [17] and Ukoha *et al*. [19] in the Democratic Republic of Congo, Accra and Enugu respectively. In this study, although male subjects had lower mean WAZ and HAZ, the difference was not statistically significant. This is in contrast to the findings of some authors [8,27,28], who reported a significant association between nutritional status and gender, whereby the above indices were lower in males. Higher resting energy expenditure, the likelihood of vigorous outdoor activities, background inflammation and hyperactive erythroid activities in males have been suggested as reasons for this difference.

CONCLUSION

Most children with SCA have normal nutritional status despite significantly lower nutritional indicators compared to children with HbAA genotype. Higher educational status of mothers and SEC were associated with a significantly higher nutritional status among the subjects.

FUNDING

CONFLICT OF INTEREST

We declare that there is no conflict of interest.

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