Factors associated with undernutrition among children with sickle cell disease attending the sickle cell clinic in Mulago National Referral Hospital, Uganda

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Abstract

Background Sickle cell disease (SCD) is among the neglected non-communicable diseases, which significantly contributes to early childhood mortality. In Uganda, over 20,000 children are estimated to be sicklers. Undernutrition is common among children with SCD and contributes to increased morbidity and mortality. There is paucity of data on prevalence of undernutrition and associated factors in Uganda. Objective To assess the extent of undernutrition and related factors among children aged 5-12 years with SCD attending the sickle cell clinic at Mulago hospital, Uganda. Methods A total of 263 children with SCD attending the sickle cell clinic at Mulago National Referral hospital were recruited consecutively between May and June 2017. The nutritional status of the children was assessed by weight-for-age, BMI-for-age, and height-for-age z-scores calculated using STATA in accordance with WHO 2007 growth standards. Binomial regression was conducted to assess the predictors of undernutrition. Results About 20.2%, 11.4%, and 13.7% of the children were underweight, wasted and stunted respectively. Wasting was significantly associated with older age (10-12 years) (AOR=4.20, CI=2.18-8.10) and living in a female headed household (AOR=0.43, CI=0.19-0.99). Stunting was significantly associated with older age (10-12 years) (AOR=2.90, CI=1.39-6.06). Underweight was significantly associated with older age (10-12 years) (AOR=2.23, CI=1.05-5.16). Conclusion Underweight, wasting and stunting were prevalent among children with SCD attending Mulago hospital. The factors associated with undernutrition were older age and living in a female headed household.

Background

Sickle cell disease (SCD) remains a major neglected tropical disease in Africa(1). The disease is a genetic disorder that affects the shape of haemoglobin in the red blood cell leading to formation of a sickle shape(2). The sickle shape contributes to co-morbidities through the life time including pulmonary hypertension, stroke, organ damage, gall bladder disease and premature mortality(3). Globally, 250,000 out of 300,000 infants born with haemoglobin disorders every year have SCD(1). Furthermore, an estimated 240,000 children in low and middle income countries are born with SCD annually of which 50%-80% die before the age of five years(2). In Uganda, about 20,000 children are born with SCD every year(4). This could be an under estimate since majority of the children are not tested in most districts in the country(5).

Several nutrient deficiencies have been reported among children with SCD and this greatly affects their quality of life(6). Undernutrition(stunting, underweight and wasting) are a common occurrence among children with SCD in Africa(6-8).

SCD has been known to cause undernutrition by increased metabolic demands, chronic and acute vaso-occlusions, poor appetite and compromised absorption(8). Other factors that influence undernutrition among children with SCD include: being a male, older age, household income, duration of exclusive breastfeeding, average weight during childhood, average number of hospitalization, anaemia severity, geographical location (urban vs. rural), history of hand and foot syndrome, more than two sickle cell crises a year, medical history of severe infections and presence of hepatomegaly(7).

Previous studies on undernutrition in children with SCD have focused on the prevalence of the condition however data on the factors associated in developing countries is scarce (7,9-11). The objective of this study was to assess the prevalence and factors associated with undernutrition among children with sickle cell disease attending the sickle cell clinic in Mulago National Referral Hospital (MNRH), Uganda.

Methods

This was a hospital based cross-sectional study conducted among 270 children with SCD who were attending the sickle cell clinic in MNRH from May to June 2017. MNRH is a tertiary hospital and serves as a national center for managing cases with SCD. On average it manages 800 sickle cell patients from across the country each month. We consecutively sampled confirmed cases of SCD aged 5-12 years attending the outpatient clinic whose caretakers provided consent to participate in the study. Recruitment of study participants was conducted as they waited for their monthly routine medical care. Very ill eligible children who needed hospitalization were excluded.

Sample size

The sample size was determined using the formula for single proportion by Kish Leslie, 1969.

Where: n = sample size; z = z value corresponding to 95% confidence interval = 1.96; p = proportion of malnutrition among SCD children = 22.7%(8) = 0.227; (8) q = $(1-p)$ = $(1-0.227)$ = 0.773 = absolute precision = 5%. Therefore, from the above formula sample size was 270.

A structured interview administered questionnaire was used to collect child weight, height, socio-demographic, co-morbidities, food intake, and household characteristics information from caretakers.

Weight of the children was measured in kilograms using a calibrated Seca 874 electronic weighing scale (9). The children were requested to take off their shoes and heavy garments and asked to stand in the middle of the platform to evenly distribute the weight to both feet(10). The weight was recorded to the nearest 0.1kg.

Height was measured in centimeters using a stadiometer. Children were asked to remove their shoes, hair ornaments and stand erect with the back to the stadiometer. With the back of the head, upper back, buttocks, back of the legs and heels in contact with the board, relaxed arms and the eyes looking horizontally, the head piece of the stadiometer was lowered so that the hair (if present) was pressed flat, height was recorded to the nearest 0.1cm.

Study variables

The dependent variable in this study was under nutrition (wasting, underweight and stunting) measured by <-2 Z-scores of BMI-for-age, weight-for-age and height-for-age anthropometric indices respectively.

The independent variables were categorized into child characteristics and caretaker / household characteristics.

The child characteristics included: age (5-9 years and 10-12 years), sex (male, female), birth order (1st, 2nd-3rd, 4th and above), morbidities experienced in the past two weeks before the study (Acute respiratory infection, fever and diarrhea) and food intake. Food intake was assessed using the validated dietary diversity score which was based on the 10 food groups consumed in the past twenty-four hours prior to the study(11). For each of the food groups consumed, a child was awarded a score of one or zero if the food group was consumed or not consumed respectively. A dietary diversity score (DDS) cut-off was constructed to describe the dietary diversity with a sum of 0-3 as inadequate DDS and 4-10 as adequate DDS score(11).

The care taker/ household characteristics included: Age of care taker (20-24, 25-29, 30-34 and above 35 years), marital status(married/living together, not married), highest level of education (primary, O level, A level, tertiary and university), main occupation(salaried worker, business, labourer, peasant farmer, house wife and other), sex of household head (male headed, female headed), number of children (1-2, 3-4, 5 and above), average household size and household wealth index. Household wealth was computed using the principal component analysis. The variables considered were obtained using questions in the 2016 Uganda Health Demographic Survey regarding asset and access variables namely: owning: 1) a radio, 2) a television, 3) mobile phone, 4) a bicycle, 5) a motorcycle, 6) a motor vehicle, 7) a piece of land, 8) large farm animals like cattle, goats and sheep, 9) small farm animals like poultry, 10) a manufactured bed, and 11) the nature of the house(12). Household wealth index was ranked into two quintiles from the lowest to the highest (1=Low and 2=Highest).

Data analyses

Data was exported from excel to stata14.0 for analysis (Statacorp, 2015). Socio demographic data was summarized using descriptive statistics like proportions and frequencies for categorical variables and mean and standard deviations for continuous variables as appropriate. Anthropometric measurements of height and weight were used to determine undernutrition(9). Height and age were converted from centimeters to meters and years to months respectively. Body Mass Index (BMI) was calculated then the BMI for age z-scores, weight for age z-scores and height for age z-scores were computed using the WHO reference growth standards. Normal nutritional status was defined as z-scores ≥-2 and undernutrition (underweight, wasting and stunting) was defined as z-sores <-2. The prevalence of underweight stunting and wasting was expressed in percentages.

In order to ascertain the factors that were associated with undernutrition we started with univariable and bivariable analysis. The factors that had a potential for being considered in the multivariable model were variables found to be statistically significant at bivariable level, factors with a P-value of < 0.2 and the insignificant variables which were deemed to be important in influencing undernutrition according to literature. We later performed multivariable analysis using binary logistic regression approach controlling for factors identified under bivariable analysis and literature. The strength of the association between variables was determined using odds ratios, P-values (α set at <0.05) and 95% confidence interval. Models were built using the stepwise regression method. Confounding was checked by observing whether variables included in the model caused a change in the odds ratio of the main exposure by at least 10%. Also confounding was checked by assessing whether variables that were insignificant at bivariable stage became significant at the multivariable level. Variables in a model that were found consistently insignificant and did not add any value in terms of goodness of fit were eliminated. The model goodness of fit was tested using Hosmer-Lemeshow goodness of fit test.

Results

From the total of 270 child care-taker pairs recruited, only 263 child-caretaker pairs were included in the final analysis because some were outliers according to the WHO anthropometric indicator cut-offs. The mean age of the children was eight years (SD±2) and majority 66.5% (175/263) were in the age group 5-9 years (Table 1). A small proportion of the children had other morbidities in the past 2 weeks including acute respiratory infection 49.1% (129/263), fever 41.4% (109/263) and diarrhea 17.9% (47/263).

Table 1: Characteristics of study participants

Child Characteristics	Frequency (n=263)	Percent
Age (Years)		
5-9	175	66.5
10-12	88	33.5
Sex		
Male	126	47.9
Dietary Diversity Score		
Inadequate	134	50.9
Adequate	129	49.1
Birth order		
1 st	74	28.1
2 nd ,3 rd	121	46.0
4 th and above	68	25.9
Morbidities in the past two weeks		
Acute respiratory infection (ARI)	129	49.1
Fever	109	41.4
Diarrhea	47	17.9

The social demographic characteristics of the caretakers are shown in table 2. The mean age of caretakers was 33 years (SD8years). Majority 70.3 % (185/263) of the caretakers were married, and about half 45.6% (120/263) had attained secondary education. Majority 73.0 % (193/263) of the respondents came from male headed households. The average household size was 5 people (SD2 people).

Table 2: Characteristics of the caretakers and their households

Care taker characteristics	Frequency (n=263)	Percent (%)
Caretaker Age (years)		
20-24	23	8.8
25-29	65	24.7
30-34	75	28.5
≥35	100	38.0
Current marital status		
Married/Living together	185	70.3
Not married	78	29.7
Highest Level of education		
Primary	92	35.0
O' level	105	39.9
A' level	15	5.7
Tertiary	33	12.6
University	18	6.8
Main Occupation		
Salaried worker	40	15.2
Business	91	34.6
Labourer	10	3.8
Peasant farmer	20	7.6
Housewife	71	27.0
Other	31	11.8
Sex of household head		
Male headed	193	73.4
Female headed	70	26.6
Number of children		
1-2	76	28.9
3-4	127	48.3
5 and above	60	22.8
Average household size	5 (SD 2)	
Wealth index		
Lowest	87	33.1
Middle	88	33.4
Highest	88	33.5

Prevalence of wasting, stunting and underweight

The children's weight ranged from 14.2 - 46.0 kg, height ranged from 100.9 - 157.6 cm, and BMI ranged from 12.1 - 20.1 kg/m². Mean z-scores for wasting, stunting and underweight were -1.08 ± 1.07 , -0.81 ± 1.07 and 0.81 ± 1.02 respectively. About 11.4% (30/263) were wasted 13.7% (36/263) were stunted, while 20.2% (53/263) of the children were underweight; details are shown in table 3.

Table 3: Nutrition status of study participants

Variable	Mean ±SD	Frequency (n=263)	Percentage (%)
Weight (kg)	22.75±5.68	-	-
Height (cm)	122.12±12.39	-	-
BMI (kg/m ²)	15.04±1.39	-	-
z-scores for wasting	-1.08 ± 1.07	-	-
z-scores for stunting	-0.80 ± 1.16	-	-
z-scores for underweight	0.81 ± 1.02	-	-
Wasting	-	30	11.4
Stunting	-	36	13.7
Underweight	-	53	20.2

Factors associated with wasting of study participants.

Wasting was significantly associated with age of the child and sex of household head (Table 4). Children aged 10-12 years were more likely to be wasted compared to their counterparts (AOR=4.27, CI=2.20-8.29). Additionally, children who were born in female headed households were less likely to be wasted compared to those born in male headed households (AOR=0.39, CI=0.16-0.92).

Table 4: Factors associated with wasting of study participants

Characteristics	Wasted		Crude OR (95%CI)	P value	Adjusted OR (95%CI)	P value
	No (n=233)	Yes (n=30)				
Age of child (Years)						
5-9	161(92.0)	14(8.0)	1.00		1.00	
10-12	72(81.8)	16(18.2)	2.56(1.18-5.52)	0.017	4.27(2.20- 8.29)	<0.01
Sex of child						
Male	113(89.7)	13(10.3)	1.00			
Female	120(87.6)	17(12.4)	1.23(0.57-2.65)	0.595		
ARI^B co morbidity						
Yes	114(88.4)	15(11.6)	1.00		1.00	
No	119(88.8)	15(11.2)	0.96(0.45-2.05)	0.912	1.37(.699- 2.698)	0.36
Fever^B co morbidity						
Yes	93(85.3)	16(14.7)	1.00		1.00	
No	140(90.9)	14(9.1)	0.58(0.27-1.25)	0.164	.685 (0.34-1.36)	0.28
Diarrhea^B co morbidity						
Yes	41(87.2)	6(12.8)	1.00		1.00	
No	192(88.9)	24(11.1)	0.85(0.33-2.22)	0.747	0.82(0.36-1.85)	0.63
Dietary Diversity Score						
Inadequate	116(86.6)	18(13.4)	1.00			
Adequate	117(90.7)	12(9.3)	0.66(0.30-1.43)	0.295		
Birth order						
1 st	66(89.2)	8(10.8)	1.00			
2 nd to 3 rd	105(86.8)	16(13.2)	1.26(0.51-3.10)	0.619		
4 and above	62(91.2)	6(8.8)	0.80(0.26-2.43)	0.692		
Sex of household head						
Male	171(88.6)	22(11.4)	1.00		1.00	
Female	62(88.6)	8(11.4)	1.00(0.42-2.37)	0.995	0.39(0.16-0.92)	0.03
Marital status of caretaker						
Married	166(89.7)	19(10.3)	1.00			
Not married	67(85.9)	11(14.1)	1.43(0.65-3.18)	0.374		
Number of children by caretaker						
1 to 2	68(89.5)	8(10.5)	1.00			
3 to 4	112(88.2)	15(11.8)	1.14(0.46-2.83)	0.780		
5 and above	53(88.3)	7(11.7)	1.12(0.38-3.29)	0.833		
Family size						
≤5 people	147(90.7)	15(9.3)	1.00		1.00	
>5 people	86(85.2)	15(14.8)	1.71(0.80-3.67)	0.169	1.71(0.89-3.30)	0.109
Wealth index						
Low	112(48.1)	20(66.7)	1.00		1.00	
High	121(51.9)	10(33.3)	0.46(0.21-1.03)	0.060	0.77(0.39-1.54)	0.46

^B=Illnesses experienced by child two weeks prior to study

Factors associated with stunting of study participants

In the present study stunting was independently associated with age of the child as shown in Table 5. Children aged 10-12 years were more likely to be stunted compared to their counterparts (AOR=2.90, CI=1.39-6.06).

Table 5: Factors associated with stunting of study participants

Characteristics	Stunted		Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
	No (n=227)	Yes (n=36)				
Age of child						
5-9years	159(90.9)	16(9.1)	1.00		1.00	
10-12years	68(77.3)	20(22.7)	2.92(1.43-5.98)	0.003	2.90(1.39-6.06)	0.005
Sex of child						
Male	111(88.1)	15(11.9)	1.00			
Female	116(84.7)	21(15.3)	1.34(0.66-2.73)	0.420		
Child experienced ARI^B						
Yes	114(88.4)	15(11.6)	1.00			
No	113(84.3)	21(15.7)	1.41(0.69-2.88)	0.342		
Child experienced Fever^B						
Yes	92(84.4)	17(15.6)	1.00			
No	135(88.7)	19(12.3)	0.76(0.38-1.54)	0.450		
Child experienced Diarrhea^B						
Yes	39(83.0)	8(17.0)	1.00			
No	188(87.0)	28(13.0)	0.73(0.31-1.71)	0.465		
Child Dietary Diversity Score						
Inadequate	116(86.6)	18(13.4)	1.00			
Adequate	111(86.1)	18(13.9)	1.05(0.52-2.11)	0.902		
Child birth position						
1 st	64(86.5)	10(13.5)	1.00			
2nd to 3 rd	104(86.0)	17(14.0)	1.05(0.45 - 2.43)	0.916		
4 th and above ^h	59(86.8)	9(13.2)	0.98(0.37-2.57)	0.961		
Sex of household head						
Male	164(85.0)	29(15.0)	1.00		1.00	
Female	63(90.0)	7(10.0)	0.63(0.26-1.51)	0.298	0.41(0.13-1.28)	0.124
Marital status of caretaker						
Married	160(86.5)	25(13.5)	1.00		1.00	
Not married	67(85.9)	11(14.1)	1.05(0.49-2.26)	0.899	1.80(0.66-4.89)	0.254
Number of children by caretaker						
1-2	70(92.1)	6(7.9)	1.00		1.00	
3 to 4	107(84.3)	20(15.7)	2.18(0.83-5.70)	0.112	1.92(0.71-5.19)	0.196
5 and above	50(86.3)	10(13.7)	2.33(0.80-6.84)	0.122	1.85(0.60-5.71)	0.283
Family size						
≤5 people	140(86.4)	22(13.6)	1.00			
>5 people	87(86.1)	14(13.9)	1.02(0.50-2.11)	0.949		
Wealth index						
Low	111(48.9)	21(58.3)	1.00			
High	116(51.1)	15(41.7)	0.80(0.43-1.46)	0.46		

Factors associated with underweight of study participants

Underweight was associated with age of the child and household wealth index (Table 6). Children aged 10-12 years were more likely to be underweight compared to their counterparts (AOR=2.23, CI=1.05-5.16).

Table 6: Factors associated with underweight of study participants

Characteristics	Underweight		Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
	No (n=210)	Yes (n=53)				
Age of child						
5-9years	154(88.0)	21(12.0)	1.00		1.00	
10-12years	56(63.6)	32(36.4)	4.19(2.23-7.87)	< 0.001	2.2(1.03-5.02)*	< 0.001
Sex of child						
Male	101(80.2)	25(19.8)	1.00			
Female	109(79.6)	28(20.4)	1.04(0.57-1.90)	0.904		
ARI ^B co morbidity						
Yes	103(79.8)	26(20.2)	1.00			
No	107(79.9)	27(20.1)	1.00(0.55-1.83)	0.999		
Fever ^B co morbidity						
Yes	82(75.2)	27(24.8)	1.00		1.00	
No	128(83.1)	26(16.9)	0.62(0.34-1.13)	0.118	0.66(0.30-1.44)	0.289
Diarrhea ^B co morbidity						
Yes	36(76.6)	11(23.4)	1.00			
No	174(80.6)	42(19.4)	0.79(0.37-1.68)	0.540		
Dietary Diversity Score						
Inadequate	108(80.6)	26(19.4)	1.00			
Adequate	102(79.1)	27(20.9)	1.10(0.60-2.01)	0.785		
Birth position						
1 st	62(83.8)	12(16.2)	1.00			
2 nd to 3 rd	92(76.0)	29(24.0)	1.63(0.77-3.43)	0.200		
4 th and above	56(82.4)	12(17.6)	1.11(0.46-2.66)	0.820		
Sex of household head						
Male	149(77.2)	44(22.8)	1.00		1.00	
Female	61(87.1)	9(12.9)	0.50(0.23-1.09)	0.08	0.67(0.21-2.10)	0.048
Caretaker Marital status						
Married	148(80.0)	37(20.0)	1.00		1.00	
Not married	62(79.5)	16(20.5)	1.03(0.53-1.99)	0.925	1.81(0.62-5.27)	
Number of children by caretaker						
1 to 2	66(86.8)	10(13.2)	1.00			
3 to 4	101(79.5)	26(20.5)	1.70(0.77-3.75)	0.190		
5 and above	43(71.7)	17(28.3)	2.61(1.09-6.23)	0.031		
Family size						
≤5 people	137(84.6)	25(15.4)	1.00		1.00	
>5 people	73(72.3)	28(27.7)	2.10(1.14-3.87)	0.017	1.60(0.72-3.58)	0.129
Wealth index						
Low	103(78.0)	29(22.0)	1.00			
High	107(81.7)	24(18.3)	0.80(0.43-1.46)	0.461		

^B=Illnesses experienced by child two weeks prior to study

Discussion

The aim of the study was to assess the factors associated with undernutrition in children with SCD aged 5-12 years attending the sickle cell clinic in MNRH. The findings revealed that older age (10-12 years) and living in a female headed household were significantly associated with undernutrition.

In this study about 20.2%, 11.4%, and 13.7% of the children were underweight, wasted and stunted respectively. This shows that undernutrition was prevalent among children with SCD according to the WHO categorisation (13). Undernutrition has a negative impact on the quality of life of children with SCD (14). Evidence from a cohort study conducted in Tanzania reported an increased risk of hospitalisation with undernutrition among patients with SCD particularly with wasting (15).

A prevalence of 20.2% was reported for underweight in this study. Similar observations were made in a recent study conducted in Accra (16). On the other hand high prevalence's have been reported for example in Tanzania (36.2%) (15). This might be explained by the difference in age groups of the study participants that is five to twelve years in the present study versus 0.5 to 48 years in the Tanzanian study which did not look at the prevalence for the children separately. Wasting was found in 11.4% of the children with SCD. The prevalence of wasting among children with SCD in other studies ranges between 18.4% to 50.3% (15,17,18). Height for age was low in 13.7% of the children with SCD. A similar study conducted in Democratic Republic of Congo among children aged 0-12 years reported stunting at 10.5% (17). This is comparable to the finding of the present study probably because both studies were conducted in the major sickle cell centers in the main cities.

7.2 Factors associated with undernutrition

Results for this study showed that older children aged between ten to twelve years were more likely to be underweight, stunted and wasted compared to the younger ones. Among children with SCD delay in growth starts early in childhood but becomes more obvious as the child grows up (19). This is likely attributed to increased demand for nutrients for growth, fighting off the recurrent infections and a lack of appetite(14). Findings are similar to other studies conducted in Philadelphia and Yemen that have reported the same trend among children with SCD (12,16). For instance evidence from a longitudinal study by

Zemel et al (2010) reported that the height status decreased with advancement in age among patients with SCD but more especially during puberty. Thus a balanced diet should be emphasized in the older children through nutrition education of all family members.

Limitations

The study was cross sectional in nature so no casual relationships can be concluded on due to lack of a temporal relationship between the predictors and nutritional status. Additionally some predictors related to the management of SCD and other comorbidities were not included in this study.

Generalisability

The generalisability of the results in this study is limited to children with SCD attending a health service setting.

Conclusion

In conclusion, undernutrition was prevalent among the children with SCD. The factors associated with under nutrition were older age (10-12 years) and living in a female headed households. Interventions like skills based nutrition education integrating older children and enhancement of women’s control of household resources by improvement of social economic status of caretakers through business trainings and providing vocational skills can improve under nutrition in children with SCD.

List Of Abbreviations

ARI	Acute Respiratory Infection
BMI	Body Mass Index
DDS	Dietary Diversity Score
SCD	Sickle Cell Disease
SD	Standard Deviation
WHO	World Health Organisation
MNRH	Mulago National Referral Hospital

Declarations

Ethics approval and consent to participate

Ethical approval to conduct the study was sought from Makerere University School of Public Health Higher Degrees Research and Ethics Committee. Furthermore, permission was also sought from Mulago Hospital Research and Ethics Committee (MREC1152). Details of the study were explained to the Head of Department and caretaker’s written consent was obtained from the participating caretakers. Care takers were interviewed individually for privacy and personal information was kept confidential by using identification numbers.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interest.

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Authors’ contributions

AR, RMK, RK and AY conceived, designed, and revised the manuscript. AR and AY made the literature search. AR and RMK did the statistical analysis. All authors read and approved the final manuscript.

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