Stunting In Children with Sickle Cell Anaemia in Lagos

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http://dx.doi.org/10.4314/njcm.v4i1.4

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Abstract

Background

Children with sickle cell anaemia are vulnerable to growth deficits.

Objective

To determine the prevalence of stunting among sickle cell anaemia children presenting at the sickle cell disease clinic of the Department of Paediatrics (LASUTH).

Methodology

This prospective, descriptive, cross-sectional study conducted between October 2009 and December 2009, using healthy age and sex matched controls with haemoglobin genotype AA. Height measurement was taken using standard techniques.

Results

100 children each with genotype SS and AA aged eight months to 15 years, with a mean of 75.27 (±50.276) months were studied. The mean height-for-age Z score of the AA controls was significantly higher than that of the SS subjects (0.521 ± 1.469 Vs -0.444 ± 1.861, p = 0.000). The scores were significantly lower in male children with sickle cell anaemia except >2 years to 5 years. On the contrary however, there was no significant difference between females with SCA and haemoglobin AA across all age group. The overall prevalence of stunting was significantly higher among SS subjects than AA controls (10% Vs 3%, p = 0.045). The age-specific prevalence for stunting was highest in SS as well as AA controls among subjects older than 10 years (24%, 8.0% respectively).

Conclusion

Children with sickle cell anaemia were shorter and more often stunted than AA controls. Stunting was more prevalent in older subjects and controls. Height should be routinely

measured during follow-up of sickle cell anaemia subjects to ensure early detection of stunting as this may be amenable to intervention with zinc supplementation.

Keywords: sickle cell anaemia, stunting

INTRODUCTION

Sickle cell anaemia is one of the commonest single gene disorders in man with variable distribution in different parts of the world and variable clinical manifestations.[1] Growth is a complex process of increase in size, which distinguishes adults from children. The growth of a child is the best general index of health and nutrition.[2] Anthropometry is the principal method of assessing growth. Commonly used parameters are Height/Length-for-Age, which is the most useful linear measurement and gives an indication of past nutrition.[3]

It has been shown that, as a group, children with sickle cell anaemia have poor growth.[4] Sickle cell anaemia commonly affects growth, leading to low mean weight, low mean height and decreased height velocity.[4 - 8] Growth delay starts in early childhood but becomes more apparent during adolescence when the growth spurt of normal children separates them from children with sickle cell disease.[4]

The appraisal of the patterns of stunting among children with sickle cell anaemia is important and may have positive long-term consequences on the early detection, prevention and control of stunting among that vulnerable group. It is expected that the data generated will provide an assessment tool for growth monitoring and assessment among children with sickle cell anaemia. Therefore, the main objective of this study was to determine the prevalence of stunting among children with sickle cell anaemia.

METHODOLOGY

The study is a descriptive cross-sectional one conducted between October and December 2009 among sickle cell anaemia children attending the sickle cell disease clinic of the Department of Paediatrics of Lagos State University Teaching Hospital, Ikeja, Lagos in South west Nigeria. The Lagos State University Teaching Hospital is an urban tertiary health centre in Lagos State, Western Nigeria. It is a major referral center serving the whole of Lagos State, which is a major point of entry into Nigeria from different parts of the world and the economic nerve centre of Nigeria.

Approval for the study was obtained from the Ethics Committee of the Lagos State University Teaching Hospital. Consecutive sickle cell anaemia patients who came for routine follow up clinic and have satisfied the study criteria were recruited. Healthy controls were children with genotype "AA," from the General Outpatient and follow-up clinics and healthy children attending other specialist clinics (e. g. paediatric dermatology clinic) at the Paediatric Outpatient department and were matched for age, and sex. The studied sample size was two hundred children, one hundred each with haemoglobin genotype SS and AA. In order to avoid lopsided clustering of subjects around a particular age or sex, the calculated sample size was stratified.

Inclusion criteria

1. Age six months to fifteen years.
2. Confirmed HbSS by electrophoresis.
3. Signed, informed consent of the caregiver.
4. Subjects who are in a steady state - steady state is defined as absence of any crisis in the preceding four weeks, no recent drop in the haemoglobin level and absence of any symptoms or sign attributable to an acute illness.[9]

5. Children who were not taking medications known to affect growth e.g. steroids.

Exclusion criteria

1. Children with congenital cardiac abnormality, chronic renal disease or abnormal chest wall deformity or chronic respiratory disorder.
2. Denial of consent.
3. Children with history of cerebrovascular accident.
4. All sickle cell anaemia children with history of long-term transfusion therapy

NB: The inclusion and exclusion criteria for the controls were the same as for subjects except that the haemoglobin genotype was AA.

Children two years of age and older had their heights measured using a stadiometer while the length of those below two years were measured using infantometer. The height/length measurements were measured three times. Variation among measurements was not more than 0.3 cm. The mean of these three measurements was recorded. The derived measurements were generated as standardized scores, Z scores. Standardized scores, Z scores for height was computed by means of the WHO Anthroplus Software Program.

Social classification was done using the scheme proposed by Oyedeji[10] and subjects were classified into five classes (I – V). Socio-economic index scores (1 to 5) were awarded to each subject, based on the occupational and educational levels of parents.

The data were recorded on standard proforma and entered into a standard computer system. The data was analyzed using Statistical package for social science (SPSS). The mean, median, standard deviation and other parameters of statistical location was generated as necessary for continuous data. Tests of statistical significance between subjects and controls included Student t-test and Mann-Whitney U test for means of quantitative data for data that

are normally distributed and those not normally distributed, respectively while chi-square analysis was used for categorical data. Regression and correlation models was set up and analyzed as necessary. Level of significance was set at $p < 0.05$.

RESULTS

Characteristics of the study population

A total of 200 children, 100 each with genotype SS and AA respectively, who met the study criteria, were recruited over a study period of three months (October 2009 through December 2009). The sample size calculation was based on estimated prevalence of stunting of 25% reported by Henderson RA et al[11] among sickle cell disease children with 90% power at the 5% level of difference between the two groups of 1.96 standard deviation in a two-tailed test. The age and gender distribution of the study patients are given in Table I.

Overall, the age of the subjects ranged from eight months to 15 years, with a mean of 75.27 (±50.276) months. The age of the SS subjects ranged from nine months to 15 years while that for AA controls ranged from eight months to 15 years. The mean age of the SS group of 76.98 (±50.06) months was not statistically different from 73.55 (±50.685) months in the AA-control group (t-value = 0.481, p= 0.631). The modal age group was 12-23 months.

Height/Length distribution of study subjects

The mean (±SD) height of all subjects was 114.34 (±26.836) cm. It was 113.31 (±25.887) cm and 115.38 (±27.845) cm among the SS subjects and AA controls, respectively, showing no statistically significant difference between both groups ($p = 0.586$).

The anthropometry Z-score comparison between the two study groups was done using Mann-Whitney test is shown in Table II. Overall, the length/height-for-age was significantly higher in HbAA controls than in HbSS subjects ($p = 0.000$).

The mean (±SD) height-for-age Z-score of all patients was 0.039 (±1.741). The overall mean Z-score was significantly lower among SS subjects compared to the AA controls. This pattern was duplicated across all age groups ($p < 0.05$).

The comparison of the height/length distribution according to age-group among the SS and AA subjects is shown in Tables IIIA and IIIB for males and females respectively. The boys with haemoglobin genotype AA had higher mean height than the SS subjects except at the age group >2years to 5years. Also the girls <2years and those >5years to 10years with haemoglobin SS had higher mean height values than their AA counterparts. The mean heights of males and females older than 10 years were not significantly different for HbAA subjects and their counterparts with HbSS.

Tables IVA and IVB showed the height/length Z-score distribution according to age-group and genotype of male and female subjects respectively. Overall, the scores were significantly lower in male children with sickle cell anaemia than their haemoglobin AA counterparts. This pattern was observed at all age-groups except >2 years to 5 years. Also, females with genotype SS had lower mean height-for-age Z-scores overall. On the contrary however, there was no significant difference when the results were analyzed according to age-groups ($p > 0.05$).

Prevalence of stunting among study patients

The prevalence of stunting among study subjects is shown in Table V. The stunted subjects are those whose height-for-age Z score is less than -2.0. The overall prevalence was significantly higher among SS subjects than AA controls (10% Vs 3%, $\chi 2 = 4.031$, $p=0.045$). The age-specific prevalence for stunting was highest among the age >10years to 15years in both SS subjects and AA controls (24%, 8.0% respectively).

DISCUSSION

From the result of this study the notable height differences between HbSS subjects and their HbAA controls were however only apparent when direct measurements were converted to Z-scores. Thus, while comparison of direct measurements obscured the height difference between sickle cell anaemia patients and controls, Z-scores revealed significantly lower length/height in HbSS subjects irrespective of gender. This provided corroboration for the findings of earlier workers in Nigeria[8] and elsewhere[4, 5] to the effect that HbSS tend to be shorter than HbAA controls. The finding is not unexpected as sickle cell anaemia is a chronic disease with potential adverse effect on growth. The significantly lower length/height-for-age Z scores obtained in the SS subjects can be explained by chronic ill-health, chronic anaemia and relative tissue hypoxia, low dietary intake or elevated energy requirements that characterize sickle cell anaemia.[12] The approach of using Z-scores is technically superior to comparing direct measurements because each individual in the study is subjected to a comparison with his/her peers of an agreed standard.

Specifically, comparison of height/length between HbSS subjects and controls according to age-groups did not show any clear trends when raw measurements were used. However, once again, conversion to Z-scores showed that male sickle cell anaemia subjects were significantly shorter than controls in all but one of the age-groups. Interestingly, the significant difference was not recorded in females. The explanation for the different pattern in males and females is not clear. However, due consideration should be given to the fact that as a single group, the mean height/length Z-score of female sickle cell anaemia subjects was significantly lower than that of controls. Lack of significant difference emerged on stratification according to age-groups. It is possible that the lower numbers attendant upon such stratification was responsible for the loss of significance. Another plausible explanation could be that there was a fortuitous concentration of female sickle cell anaemia with relatively less severe affection of height.

It is attractive to argue that the height of older patients would be more adversely affected because they have had the disease for a longer period, as was demonstrated albeit inconsistently, in the current study. That trend would be in keeping with previous reports of height deficits in HbSS subjects appearing with increasing age.[13–15] Incidentally, the current study was not designed to study subjects older than 15 years so it was not possible to test the suggestion of catch-up growth in height attributed to delay in epiphyseal closure.[16]

The overall prevalence of stunting among sickle cell anaemia subjects observed was 10% and 3% among SS subjects and AA controls respectively. This was lower than 25% obtained in a survey of 63 children with sickle cell anaemia in Baltimore.[17] The observed difference is possibly an effect of sample size in the Baltimore study as small sample size is known to produce exaggerated prevalence rates. However, the disparity in the age range of the study subjects may also account for this observed difference in prevalence rates of stunting; the upper age-limit for the current study is 15years while it was 18years. It is plausible that the lower prevalence of stunting in the current study was because younger children were studied than was the case in the Baltimore study. Support for the claim is found in the fact that in both the current study and the one from Baltimore, children older than 10 years were the most affected by stunting. That trend would dictate that more stunted children would be expected had our age range stretched to 18 years. The observed difference between both studies may also be due to disparity in severity of illness across the studies which would be very difficult to compare.

The age-related trend in which the oldest study group (>10years to 15years) had the highest prevalence of stunting among SS subjects may suggest that growth delay started earlier but increased disproportionately as a result of repeated illness (crises) against a chronically hypoxic background. Some authors have also reported that maximum lag in heights between children with sickle cell anaemia and controls occurred at around 10 – 15 years of age.[18]

Several factors have been implicated in the different aspects of the growth abnormalities seen in children with sickle cell disease. Nutritional studies of children with SCD have identified numerous deficits that likely contribute to growth failure. These nutritional deficits include increased energy requirements associated with increased resting energy expenditure, inadequate dietary intake, elevated nutrient requirements resulting from chronic haemolysis and erythropoiesis, and accelerated protein turnover. [19 - 22] Several studies have also reported that individuals with SCD have deficient vitamins B6[23, 24], D[25], and E [26, 27]; retinol[28] and zinc

[29 - 31], all of which may be related to growth failure in children with SCD. The current study did not set out to assess these nutritional factors but their applicability in our setting is not far-fetched considering the high prevalence rate of malnutrition.

Overall, stunting occurred most frequently in subjects and controls >10years to 15years. Stunting likely reflects malnutrition (protein, energy, and micronutrient deficits) in the growing child and adolescent with SCD and the long-term effects of severe anemia.[15] This is probably related to the well-described increased energy and micronutrient requirements as well as endocrine abnormalities such as hypogonadism, and low growth hormone production. Investigation of these claims was not part of the aims of the current study but do merit future study to determine their possible role in the etiology and potential in the treatment of stunting in SCD children and adolescents.

Several interventions have been suggested to correct growth retardation or to achieve and maintain optimal growth in children and adolescents with sickle cell anaemia. In a study by Wang et al[32] it was observed that long-term blood transfusion was associated with significantly improved height Z scores among children with sickle cell anaemia. Also, Zemel et al[31] reported an improved rate of linear growth in prepubertal children with sickle cell anaemia whose diets were supplemented with zinc sulfate. Zinc is a trace element essential for growth[33]. Thus, zinc supplementation should be considered in sickle cell anaemia children. On the other hand, a study by Abshire[34] reported that there is no correlation between plasma zinc levels and height-for-age Z score in growing adolescent patients with SCD. These findings suggested that zinc supplementation may not be necessary in all patients with SCD. More importantly, investigation of zinc levels and controlled intervention studies of zinc supplementation are needed in our setting in order to define policies on zinc supplementation to patients with sickle cell anaemia who are above 10years since this is the age at which stunting is most prevalent from the study.

In trying to proffer useful interventions for growth failure in sickle cell anaemia, it is attractive to recommend the routine use of hydroxyurea. Some workers [35] have reported better growth and health indices with its use while others [36] did not find it specifically useful in growth failure. Again, the claims are worth investigating in our own setting with a large number of sickle cell anemia subjects.

CONCLUSION

The mean height/length Z-scores for children with sickle cell anaemia is significantly lower compared to children with haemoglobin genotype AA. The sickle cell anaemia children have a greater prevalence of stunting than children with haemoglobin AA (10% and 3% respectively). The highest prevalence was observed in the >10years to 15years group.

RECOMMENDATIONS

1. Routine anthropometric measurements during follow-up clinic attendance by children with sickle cell anaemia should be encouraged to ensure early detection of stunting and subsequent intervention to correct the growth deficit.
2. Special attention should be paid to patients with sickle cell anaemia who are below 10years of age since stunting is most prevalent among children with sickle cell anaemia above 10years of age.
3. Height-for-age Z-scores showed a deficit in majority of the SS subjects and some of the AA controls. There is therefore a need for use of Z-scores rather than simple height measurements in growth monitoring.

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Table I – Age and gender distribution of study populations

Characteristics		AA	SS	ALL
Gender				
	Male	50	50	100
	Female	50	50	100
	Total	100	100	200
	Age (years)			
Male				
	<2	13(26.0)	13(26.0)	26(26.0)
	>2 – 5	13(26.0)	13(26.0)	26(26.0)
	>5 – 10	12(24.0)	12(24.0)	24(24.0)
	>10 – 15	12(24.0)	12(24.0)	24(24.0)
	Total	50	50	100
Female				
	<2	12(24.0)	12(24.0)	24(24.0)
	>2 – 5	12(24.0)	12(24.0)	24(24.0)
	>5 – 10	13(26.0)	13(26.0)	26(26.0)
	>10 – 15	13(26.0)	13(26.0)	26(26.0)
	Total	50	50	100

NB: Values in parenthesis are in % of column total

Table II: Height/Length Z-score distribution of 200 study subjects according to age but irrespective of gender

Age Group	SS	AA	M-W U -value	p-value
<2yrs				
Mean (SD)	-0.373(2.232)	0.875(0.913)	182.50	0.012*
Median	0.08	0.77		
Range	-8.29 to 3.41	-1.31 to 2.98		
>2yrs – 5yrs				
Mean (SD)	-0.068(1.156)	0.366(1.986)	203.50	0.034*
Median	-0.17	0.98		
Range	-1.98 to 1.94	-7.94 to 1.92		
>5yrs – 10yrs				
Mean (SD)	-0.111(2.006)	0.665(1.051)	171.50	0.006*
Median	-0.37	0.48		
Range	-4.93 to 7.27	-1.13 to 3.64		
>10yrs – 15yrs				
Mean (SD)	-1.224(1.744)	0.178(1.651)	162.50	0.004*
Median	-1.20	0.16		
Range	-5.02 to 3.43	-3.53 to 3.44		
All subjects				
Mean (SD)	-0.444(1.861)	0.521(1.469)	2904.00	0.000*
Median	-0.425	0.620		
Range	-8.29 to 7.27	-7.94 to 3.64		

SD = standard deviation * = statistically significant Mann-Whitney U test = (M-W U)

Table IIIA: Height/Length distribution of male subjects according to age

Age Group		SS	AA	t-value	p-value
<2yrs					
	Mean (SD)	81.31(9.008)	84.58(3.673)	-1.212	0.237
	Median	81.50	86.00		
	Range	61.00 - 98.00	77.00 – 90.00		
>2yrs – 5yrs					
	Mean (SD)	104.30(8.048)	99.85(9.982)	1.252	0.222
	Median	105.50	95.00		
	Range	92.00 - 119.00	88.00 - 117.00		
>5yrs – 10yrs					
	Mean (SD)	123.01(11.032)	130.75(8.843)	-1.897	0.071
	Median	126.00	132.50		
	Range	96.00 - 135.00	114.00 - 145.00		
>10yrs – 15yrs					
	Mean (SD)	141.35(6.868)	149.29(8.747)	-1.448	0.162
	Median	141.35	148.90		
	Range	112.00 - 174.00	136.00 - 172.00		

SD = standard deviation

Table IIIB: Height/Length distribution of female subjects according to age

Age Group		SS	AA	t-value	p-value
<2yrs					
	Mean (SD)	80.54(7.674)	78.46(6.611)	0.713	0.484
	Median	82.00	78.75		
	Range	64.00 - 90.00	70.00 – 88.00		
>2yrs – 5yrs					
	Mean (SD)	100.77(8.016)	101.75(14.410)	-0.207	0.838
	Median	100.75	105.25		
	Range	84.00 - 110.00	61.00 - 117.00		
>5yrs – 10yrs					
	Mean (SD)	128.96(8.584)	126.70(8.324)	0.682	0.502
	Median	128.50	127.00		
	Range	117.00 - 153.00	115.00 - 141.00		
>10yrs – 15yrs					
	Mean (SD)	145.64(10.835)	151.57(7.734)	-1.606	0.121
	Median	144.00	152.00		
	Range	130.00 - 164.00	139.00 - 166.00		

SD = standard deviation

Table IVA – Height/Length Z-score distribution of male subjects according to age

Age Group	SS	AA	M-W U -value	p-value
<2yrs				
Mean (SD)	-0.777(2.792)	0.869(0.891)	44.00	0.039*
Median	-0.44	0.61		
Range	-8.29 to 3.41	-0.09 to 2.98		
>2yrs – 5yrs				
Mean (SD)	0.133(1.178)	0.576(1.070)	64.50	0.311
Median	-0.04	0.75		
Range	-1.96 to 1.94	-1.11 to 1.92		
>5yrs – 10yrs				
Mean (SD)	-0.757(1.466)	0.988(1.047)	11.00	0.000*
Median	-0.37	0.62		
Range	-4.93 to 0.65	-0.14 to 3.64		
>10yrs – 15yrs				
Mean (SD)	-1.491(2.174)	-0.070(1.451)	32.00	0.02*
Median	-1.32	0.17		
Range	-5.02 to 3.43	-3.53 to 1.99		

SD = standard deviation * = statistically significant Mann-Whitney U test = (M-W U)

Table IVB – Height/Length Z-score distribution of female subjects according to age

Age Group	SS	AA	M-W U -value	p-value
<2yrs				
Mean (SD)	0.066(1.401)	0.882(0.976)	40.00	0.068
Median	0.325	0.860		
Range	-2.71 to 2.25	-1.31 to 2.25		
>2yrs – 5yrs				
Mean (SD)	-0.285(1.141)	0.138(2.692)	38.00	0.052
Median	-0.305	1.300		
Range	-1.98 to 1.54	-7.94 to 1.58		
>5yrs – 10yrs				
Mean (SD)	0.485(2.297)	0.365(1.000)	67.00	0.390
Median	-0.010	0.060		
Range	-1.46 to 7.27	-1.13 to 2.12		
>10yrs – 15yrs				
Mean (SD)	-0.977(1.271)	0.407(1.844)	47.00	0.057
Median	-1.050	0.05		
Range	-2.87 to 1.05	-2.06 to 3.44		

SD = standard deviation * = statistically significant Mann-Whitney U test = (M-W U)

Table V – Prevalence of stunting among study patients

	SS		AA	
Age group (years)	No in group	No affected	No in group	No affected
<2yrs	25	3(12.0)	25	0(0.0)
>2yrs – 5yrs	25	0(0.0)	25	1(4.0)
>5yrs – 10yrs	25	1(4.0)	25	0(0.0)
>10yrs – 15yrs	25	6(24.0)	25	2(8.0)
Total	100	10(10.0)	100	3(3.0)

NB: Values in parenthesis are in % of number in group

$\chi 2$: 4.031 p = 0.045+ + = Chi-square test ($\chi 2$)

Table VI – Characteristics of children with stunting

	SS		AA	
	No in group	No affected	No in group	No affected

Marital status of parents				
Married	95	9(9.5)	97	3(3.1)
Widowed	4	1(25.0)	1	0(0.0)
Separated	1	0(0.0)	1	0(0.0)
Single	0	0(0.0)	1	0(0.0)
Family structure				
Monogamous*	88	10(11.4)	93	3(3.2)
Polygamous*	7	0(0.0)	4	0(0.0)
Family size				
≤4	86	4(4.7)	86	1(1.2)
>4	14	6(42.9)	14	2(14.3)
Birth order of subject				
1	31	3(9.7)	36	3(8.3)
2 – 4	64	7(10.9)	60	0(0.0)
≥5	5	0(0.0)	4	0(0.0)
Socioeconomic strata				
Upper strata	38	4(10.5)	58	1(1.7)
Middle strata	43	4(9.3)	32	2(6.3)
Lower strata	19	2(10.5)	10	0(0.0)
Blood transfusion	43	6(14.0)	3	0(0.0)
Blood transfusion ever	19	2(10.5)	3	0(0.0)
Recurrent blood transfusion	24	4(16.7)	0	0(0.0)

NB: Values in parenthesis are in % of number in group

* = Based on number of subjects whose marital status of caregiver/parent is married