Intestinal Helminthic Infection among Children with Sickle Cell Anaemia in Abakaliki, Ebonyi State: Prevalence and Predictors for its Development

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Abstract

Background: The sickle-cell gene is widespread in Africa and anemia, a common finding in sickle cell anemia (SCA) may occasionally result from other nonhemolytic causes such as helminthic infestations. The study is aimed at demonstrating the prevalence of intestinal helminths, risk factors of intestinal helminthic infection, and the hemoglobin level of infected children with SCA in Abakaliki, Ebonyi State. **Subjects and Methods:** This is a hospital-based cross-sectional study conducted between August and October 2018 involving 120 children aged 2–18 years with SCA. Risk factors for intestinal helminthic infections were assessed using a structured questionnaire. Stool was analyzed using the Kato-Katz method while the hemoglobin level was analyzed using an automated machine. **Results:** Among the recruited children, 55.8% were male within the age range 2–18 years with a mean age of 8.6 (±4.6 standard deviation [SD]) years and 9.1 (±3.9 SD) years for the boys and the girls, respectively. Eleven stool samples contained intestinal helminths. Lack of/poor handwashing before eating ($P = 0.003$) and after defecating ($P < 0.001$) were some of the predictors of having intestinal helminths, while sociodemographic factors such as Socioeconomic status ($P < 0.001$), level of education ($P = 0.015$), position of child in the family birth order ($P = 0.028$) and residence ($P < 0.001$) were all statistically significant to the development of intestinal helminths in the study children. The median hemoglobin of subjects who were infected with intestinal helminths was 6.5 g/dl compared to 7.9 g/dl in noninfected subjects ($P = 0.010$). **Conclusions:** Although the prevalence of intestinal helminthic infection among SCA patients in Ebonyi State is low, it has been linked to a number of risk factors and associated with lower hemoglobin levels among infected subjects.

Keywords: Children, intestinal helminths, prevalence, risk factors, sickle cell anaemia

Introduction

The sickle-cell gene is widespread in Africa, the Middle East and Asia and by population movement, in Northern Europe, North America and the Caribbean.[1] About 100 million people worldwide are affected by the burden of sickle cell disease with over 300,000 children born every year with SCD. Approximately 70% of these births occur in Sub-Saharan Africa where majority of them die before the age of 5 years as a result of limited access to good management.[1] In Nigeria, sickle cell disease is among the ten priority non-communicable diseases (NCDs) and significantly contributes to morbidity and mortality in children and adults.[2] A most recent Nigerian study shows that 20% of children aged 6-59 months are sickle-cell carriers (HbAS), 2% have the haemoglobin C trait (HbAC) while 1% has SCD (HBSS and HbSC) in Nigeria[2] The prevalence of SCD is highest in the South West (2%) and lowest in the South South (0.3%).[2] This SCD prevalence rate is thought to be this high because the carrier state protects against malaria infection.[3]

Access this article online	
Quick Response Code:	Website: www.njmonline.org
	DOI: 10.4103/NJM.NJM_16_20

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How to cite this article: Onoh E, Manyike PC, Muoneke UV, Okike CO, Ikegwuonu C, Ibe BC. Intestinal helminthic infection among children with sickle cell anaemia in Abakaliki, Ebonyi State: Prevalence and predictors for its development. Niger J Med 2020;29:217-23.

Submitted: 24-Mar-2020 **Revised:** 16-Apr-2020
Accepted: 25-05-2020 **Published:** 26-Jun-2020

Sickle cell anemia (SCA) is a hemoglobinopathy resulting from the substitution of glutamate with valine at position six of the beta globulin chain of hemoglobin of red blood cells (RBCs).[4] Under deoxygenating conditions, HbSS undergoes a marked decrease in solubility, increased viscosity, and polymerization, thereby distorting the cell membrane giving it a sickle-shaped appearance.[4,5]

Recurrent episodes of sickling lead to loss of original biconcave shape resulting in rigidity of RBCs, which are engulfed by phagocytic cells of the reticuloendothelial system and hemolyzed, repeated cycles results in the reduction of the RBCs lifespan leading to anemia.[4,5] Chronic hemolysis is usually the predominant factor in the etiology of anemia in SCA; however, nonhemolytic factors such as infection with intestinal parasites may also contribute to the development of anemia in such patients.[6]

Intestinal helminthic infection is one of the major health problems worldwide being more serious in sub-Saharan Africa, Asia, and Latin America due to poor environmental sanitation, inadequate water supply, fast population growth, and other socioeconomic problems.[7-9] They can lead to malabsorption of nutrients, intestinal blood loss and can compete with the host for available nutrients necessary for RBC production.[10-12] These activities of intestinal helminths may exacerbate the severity of steady-state anemia in infected SCA patients because of associated ongoing hemolysis. Ahmed and Uraka[6] found a significantly lower packed cell volume in adult SCA patients infected with intestinal parasites when compared to uninfected SCA patients. Furthermore, Mahdi and Ali[13] found a higher prevalence of intestinal parasites among SCA patients citing low immunity in SCA patients as the reason for the higher prevalence of intestinal helminthic infection noted.

There is a paucity of published data both on the prevalence of intestinal parasites and on the impact of intestinal helminthic infection on the hematological profile of children with SCA in our environment. It is hoped that the findings of this study may stimulate the need for routine deworming as part of the management of SCA subjects and also complement the existing data and body of knowledge.

Subjects and Methods

This was a hospital-based cross-sectional study conducted at the sickle cell center of the Federal University Teaching Hospital Abakaliki (FETHA) between August 2018 and October 2018. Children aged 2–18 years of age with SCA who attend FETHA, met the inclusion criteria and gave consent were consecutively recruited for this study.

FETHA is the major tertiary hospital in Ebonyi State South-Eastern Nigeria located in Abakaliki, the State Capital and takes care of the health needs of the Ebonyi people and other persons from neighboring states.

The research team obtained consent from caregivers, collected venous blood and stool samples for this study. Pretested structured questionnaires were administered to obtain medical history, including the patients' bio-data and the parents' socioeconomic statuses.

The hematological parameters were analyzed using a blood auto-analyzer (Mindray BC-5300 five-part auto-analyzer manufactured by Guangzhou Medsinglong Medical Equipment Co. Ltd China) while the blood films were examined microscopically. The stool samples were analyzed using the WHO recommended method for stool analysis for helminths (the Kato-Katz technique).[14]

Subjects who had ova of parasites in their stool were dewormed using some antihelminthic drugs.

Ethical considerations

Ethical approval for the study was obtained from the Research and Ethics Committee of the Federal Teaching Hospital Abakaliki, while written informed consent duly signed was obtained from the parents/guardians.

Data analysis

The collated data from the questionnaire were entered into the Statistical Package for the Social Sciences version 21 IBM SPSS Statistics for Windows, version 21 (IBM Corp., Armonk, N.Y., USA) for the analysis. The results were presented using frequency tables and bar charts.

The qualitative data (sex, sociodemographic data, and risk factors for intestinal helminthic infection) were summarized using percentages. Fisher's exact test (for categorical variables with frequency <5) was used to test the nonassociation between the categorical variables and the presence of intestinal helminths infection.[15] Variables that showed statistically significant association with the presence of intestinal helminths were further analyzed using multivariate logistic regression to determine the adjusted odds ratio and confidence intervals. The level of significance was set at 0.05 (95% confidence interval).

Results

A total of 120 children with SCA were screened, stool and blood samples were collected from them for the study.

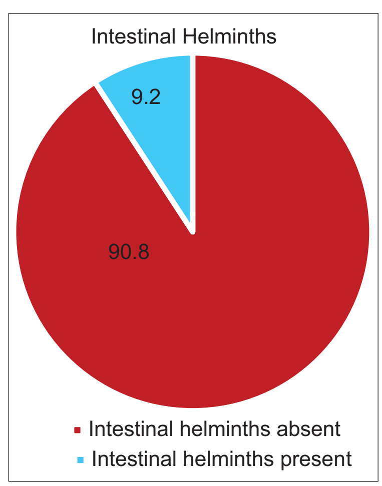

Figure 1: Pie chart showing Prevalence of intestinal helminthic infection

Table 1: Sociodemographic characteristics

Sociodemographic variable	Frequency (%)
Age group (years)	
2-6	48 (40.0)
7-12	40 (33.3)
13-18	32 (26.7)
Gender	
Male	67 (55.8)
Female	53 (44.2)
Place of abode	
Urban	66 (55.0)
Semi-urban	14 (11.7)
Rural	40 (33.3)
Number of children in the household	
<4	51 (42.5)
≥4	69 (57.5)
Position of child in the family	
<4	92 (76.7)
≥4	28 (23.3)
Educational level of child	
Prenursery	13 (10.8)
Nursery	37 (30.8)
Primary	30 (25.0)
Secondary	40 (33.3)
Educational level of father	
No formal education	12 (10.0)
Primary/Junior secondary	28 (23.3)
School cert/Grade II	27 (22.5)
NCE/OND	6 (5.0)
University education	47 (39.5)
Educational level of mother	
No formal education	6 (5.0)
Primary/Junior Secondary	31 (25.8)
School cert/Grade II	45 (37.5)
NCE/OND	4 (3.3)
University education	34 (28.3)
Socioeconomic class	
High socioeconomic class	30 (25.0)
Middle socioeconomic class	44 (36.7)
Low socioeconomic class	46 (38.3)

Table 2: Sanitation and hygiene characteristics

Sanitation and hygiene variables	Frequency (%)
Major source of drinking water	
Pipe-borne	3 (2.5)
Borehole	35 (29.2)
Well	12 (10.0)
Sachet water	70 (58.3)
Caregiver boils drinking water	
Yes	5 (4.2)
No	115 (95.8)
Availability of toilet in the house	
Yes	100 (83.3)
No	20 (16.7)
Usual place of defecation	
Water closet	80 (66.7)
Pit latrine	12 (10.0)
Others (bush)	28 (23.3)
Hand washing before meal preparation	
Yes	74 (61.7)
No	11 (9.2)
Sometimes	35 (29.2)
Hand washing after defecation	
Yes	77 (64.2)
No	5 (4.2)
Sometimes	38 (31.7)
Hand washing before feeding a child/eating	
Yes	84 (70.0)
No	0 (0.0)
Sometimes	36 (30.0)
Method of hand washing	
With water only	62 (51.7)
With water and soap	58 (48.3)
Wear foot wears to school	
Yes	120 (100)
No	0 (0)
Usually wear foot wears after school hours	
Yes	21 (17.5)
No	99 (82.5)

Sociodemographic characteristics of subjects

Sixty-seven subjects (55.8%) were males giving a male: female ratio of 1.26:1.00. The age range for both genders was 2–18 years. Majority of the subjects (40%) were aged 2–6 years, as shown in Table 1.

Prevalence and burden of intestinal helminths

Out of 120 subjects' stool samples examined, 11 were infected with intestinal helminths giving a prevalence of 9.2% [Figure 1]. The helminths were *Ascaris lumbricoides* (72.7%) and hookworms (27.3%).

Seventy-five percent and 66.7% of the subjects infected with *A. lumbricoides* and hookworms, respectively, had light infection according to the WHO classification.[16] There was no case of mixed infection.

Sanitation and hygiene

Table 2 shows the findings on sanitation and hygiene among the subjects and their caregivers. The major source of drinking water was sachet water, 95.8% don't boil their drinking water. Toilet facilities were in the home of 83.3% of subjects while the rest defecate in the bush. Water closet is the most common toilet facility used by most families.

Among the subject's guardians, most of them wash their hands before meal preparation, few of them (4.2%) usually do not wash hands after defecation, however, before feeding a child/eating, 70% of patients always wash their hands About half of

Table 3: Relationship between sociodemographic characteristics and helminthic infection

Sociodemographic variables	Helminths infection		Total, *n* (%)	χ^2	*P*
	Infected, *n* (%)	Not infected, *n* (%)			
Age group (years)					
2-6	6 (12.5)	42 (87.5)	48 (40.0)	1.100	0.577 (FT)
7-12	3 (7.5)	37 (92.5)	40 (33.3)		
13-18	2 (6.3)	30 (93.7)	32 (26.7)		
Sex					
Male	8 (11.9)	59 (88.1)	67 (55.8)	0.749	0.343 (FT)
Female	3 (5.7)	50 (94.3)	53 (44.2)		
Place of abode					
Urban/semi-urban	0 (0)	80 (100)	80 (66.7)	21.030	<0.001* (FT)
Rural	11 (27.5)	29 (72.5)	40 (33.3)		
Number of children in household					
<4	2 (3.9)	49 (96.1)	51 (42.5)	1.937	0.114 (FT)
≥4	9 (13.0)	60 (87.0)	69 (57.5)		
Position of child in household					
<4	5 (5.4)	87 (94.6)	92 (76.7)	4.814	0.028*
≥4	6 (21.4)	22 (78.6)	28 (23.3)		
Educational level of child					
Primary and lower	11 (13.8)	69 (86.2)	80 (66.7)	4.516	0.015* (FT)
Secondary and higher	0 (0.0)	40 (100)	40 (33.3)		
Socioeconomic status					
Higher	0 (0.0)	30 (100)	30 (25.0)	19.500	<0.001* (FT)
Middle	0 (0.0)	44 (100)	44 (36.7)		
Lower	11 (23.9)	35 (76.1)	46 (38.3)		

*Statistically significant. *P* values reported when any of the variable is <5. FT: Fisher's exact test

Table 4: Logistic regression analysis of predictors of intestinal helminthic infection among children with sickle cell anaemia

Variables	AOR (95% CI)	*P*
Position of child in household		
<4 (reference)		
≥4	8.2 (0.9-77.8)	0.066
Availability of toilet in the house		
Available (reference)		
Not available	7.1 (0.6-91.0)	0.131
Toilet facility type		
Water closet/pit latrine (reference)		
Others (bush)	8.5 (0.6-119.1)	0.111
Hand washing before feeding		
Wash hand always (reference)		
Wash hand sometimes	35.5 (3.4-367.8)	0.003*
Hand washing after defecation		
Wash hand always or sometimes (reference)		
Don't wash hand	199.9 (7.8-512.7)	0.001*

*Statistically significant. *P*-values from multivariate logistic regression. Other predictors as; use of anti-helminths drugs, method of hand washing, socioeconomic status and child level of education were not included because of zero events. The ORs were infinity. This means that they almost perfectly predict the occurrence of intestinal helminthic infection. ORs: Odds ratios, AOR: Adjusted OR, CI: Confidence interval

the patients wash their hands without soap and 82.5% do not wear footwear after school hours.

Sociodemographic characteristics and helminthic infection

Table 3 shows the relationship between sociodemographic characteristics and intestinal parasites infection. Living in rural areas ($P < 0.001$), being ≥4th child in the family birth order ($P < 0.028$), being in primary school or lower ($P < 0.015$), and coming from low socioeconomic class ($P < 0.001$) were all statistically significant in their relationship with the prevalence of intestinal helminthic infections.

Table 4 shows the multivariate logistic regression of the predictors of the development of intestinal helminthic infection. Washing of hands "sometimes" before eating or feeding a child, appeared to increase the odds of having intestinal helminthic infection by 35.5 (3.4–367.8 confidence level [CL]) compared to those that "always" wash their hands before eating or feeding a child.

Those who don't wash their hands after defecation have 199.9 (7.8–512.7 CL) odds of being infected by intestinal helminths compared to those that wash their hands sometimes/always after defecation. These findings were statistically significant.

Other predictors as; use of anti-helminths drugs, method of hand washing, socioeconomic status and child level of education were not included because of zero events. The odd ratios were infinity. This means that they almost perfectly predict the occurrence of intestinal helminthic infection.[17]

Table 5: Comparison haemoglobin level across the various age groups between infected and noninfected sickle-cell anaemia subjects

Age group (years)	SCA patients without helminthic infection		SCA patients with helminthic infection		Mann-Whitney U-test (*P*)
	Median Hb (g/dl)	Range (g/dl)	Median Hb (g/dl)	Range (g/dl)	
2-6	7.2	4.3-11.1	6.3	5-6.5	0.018*
7-12	8.9	5.3-11.7	6.5	5.0-12.4	0.487
13-18	8.3	3.2-15.8	9.1	6.0-12.2	0.708

*Statistically significant. Hb: Haemoglobin, SCA: Sickle-cell anaemia

Table 5 shows the analysis of hemoglobin level by age group in subjects infected with intestinal helminths and those who were not infected. Subjects' 2–6 years of age who had intestinal helminthic infection had significantly lower median hemoglobin levels compared to noninfected subjects in the same age group ($P = 0.018$). There was no significant difference in the median hemoglobin level between infected and noninfected SCA subjects above 6 years of age.

Discussion

The prevalence of intestinal helminthic infection found in this study was 9.2%. This is lower than the findings of 27% by Ahmed and Uraka[6] in 2011 and 53% by Sodipo *et al.*[10] in 1997. The lower prevalence in this study could have resulted from two important factors, which include: a possible improvement in the standard of living following regular health talks, counseling and home visitations offered to the SCA patients and their caregivers by the supervising unit. The second factor could be because of the method of diagnosis employed (using the Kato-Katz technique instead of using the combination of both direct wet mount and formol ether concentration). This combination is said to possess better sensitivity than Kato-Katz technique since it is known that the combination of different diagnostic methods increases the chance of finding intestinal helminths.[18]

The study result compares with the findings of Ohiolei *et al.*[19] who demonstrated a decreasing trend in the prevalence of intestinal helminthiasis among the general population in a systematic review. They attributed it to the rising level of education, standard of living, and use of preventive measures such as periodic de-worming of the general population.

In the multivariate logistic regression, subjects who washed their hands "sometimes" before feeding had increased odds of intestinal helminthic infection (adjusted odds ratio [AOR] = 35.5; 95% CL: 3.4–367.8 $P = 0.003$) than those that always washed their hands. Similarly, subjects who do not wash their hands after defecation also had increased odds of being infected compared to those who washed their hands sometimes or always (AOR = 199; 95% CL: 7.8–512.7 $P = 0.001$).

Yahaya *et al.*[20] in their study on helminthiasis among Almajiri children in North-East Nigeria, demonstrated the presence of eggs of intestinal helminths in the fingernails of 54.8% of these study children. They went on to conclude that these eggs could easily have been prevented from oral ingestion if they had observed thorough and proper handwashing. Poor handwashing practices have been associated with an increased prevalence of intestinal parasite infection in other studies.[21-23]

Some of the risk factors that were significantly associated with intestinal helminthiasis in the bivariate analysis were nonavailability of toilet facility in the house, defecating in the bush, drinking from well water, lower socioeconomic class, rural residence and not washing hands with soap and water. Others include: Being the 4th child or more in the family birth order, being in Nursery/primary school and not receiving anti-helminthic drugs.

In this study, the prevalence of intestinal helminthic infection was significantly higher among those that did not have toilet facilities in their house and those that often defecate in the bush (which often contaminates the water in inappropriately constructed wells, rivers, and streams). The finding of increased prevalence of intestinal helminthic infection among those without home toilet facility in this study, has also been noted by other authors.[24,25]

The availability of a good source of drinking water also affected the prevalence of intestinal helminthic infection in the study subjects. In this study, 90% of patients drank from either pipe-borne water, bore-hole water or sachet water and this may be related to the low prevalence of intestinal helminthic infection compared to other previous studies. About 50% of those that drink from well waters have an intestinal helminthic infection, compared to 8.6%, 2.9%, and 0% noted in those that drink from bore-hole water, sachet water, and pipe-borne water, respectively. This finding may be due to rainwater carrying waste into unprotected well waters during raining season. Scolari *et al.* and Adefioye *et al.* also made similar observations among those that drink from a poor source of drinking water.[24,25]

The low socioeconomic class was associated with an increased prevalence of intestinal helminthic infection in this study ($P < 0.001$). This finding may be due to the inability of the parents from low socioeconomic class to provide necessary amenities, maintain good personal and environmental hygiene. Ilechukwu *et al.*[26] in Enugu also noted an increased prevalence of intestinal helminthic infection among patients from lower socioeconomic class.

The place of residence was also associated with the occurrence of intestinal helminthic infection wherein intestinal helminthic infection was exclusively found among the rural dwellers.

This may be due to absence or inadequate basic amenities such proper sewage disposal and a source of good drinking water in these rural areas. Oninla *et al.*,[27] Scolari *et al.*[24] and Ilechukwu *et al.*[26] also noted an increased prevalence of intestinal helminthic infection among rural dwellers in Ife, Brazil, and Enugu, respectively.

In this study, most of the children infected with intestinal helminths were those 2–6 years and those in primary school or lower. These findings may be due to poor supervision and personal hygiene practices among these subjects. Adefioye *et al.*[25] also made similar observations among 407 school children in Illie Osun State Nigeria.

Children whose position in the family is 4th or more had a higher prevalence of intestinal helminthic infection, as seen in the index study. This may be due to the decreasing quality of care to older children as family size increases. This is even more difficult if one or more child in the family has a chronic disease such as SCA. These children may be left alone unsupervised, may play around in unhygienic environment, picking contaminated objects into their mouths. These findings are also similar to what Adefioye *et al.*[25] and Teshale *et al.*[28] noted in Illie (Nigeria) and North Western Tigray Ethiopia, respectively.

It was also demonstrated in this study that the prevalence of intestinal helminthic infection among those that did not receive antihelminthic drugs in the past 6 months was 16.9% compared to 0% noted among those that received antihelminthic drug. Onwuamah *et al.*[29] also found a decreased prevalence of intestinal helminths among subjects that received antihelminthic drugs in the preceding 6 months. This buttresses the usefulness of antihelminthic drugs in the control of intestinal helminths as recommended by the WHO.[30]

Hemoglobin level in subjects infected with intestinal helminths was significantly lower than the hemoglobin level of noninfected subjects with SCA, as demonstrated in this study. The lower hemoglobin level could be attributed to intestinal blood and nutrient loss due to the activities of the helminths in the host intestines.[31] This is similar to the finding of Ahmed and Uraka[6] who also found a significantly low hemoglobin level in SCA subjects infected with intestinal helminths compared to noninfected subjects.

In the age group analysis of hemoglobin level, subjects 2–6 years of age, who were infected with intestinal helminths, had significantly lower haemoglobin levels compared to noninfected subjects in this same age group. This was also the age group that had a higher prevalence of intestinal helminthic infection. However, there was no significant difference in the median hemoglobin level among infected and noninfected subjects >6 years of age. This is probably due to the small number of infected patients in the older age groups.

Conclusions

Poor personal and environmental hygiene were found to be associated with the presence of intestinal heminthic infection in children with SCA even as. Patients who were infected with intestinal helminths had lower hemoglobin levels compared to noninfected subjects. Efforts, therefore, should be made to incorporate antihelminthic drugs in the routine management of SCA as well as improving the quality of their personal and environmental hygiene

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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