Anthropometric Parameters Of Children With And Without Sickle Cell Disease Admitted To The Department of Child Health, Korle Bu Teaching Hospital

Asante HJ[1], Turay I[2]*, Sodzi-Tettey N[3], Odonkor P[3]

[1]Department of Paediatrics, Family Health Medical School, Family Health University College, Teshie-Accra.

[2]Department of Child Health, Korle Bu Teaching Hospital, Accra, Ghana

[3]Department of Physiology, Family Health Medical School, Family Health University College, Teshie-Accra.

***Corresponding Author: Ishmael Turay**
Address: Department of Child Health, Korle Bu Teaching Hospital, Accra, Ghana Phone: +233 20 1399308 Email: turayishmael@gmail.com

Abstract

Introduction: A key component in the comprehensive care of children with Sickle Cell Disease is the monitoring of their nutritional status. This allows for the early detection of growth failure and related nutritional deficiencies. This study provides a valuable insight into the relationship between anthropometric parameters of children with and without Sickle Cell Disease (SCD). It also informs the development of evidence-based interventions that can improve the health and well-being of affected children.

Aim: To determine the association between the anthropometric indices of children with and without Sickle Cell Disease at the Korle Bu Teaching Hospital of Ghana.

Methods: This was a comparative cross-sectional study at the Korle Bu Teaching Hospital of Ghana. A systematic probability sampling method was used to recruit 50 children with Sickle Cell Disease and 50 without the condition. The anthropometric parameters were measured and plotted on the World Health Organization standard growth charts. Data was analyzed using IBM Statistical Package for the Social Sciences version 25.0.

Results: The prevalence of malnutrition among children with SCD who were above and below age 5 were 29% and 21.1%, respectively. This was higher than what was obtained for the control group (21% and 13%, respectively). The anthropometric characteristics of children with Sickle Cell Disease and those without it did not correlate. A significant association was however observed between the anthropometric parameters of the children with SCD and their haemoglobin values as well as the prevalence of vaso-occlusive crises within the past year (p-value <0.05).

Conclusion: This study found that children with SCD were more undernourished than their non-affected counterparts. The number of vaso-occlusive crises and hemoglobin levels were significantly influenced by anthropometric characteristics. Malnourished children with Sickle Cell Disease (SCD) were more likely to experience vaso-occlusive crises and low haemoglobin levels.

Keywords: Anthropometry, Malnutrition, Sickle Cell Disease, Pediatrics

Introduction

Sickle Cell Disease (SCD) is a genetic blood disorder that is recognized as one of the most common chronic diseases among humans with different clinical manifestations. Around 5% of the world's population is estimated to have SCD and thalassemia-associated genes, World Health Organization (WHO).[1] The majority of children born with Sickle Cell Disease live in the developing world with an estimated 240,000 born annually from Sub-Saharan Africa.[2] In Ghana, 2% of all annual newborns suffer from sickle cell disease, with 25% of the general population being carriers of the Sickle Cell Gene.[3]

Childhood is a crucial time for a person's growth and development, particularly in terms of the processes involved in the body's biological maturation, and a balanced diet can help this mechanism work better.[2] A key component of comprehensive care for children with Sickle Cell Disease is the monitoring of growth and nutritional status, which enables early detection of growth failure and related conditions.[4] Understanding the nutrient requirement for the age-group is crucial and demands complete attention because insufficient nutrient intake can lead to excesses or deficiencies, which severely jeopardizes the nutritional status.

Although there is a noticeable variation between the body shapes of children with SCD and those without SCD, the body mass index classification cut-off is regrettably the same for both groups of children.[5] Stunting and undernutrition mark the nutritional status of sickle cell patients, but some surveys have shown trends of overweight in some countries.[6-11]

There is limited information to guide the development of evidence-based interventions to enhance the health and well-being of affected children. The primary aim of this study was to examine the associations between the anthropometric parameters of children with and without SCD in a teaching hospital in Ghana.

Methods

This a comparative cross-sectional study carried out at the Department of Child Health Korle Bu Teaching Hospital (KBTH). The study population is made up of children with Sickle Cell Disease between the ages of 1 to 15 years who were attendants at the KBTH Paediatric Sickle Cell Clinic within the study period.

The control group was drawn from age-matched and sex-matched non-Sickle Cell Disease patients who were recruited from the outpatient department of the Department of Child Health (DCH), KBTH during the study period. The sample size was calculated using the Braxton-Health formula below:

$$n=(r+1)\ \frac{(p)(1-p)(Z\beta+Z\alpha/2)^2}{r\qquad (p1-p2)^2}$$

Fifty children with SCD (Cases) and fifty age-matched and sex-matched children without SCD were selected as the control group. Anthropometric measurements including weight, height, mid-upper arm circumference, and the haemoglobin levels of all participants were recorded, together with demographic details of the patients and their parents/caregivers. The Statistical Package for Social Sciences (SPSS) version 25.0 was used for the analysis. To investigate the relationships among the anthropometric indices, descriptive and inferential statistics were used. The Chi-square test of association was used to compare the anthropometric characteristics between the cases and controls. A Multivariate Analysis of Variance (MANOVA) was used to determine the association between anthropometric parameters and haemoglobin levels. The Wilks' Lambda test was used to determine the association between the number of vaso-occlusive crises among children with SCD in the previous year and their anthropometric parameters.

Ethical approval was obtained from the Ethics Committee of the Korle Bu Teaching Hospital and Family Health University College Ethics and Protocol Review Committee (FHUC-EPRC-0282023). Informed consent was obtained from the parents/caregivers and assent from children over 7 years. No personally identifying information was collected and the confidentiality of respondents was ensured.

Results

There were 64% (32) males and 36% (18) females in each group. In terms of age distribution, most of the respondents, (58%) in both groups, were between the ages of 7 and 15 years, 12% within the ages of 1 and 2 years, and the remaining were from the ages of 3 and 6 years, which represented 30% of the respondents in both groups as illustrated in Table 1.

Table 1 Demographic characteristics of Cases and Controls

		Case		Control		Total	
Demographic Variable	**Category**	**Frequency**	**Percent (%) of group**	**Frequency**	**Percent (%) of group**	**Frequency**	**Percent (%)**
Age Group (years)	1 – 2	6	12.0	6	12.0	12	12.0
	3 – 6	15	30.0	15	30.0	30	30.0
	7 – 15	29	58.0	29	58.0	58	58.0
Sex	Male	32	64.0	32	64.0	64	64.0
	Female	18	36.0	18	36.0	36	36.0
Class	Not in school	6	12.0	6	12.0	12	12.0
	Nursery	6	12.0	6	12.0	12	12.0
	Kindergarten	6	12.0	6	12.0	12	12.0
	Primary	20	40.0	20	40.0	40	40.0
	JHS	8	16.0	7	16.0	15	15.0
	SHS	4	8.0	5	8.0	9	9.0
Sex of guardian	Male	11	22.0	8	16.0	19	19.0
	Female	39	78.0	42	84.0	81	81.0
Level of Education of Guardian	None	1	2.0	1	2.0	2	2.0
	Basic	7	14.0	6	12.0	13	13.0
	JHS	4	8.0	5	10.0	9	9.0
	SHS	11	22.0	15	30.0	26	26.0
	Vocational	10	20.0	11	22.0	21	21.0
	Tertiary	17	34.0	12	24.0	39	39.0
Employment status	Employed	47	94.0	47	94.0	94	94.0
	Unemployed	3	6.0	2	4.0	5	5.0
	Retired	0	0.0	1	2.0	1	1.0
Occupation	Unemployed	3	6.0	3	6.0	6	6.0
	Professional	24	48.0	21	42.0	45	45.0
	Civil Servant	4	8.0	3	6.0	7	7.0
	Artisan	17	34.0	16	32.0	33	33.0
	Student	1	2.0	0	0.0	1	1.0
	Trader	1	2.0	7	14.0	8	8.0
Marital Status	Single	9	18.0	10	20.0	19	19.0
	Married	39	78.0	33	66.0	72	72.0
	Divorced	1	2.0	4	8.0	5	5.0
	Co-habiting	1	2.0	3	6.0	4	4.0
Ethnicity	Ga/Adangbe	12	24.0	16	32.0	28	28.0
	Akan	23	46.0	21	42.0	44	44.0
	Ewe	9	18.0	8	16.0	17	17.0
	Northerner	5	10.0	5	10.0	10	10.0
	Other	1	2.0	0	0.0	1	1.0

Weight for Height (WFH), Length/Height for Age (L/HFA), Weight for Age (WFA), and Mid Upper Arm Circumference (MUAC) were plotted for all participants below the age of 5 years (38). Body Mass Index (BMI) for Age and HFA was computed for all those over the age of 5 years (62). The comparison of the nutritional status of respondents in the cases and control groups are presented using tables.

From Table 2, many of the respondents in both groups had normal weight for height measurements. There were 73.7% (14) respondents in the cases group who were of normal weight as against 84.2% (16) of cases in the control group. Around 21% (4) of the respondents with SCD were found to be moderately malnourished compared to none from the control group. The Chi-square test was used to determine the association between the weight-for-height measurements for both groups. There was no significant association between the two groups.

Table 2 Weight for height for the cases and the control groups of under 5.

Weight for Height	Cases	(%)	Control	(%)	P value
Obese	1	5.2	1	5.2	0.10
Overweight	0	0.0	2	10.5	
Normal	14	73.7	16	84.3	
Moderately Malnourished	4	21.1	0	0.0	
Total	**19**	**100.0**	**19**	**100.0**	

It was observed that most of the respondents had normal height-for-age; 74% (14) of cases with SCD as compared to 63% (12) without the disease. Eleven percent (2) of the cases were stunted compared to 5.2 % (1) from the control group. The number of respondents in the control group who were tall for their age, 31.6% (6), was twice the number in the cases group who were in the same category, 15.8%. The chi-square test yielded a p-value of 0.475 which was not evidence enough to suggest a significant association between the two groups in terms of their height for age measurement

Many of the respondents in the two groups had normal Mid-Upper Arm Circumference (MUAC) measurements; 84.2% (16) in the cases group and 89.5% (17) in the control group. About 16% (3) of participants in the SCD group were moderately malnourished as against 11% (2) in the control group. The chi-square was however 0.631. thus, failing to reject the null hypothesis.

In terms of weight for age, 22 (70.0%) of the respondents in the control group were either of normal weight, or overweight/obese. There were no reports of underweight among participants in the control group. In the SCD group, 73.7% (14) of respondents were of normal weight, compared to 89.5% (17) in the control group. Malnourished responders made up 21.1% (4) of the SCD group. This indicates a higher prevalence of malnutrition among children with SCD than those without the disease. The p-value was, however, 0.099.

Table 3 shows the distribution of participants based on their BMI for age, i.e. for both cases and controls. This was calculated for all participants over the age of 5 years. A large proportion of the interviewees in the two groups were noted to be of normal weight: 77.4% (24) in the control group and 67.8% (21) in the case group. Compared to the control group's 13% (4), respondents in the SCD group's 29% (9) respondents were significantly thinner. The chi-square test however yielded a p-value of 0.343.

Table 3 BMI for age for both the SCD and Non-SCD of groups 5 years and above.

Weight for Height	Count	(%)	Count	(%)	p value
Obese	1	3.2	1	3.2	0.34
Overweight	0	0.0	2	6.4	
Normal	21	67.8	24	77.4	
Thinness	4	12.9	1	3.2	
Severely Thin	5	16.1	3	9.8	
Total	**31**	**100.0**	**31**	**100.0**	

In the control group, the mean haemoglobin level was observed to be 11.99g/dl, while in the cases group, it was found to be 8.62g/dl. Furthermore, the spread or variability of haemoglobin levels differed between the two groups. The standard deviation of haemoglobin levels was 2.18 for non-SCD patients, while for SCD patients, it was 1.62. A p-value of <0.001 was obtained indicating a significant association between

the categorical anthropometric measurement and haemoglobin levels.

It was shown that 44% of Cases had no incidence of vaso-occlusive crises in the previous year, whereas the remaining 66%(66) had at least one episode. About 6% of respondents reported experiencing at least three episodes of vaso-occlusive crises in the previous year. Further analysis of the crises revealed that 42.8%(28) of the respondents who had at least one crisis over the past year mainly suffered from hyper-hemolytic crisis accompanied by the passage of cola-colored urine.

Table 4 shows the distribution of participants with SCD based on the number of admissions in the previous year. About 85.8% of SCD patients who experienced at least one crisis in the previous year were admitted to the hospital at least once.

The majority of those who had at least one admission (21/24,87.5%) were diagnosed with abdominal vaso-occlusive crises, 29%(7) presented with chest discomfort, and 16.7% (4)with bone pain crises.

Table 4 Number of Admissions among SCD respondents.

Number of Admissions	Frequency	Percent (%)
0	4	14.2
1	12	42.8
2	8	28.6
3	2	7.1
4	2	14.3
Total	**28**	**100.00**

The Wilks' Lambda test was used to determine the association between the number of vaso-occlusive crises and the anthropometric parameters. The p-value obtained was <0.001 indicating a significant association between the categorical anthropometric measures and the prevalence of vaso-occlusive crisis.

Discussion

The nutritional status of SCD and non-SCD patients were compared using the Z-scores of weights for height, weight for age, height for age, BMI for age, and MUAC for both groups. The findings from the current study differ from that of a study by Mukherjee and Gangakhedar (2004)[8] who found that in comparison to healthy children of the same sex and age, male and female SCD patients were shown to have reduced weights, heights, sitting heights, mid-upper arm circumferences, skin fold thickness, and body mass indices. These findings lead to the conclusion that SCD patients tend to be smaller, shorter, and undernourished than Non-Sickle Cell Disease children. It is also different from a study by Osei-Yeboah and Rodrigues (2011)[12] who found that 61.3% of SCD patients were malnourished as compared to 28.35% of non SCD patients. This is however similar to that of Mitchelle et al.,[9] who found out that children with SCD generally exhibit normal growth during childhood and adolescence although 5-10% are at risk of poor growth or obesity. In all of the anthropometric indices between the SCD and non-SCD, it was observed that there was no significant association between the indices and the respondents. Therefore, it can be inferred that the prevalence of undernutrition among participants with SCD has improved over time. This improvement may be ascribed to health education initiatives and improved SCD patient health care services, including enhanced functioning of sickle cell clinics, various treatment options, and routine monitoring.

The mean haemoglobin level among SCD patients in this study is lower than non-SCD patients and there is also greater variability in haemoglobin levels among the non-SCD patients than SCD patients. Comparing the findings from this study to that of a study conducted by Islam et al., [5] in Nigeria, the mean haemoglobin levels obtained were slightly lower than what was obtained in the current study. A significant association was noted between anthropometric measurements and haemoglobin levels of children with SCD. Mandese et al., demonstrated that low body weight and BMI might adversely affect total haemoglobin levels.[7] Dos Santos et al., on the nutritional status of children and adolescents with Sickle Cell Disease observed that, there was a significant association between the nutritional status of children and adolescents with SCD and their haemoglobin levels. SCD patients are known to have low haemoglobin levels despite their nutritional status as compared to non-Sickle Cell

Disease children.[4] This is similar to findings from the current study in which a significant decrease in the haemoglobin levels of children with SCD compared to those without the disease was noted. This may be attributed to the underlying genetic basis of the disease.[5]

A research on the management of vaso-occlusive crisis in Sickle Cell Disease, Yale et al., found that the most prevalent sites of discomfort were the chest, abdomen, and back.[13] Salako et al., 2020 on the pattern and severity of vaso-occlusive crises in SCD patients found that the commonest sites of pain were the extremities (upper and lower limbs) though pain in the lower limbs were commoner.[14] Sixty-six per cent of the SCD patients in this study experienced at least one crisis in the previous 12 months. Haemolytic crises accounted for 42.8% of all reported crises, with abdominal pain and acute chest syndrome (chest pain) following closely behind. This may be explained by the fact that the majority of study participants were dehydrated and were at risk of malaria and other infectious diseases that may have predisposed them to haemolysis.

From the current study, the highest number of admissions within a year reported by a participant was 4 and this was reported by 14.3% of the participants. Most of the participants representing 42.8% of those with SCD had been admitted once, whilst 14% had no admission within the past year. These findings are contrary to what was found in a systemic literature review of 1436 literature on the frequency of vaso-occlusive crises in SCD patients. It was reported that the proportion of patients experiencing ≥3 VOCs/year ranged from 4 to 67% and the proportion of patients experiencing ≥5 VOCs/year ranged from 18 to 59%.[15] This is likely because of the limitation in our sample size compared to the other studies.

The limitations of this study include no consideration made for participants' dietary habits, medication schedule, and level of physical activity, however comparism of demographically match cases and controls could mitigate this limitation.

Conclusion

The findings of this study indicate that the prevalence of undernutrition among respondents with SCD was relatively higher than those without the condition. There was no significant association between the nutritional status of children with and without SCD. A statistically significant association was however obtained between the anthropometric measurements and the haemoglobin levels of participants from the two groups. Among the children with sickle cell disease, the number of vaso-occlusive crises that occurred in the previous year is also statistically and significantly influenced by their nutritional status.

Acknowledgement

The authors are grateful to the Department of Child Health, KBTH for the support during the study. Appreciation also goes to the parents/guardians and children for participating in this study.

Conflict of Interest

The authors declare that they have no competing interest.

References

1. World Health Organization. Sickle cell disease. Regional Office for Africa. 2021. Available from: https://www.afro.who.int/health-topics/sickle-cell-disease.

2. Araujo J, Araújo L, Lima C, Souza M. Food consumption and nutritional status of children with sickle cell disease: a systematic review. Rev Aten Saúde. 2022;20(72):80-91.

3. Boadu I, Ohemeng A, Renner LA. Dietary intakes and nutritional status of children with sickle cell disease at the Princess Marie Louise Hospital, Accra - A survey. BMC Nutr. 2018;4(1). Available from: https://doi.org/10.1186/s40795-018-0241-z.

4. dos Santos SA, de Oliveira CL, Cortez PI, Rodriguez CSC. Nutritional status of children and adolescents with sickle cell disease. J Nutr Med Diet Care. 2018;4:027. Available from: doi.org/10.23937/2572-3278.1510027.

5. Islam MR, Moinuddin M, Ahmed A, et al. Association of sickle cell disease with anthropometric indices among under-five children: evidence from 2018 Nigeria Demographic and Health Survey. BMC Med. 2021;19:5. Available from: https://doi.org/10.1186/s12916-020-01879-1.

6. Kuissi Kamgaing E, Minto'o Rogombe S, Minko J, Eyi Zang C, Bisvigou U, Koko J, et al. Linear growth and nutritional status of young Gabonese sickle cell patients, and associated factors. Int J Clin Pediatr. 2018;7(1-2):1-5. Available from: https://doi.org/10.14740/ijcp290w.

7. Mandese V, Marotti F, Bedetti L, Bigi E, Palazzi G, Iughetti L. Effects of nutritional intake on disease severity in children with sickle cell disease. Nutr J. 2016;15(1):46.

8. Mukherjee MB, Gangakhedkar R. Physical growth of children with sickle cell disease. Indian J Hum Genet. 2004;10.

9. Mitchell MJ, Carpenter GJ, Crosby LE, Bishop CT, Hines J, Noll J. Growth status in children and adolescents with sickle cell disease. Pediatr Hematol Oncol. 2009;26(4):202-215.

10. Osei TB, Apprey C, Mills-Robertson FC, Ohemeng AN. Nutritional status of children with sickle cell disease: A study at the Komfo Anokye Teaching Hospital of Ghana. Nutr Food Sci. 2019;49(2):232-239. Available from: https://doi.org/10.1108/NFS-03-2018-0100.

11. Osei-Yeboah CT, Rodrigues O. Renal status of children with sickle cell disease in Accra, Ghana. West Afr J Med. 2011;45.

12. Osei-Yeboah C, Rodrigues O, Enweronu-Laryea C. Nutritional status of children with sickle cell disease at Korle Bu Teaching Hospital, Accra, Ghana. West Afr J Med. 2011;30(4):262-267. PMID: 22669830.

13. Yale SH, Nagib N, Guthrie T. Approach to the vaso-occlusive crisis in adults with sickle cell disease. Am Fam Physician. 2000;61(5):1349-1356, 1363-1364. PMID: 10735342.

14. Salako A, Aworanti O, Okoli C, Odubela O, Ogundeji S. Pattern and severity of vaso occlusive crisis in pediatric sickle cell anemia patients. Acad J Ped Neonatol. 2020;9(5):555828. Available from: doi: 10.19080/AJPN.2020.09.555828.

15. Zaidi AU, Glaros AK, Lee S. A systematic literature review of frequency of vaso-occlusive crises in sickle cell disease. Orphanet J Rare Dis. 2021;16:460. Available from: https://doi.org/10.1186/s13023-021-02096-6.