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Research Article

Dietary Intake and Nutrients Adequacy among Young Adults with Sickle Cell Disease in Ile-Ife, Southwest Nigeria

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ABSTRACT

Sickle cell disease (SCD) is a chronic and genetically mutated disease seen among the African descent, of which the need to study the nutritional status and the socio-demographic characteristics is a challenge. The aim of the study was to determine the dietary intake, level of nutritional status, and sociodemographic characteristics of people with sickle cell disease in Ile-Ife, Osun State, Nigeria. The study involved 100 participants, 50 in the test group (Hb SS patients) and 50 control (other genotypes/non-Hb SS patients) in the control group, recruited at the Obafemi Awolowo University's health center in Ile- Ife. A questionnaire was issued to gather information on participants. Dietary data were obtained by the socio-demographic using 24-hour dietary recall, food frequency questionnaire was distributed to the participants. Characteristics, including their body mass index (BMS) height and weight were measured. From the study, about 76.3% of the respondents did not meet the total calorie needed while 23.7% met the expectation of total calorie needed daily. Proteins and carbohydrate as a major micronutrient met the requirement 54.6% and 93.8% respectively. Fibre intake was grossly inadequate with 80.4%, mineral salts and vitamins showed inadequate intake, most especially, folate, retinol, beta carotene and vitamin D. It is evident that nutritional management should go with medical care provided to patients with sickle cell disease. The nutritional management should also focus on conscious selection of food to ensure adequacy of both macronutrients and micronutrients necessary for maximum functioning of the body and maintaining good nutritional status.

Keywords: *Sickle cell disease, Anaemia, Dietary intake, Nutritional status, Haemoglobin*

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INTRODUCTION

Sickle cell disease (SCD) is a chronic genetically inherited disease, usually seen among African descent. SCD is characterized by abnormal haemoglobin (HB) in which the sickled beta-globin is inherited. SCD remains a global problem affecting 20-25 million people worldwide; infants with SCD in Africa who die before the age of five years are 50- 80% (Stephen *et al*., 2018).

Undernutrition has been considered a complication of sickle cell disease and should be considered in clinical care. However, awareness in past decades has not been sufficiently examined empirically (Singer *et al*., 2020). There are several approaches used in the management of SCD, including natural products, hydroxyurea, blood transfusion, and nutrient supplements; despite all of these, adequate dietary intake, protein-energy calorie deficiency still exists, this implies insufficient nutrient availability hindering growth and development. Hence, there is a need to proffer solutions to the inadequacy of nutrients in SCD, which could be through supplementation of nutrients or providing adequacy of nutrient (Martyres *et al*., 2016).

Studies suggest that nutrient deficiencies in sickle cell patients are more likely due to increased nutrient requirement due to the burden of the disease (Charlotte *et al*., 2022). Presently, there is no special recommended dietary allowance for HBSS patients with the burden of the disease, unlike in pregnancy or certain growth spurts. Micronutrient deficiencies in HBSS patients have been associated mostly with iron, folic acid, zinc, copper, and pyridoxine, and the role of these

deficiencies has mediated with immunity, as in the case of zinc, the imbalance between TH1 and TH2 functions leads to decreased cell-mediated immune functions (Prasad, 2002) and growth (Zemel *et al*., 2002). Evidence shows that the pathophysiology of SCD has significant nutritional implications which encompass increased nutrient requirements, nutrient deficiencies, and abnormalities in growth. (Al-Saqladi *et al*., 2008, Bello-Manga *et al*., 2016, Platt *et al*., 1984).

Nutritional inadequacies in HBSS patients may be due to decreased nutrient intake, high catabolism due to the disease, and malabsorption along the intestinal tract. Data from previous studies revealed normal food intake in HBSS patients, however, as the age of the patients advances, there is a decline in the adequacy of dietary intake. IL-6 pro-inflammatory cytokine is known to be elevated in HBSS patients, and this protein is associated with decreased appetite and wasting. The proteins suppress appetite, which leads to a reduction in food intake.

Nutritional care should be focused on a facet of patient-centred care for individuals with sickle cell disease since nutritional intervention can be used to address increased energy expenditure and nutritional requirement (CHA 2014; NHS 2010). It was hypothesized that in Africa, malnutrition is an aggravating element impacting the course of SCD as a result of inadequate nutrition intake among a substantial proportion of the population (Piel *et al*., 2014). Children in middle- and lower-income countries with sickle cell disease may have higher likelihood of acquiring malnutrition. Delayed maturity, stunted growth and compromised immune responses seen in SCD are mainly attributed to disease-related nutritional deficiency (Behera *et al*., 2012).

A major explanation for nutritional deficiency in HBSS patients is hypermetabolism; increased metabolic requirements with reduced nutrient intake bring forth nutrient's inadequacy. It is getting more obvious that emphasis should be placed on adequate intake of macronutrients in the recommendations for SCD than the traditional supplementation with micronutrients which studies had addressed in comparison with SCD (Hyacinth *et al*., 2010).
Hypermetabolic state related to higher energy requirements is a major cause of nutritional deficiency in SCD. Erythropoiesis, protein catabolism, myocardial energy expenditure and proinflammatory cytokines contribute to the higher energy requirement (Hibbert *et al*., 1992, Hibbert *et al*., 2005, Hibbert *et al*., 2006).

Nutrients obtained through dietary intake and amino acids derived from protein breakdown are channelled to the replacement of red blood cells which are constantly removed because of haemolysis. These irregularities in the metabolism elevate the energy requirement of the body and impair the availability of nutrients necessary for growth, development and maintaining adequate muscle mass in adults. This leads to severe undernutrition which is clinically manifested.
The approach to treatment of SCD involves intricate and multifaceted approaches. SCD carries elevated nutritional vulnerabilities, and employing nutrition as supplementary treatment in combating several diets- related chronic disorders that are found with sickle cell disease is still not made a primary focus on delivering adequate care. The emphasis had been on increasing red cell count through various means without putting attention to the alterations in the structure and roles of the sickled red blood cell which may correlate with experiencing the onset of a nutritional shortage.

The generation of red blood cells necessitates numerous building blocks, most importantly protein. Protein synthesis incurs significant energy expenditure and can constrain nutrient availability essential for body mass growth and upkeep. It is important to say that an appropriate diet tailored to one's age, gender, and dietary intake of an individual will not adequately address the nutritional requirements of someone dealing with SCD. The study aimed to determine the dietary intake, nutritional status, and sociodemographic characteristics of people with sickle cell disease in Ile-Ife, Osun State, Nigeria.

MATERIALS AND METHODS

This is a cross-sectional study undertaken at the Department of Haematology and Immunology, Obafemi Awolowo University Teaching Hospital, Ile-Ife Osun State, Nigeria. Ethical clearance was requested and granted by the research and ethics committee of Obafemi Awolowo University Health Centre, Ref: (D.MHS/2023) Ile-Ife, for the study. Informed written consent was secured from every participant involved. Ethical approval was also sought and obtained at the Human Research Ethics Committee, Faculty of Health and Wellness Sciences, Cape Peninsula University of Technology, (CPUT/HWS-REC2021 renewal) Bellville, South Africa.
A total of hundred (100) participants were recruited for the study. Fifty (50) young adults ages 18 to 48 years with sickle cell disease attending the Haematology Day Clinic of the Obafemi Awolowo University Health Centre and 50 age-match non- SCD participants as Control.
Dietary Data were obtained through a single 24-hour dietary recall. The patients were made to recount all food and beverages they had consumed in the past 24 hours. An estimate of the quantity of food consumed was derived using food models and serving sizes. Dietary intakes were converted into energy and nutrients using the Nigerian Food Composition Tables, which cover major food concerns in Nigeria and mostly in the Locality.
Height in metres and weight in kg was measured using a Stadiometer and a body weighing scale. The height and body weight were recorded for each participant. The height in metres and weight in kg were used to derive the patient's Body Mass Index (BMI).

Data analysis: Data entry and analysis were conducted using SPSS version 25. Body mass index was calculated and graded into thin, normal, overweight, and Obese. Food and beverages consumed were converted via the information on serving sizes and provided food models. An estimate of food and beverages consumed were converted to grams. The Nigerian food composition table was used to determine all nutrients available in the estimates of food and beverages consumed by respondents. The estimated nutrients from the 24 Hours food recall was compared to the Recommended Daily Allowance to determine nutrient adequacy.

RESULTS

Among the participants, 51% were females, 49% males of which 77% were under 30 years of age. In the control group,58% were males and 42% females while males were 40% and female 60% in the test group. Most (96%) of the respondents in the control group and 58% in the test group were under 30 years. The mean age of the respondents was 26.3± 8.61 years. The mean age in the control and test group was 22.5± 4.46 years and 30.2± 9.98 years respectively.

Nutritional status: The mean weight of the respondents is 57.8 ± 9.50 kg, height 1.7± 0.14 M and BMI 21.3± 3.02 Kg/M2. The control and test group nutritional status are quite similar, the mean height of the control and test group is 1.70±0.16M and 1.6± 0.08M respectively. Similarly, the mean weight of the control and test is 63.7± 8.85Kg and 52.0± 5.87Kg respectively. Also, the mean BMI from the control and test groups are 22.1± 3.04Kg/M2 and 20.6± 2.85Kg/M2 respectively.

The result of the nutritional status of respondents as measured by the BMI shows that 18% of the respondents were underweight, indicated by a BMI < 18.5 Kg/m^2, 73% are within the optimal/ normal range, indicated by a BMI 18.5-24.9 Kg/M2 and 9% of the respondents were overweight which was revealed by a BMI ranging between 25.0-29.9Kg/M^2.

In the test group, 26% were underweight, while the majority (68%) were within the normal BMI range and a few 6% were overweight. The BMI distribution according to sex in both the control and test group shows that 6.9% of males and 14.3% of females were underweight in the control group, while 79.3% of males and 76.2 % of females were within the normal range, 13.8% male and 9.5% female were overweight. In the test group, 30% male, 23.3% female was under weighed with 13% male, 21% female were within the normal BMI range, and 5% of males and 6.7% of females were overweight.

Nutrient adequacy: When the intake of nutrients was compared to the recommended daily allowance described in Table 1, to determine adequacy or inadequacy, it was discovered that most of the respondents (76.3%) did not meet the total calorie expected and 23.7% met the expectation of the total calorie needed daily. More than half (54.6%) met the recommended allowance for protein intake. Similarly, the requirement for carbohydrates as a major macronutrient was observed to be met adequately by 93.8% of the respondents. However, 80.4% of the respondents had inadequate fibre intake. Additionally, zinc (56.7%), copper (93.8%) and Iron (55.6%) met the recommendation and were found adequate in the diet.

In contrast, calcium (99%), magnesium (83.5%), phosphorus (76.3%), potassium (83.5%), sodium (87.6%), vitamin A (85.6%), vitamin E (97.9%), thiamine (70.1%), riboflavin (55.7%), Niacin (81.4%), vitamin B 12 (80.9%) and vitamin C (92.6%) recommendations were not met and, found deficit or inadequate in the diet.

Also, no respondent met the recommendation for folate, retinol, beta carotene and vitamin D.nBetween the control and test group, there were similarities and few contrast in the adequacy of some nutrients. It was observed that 34% of the respondents in the control group had adequate calorie intake and a few (12.8%) of the test group had adequate calorie intake. There was dissimilarity in the protein adequacy in the groups. 78% of the respondents in the control group had adequate protein intake while just 29.8% in the test had. Carbohydrate adequacy was similar across the two groups, 92% and 95.7% of the respondents consumed adequate carbohydrates in the control and test group respectively.

Table 1:
Dietary Intakes of Respondents Based on a Single 24-Hr Recall

Nutrient	Daily Mean Intake n = 100			Proportions of Respondents who met Recommended Values			
	Control (n = 50)	Test (n = 50)	P value	Control (n = 50) (%)	Test (n = 50) (%)	P value	Chi-square
Energy (kcal)	1.916 ± 112.8	1461 ± 74.93	0.0011	17 (34.0)	6 (12.8)	0.014	6.039
Protein (g)	220.2 ± 48.91	60.27 ±9.420	0.0018	39 (78)	14 (29.8)	0.001	22.721
Carbohydrate (g)	309.5 ± 18.69	264.7 ±11.77	0.0453	46 (92)	45(95.7)	0.444	0.585
Fat (g)	40.78 ± 4.318	20.27 ±2.761	0.0001	-	-	-	-
Fibre (g)	12.29 ± 2.705	27.84 ±6.225	0.0242	9 (18.8)	10 (20.4)	0.837	0.042
Calcium (g)	260.3 ± 35.37	196.4 ±29.50	0.1687	1 (2)	0 (0)	0.320	0.990
Iron (mg)	15.85 ± 0.969	11.17 ± 0.95	0.0008	34 (68)	10 (20.4)	0.001	22.701
Magnesium (mg)	187.0 ± 35.59	214.3 ±36.27	0.5922	9 (18.8)	8 (16.3)	0.754	0.099
Phosphorus (mg)	1001 ± 168.3	657.8 ±125.1	0.1053	16 (33.3)	7 (14.3)	0.027	4.863
Potassium (mg)	1353 ± 342.3	15830 ±1463	0.3249	9 (18.8)	7 (14.3)	0.554	0.351
Sodium (mg)	543.4 ± 145.9	676.8 ±184.9	0.5721	9 (18.8)	3 (6.1)	0.059	0.351
Zinc (mg)	15.98 ±1.166	11.06 ± 0.94	0.0014	37 (77.1)	18 (36.7)	0.001	16.079
Copper (mg)	18.49 ± 1.932	18.97 ± 4.45	0.9213	46 (95.8)	45 (91.8)	0.414	0.667
Manganese (mg)	30.34 ± 10.15	26.80 ±9.152	0.7958	21 (43.8)	25 (51.0)	0.473	0.514
Vitamin A (mg)	30.34 ± 10.15	174.6 ±50.48	0.6938	8 (16.7)	6 (12.2)	0.536	0.384
Retinol (mg)	87.80 ± 18.43	21.78 ±7.909	0.0013	-	-	-	-
β Carotene (mcg)	4336 ± 1462	3417 ± 1100	0.6154	-	-	-	-
Vitamin D (mcg)	25.30 ± 11.58	1.599 ±0.462	0.0414	-	-	-	-
Vitamin D (mcg)	1.754 ± 0.516	1.743 ±0.471	0.9875	-	-	-	-

Fibre consumption was recorded to be generally low compared to the daily recommendation among the respondents, 18.8% and 20.4% respondents had adequate consumption in the control and test group respectively. There was no record of any respondents in the test group with calcium adequacy and only 2% of respondents in the control group recorded calcium adequacy. Findings from the results shows that iron intake was more pronounced among the test group with 79.6% of the respondents having Iron intake adequacy, also, 68% of the respondents in the control group had iron intake adequate.

Some micronutrients such as magnesium, phosphorus, potassium and sodium had similar findings across the groups. The results of the findings of the adequacy of these nutrients across the groups shows that most of the respondents had inadequate intake of these nutrients in their diet. For Zinc consumption, there were dissimilarities in the findings across the Group where 77% of the respondents had adequate consumption in the control group while more than half (63.3%) in the test group had inadequate consumption.
Copper intake was excellent across the groups, 95.8% and 91.8% of the respondent's intake was adequate in the control and test group respectively. Results of other vitamins and micronutrients was similar across the group as no respondent was shown to have adequacy of any in their diet.

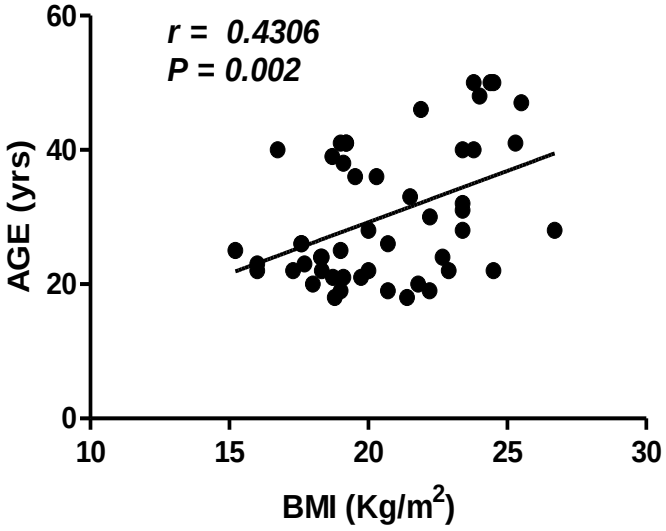

Figure 1:
There was a positive correlation between age and body mass index.

Mean of Nutrient Intake: The Mean of all nutrients is shown on Table 1. The values for major micronutrient and nutrient of importance are stated below. Mean energy intake in the control and test are 1916 ± 112.8 and 1461 ± 74.93 respectively. Mean values for carbohydrate intake in the control and test are 309.5 ± 18.69 and 264.7 ± 11.77 respectively. Mean values for protein intake in the control and test are 220.2 ± 48.91 and 60.27 ± 9.420 respectively. Mean values for Fat intake in the control and test are 40.78 ± 4.318 and 20.27 ± 2.761 respectively. Mean values for Iron intake in the control and test are 15.85 ± 0.969 and 11.17 ± 0.95 respectively. The differences across the groups are of significance. The test group have lower intakes in comparison to the control group.

Age of the individual participant and body mass index: The result, shown in Fig. 1 shows that the higher the age of the respondents the more the BMI values. This implies that underweight abound more in the younger respondents.

DISCUSSION

Majority of the participants (60%) in the test group were female, this finding was inconsistent with the findings of Osei-Yeboah and Rodrigues (2011), whose male participants were more (57%) and Al-Saqladi *et al* 2010 whose respondents constitute 54.9% male.

According to Aderibigbe *et al*(Aderibigbe *et al*., 1999), research carried out in Ilorin, Nigeria, the findings of the research shows that there was a significant reduction in body weight among individuals with SCD. This is similar to the findings of this research. VanderJagt *et al*.(VanderJagt *et al*., 2000) has similar findings with Aderibigbe *et al*.(Aderibigbe *et al*., 1999) as there was substantially decreased weight, particularly among male individuals aged 10-18 years. Similarly, significant lowered BMI was noted for males in the same category. VanderJagt *et al*.(VanderJagt *et al*., 2002) further reported that there was significantly lower weight, BMI and height in females and males with SCD. Al-Saqladi *et al*.(Al-Saqladi *et al*., 2008) reveal significantly lower weight in individuals with SCD aged 18 years. Significantly lower MUAC in individuals with SCD. Glew *et al*.(Glew *et al*., 2003) reported markedly reduced weight and stature among individuals with sickle cell Disease (SCD) when compared with a control group. Okolosi (2020) reported that SCD is strongly linked to being underweight and stunting with the males more likely than the females reports significant weight reduction in individuals affected by sickle cell disease (SCD) and 48% having sickle cell disease were underweight, 13% in the control group were underweight. Esezobor *et al*. (Eleonor *et al*., 2016) reported 2% of respondents with sickle cell disease were overweight or obese. Toly-Ndour *et al*. Toly-Ndour *et al*., (2011) reported that 4.3% were overweight or obese and substantially lower body mass index in individuals with SCD in Nigeria. Onukwuli *et al*.(Onukwuli *et al*., 2018) observed significantly lower body mass index in individuals with SCD. The participants are only females.

To maintain an optimum health status, the BMI of an adult should be in the range of 18.5-24.9 Kg/m2. However, the mean BMI for sickle cell patients (Control) is 20.6 ± 2.85 which is similar to 20.8 ± 3.1 by Awab and Lamis in 2018 and lower to 17.11 ± 13.76 kg/m2 obtained by Mandese *et al*., 2016 and 18.48 ± 2.02 kg/m2 by Kotue *et al* 2020. In this study, results showed overweight exists in sickle cell patients and this agrees with the findings of (Chawla *et al*., 2013) who reported 13% being overweight and obese as a young adult with SCD. A study by Akodu *et al*. (2012) showed that 2.5% of his subjects were obese, this is quite different from the

findings of our study, as no respondent was categorized as obese. The findings of the nutritional status of the test and control groups are different from the findings of Ukoha *et al*. (Ukoha *et al*., 2020) as a significant proportion of the sickle cell patients are within the normal BMI range.

The general belief with sickle cell patients had been that most of patients are stunted from their childhood. Hence, the findings from this study are of interest as we observed that 6% were overweight. This is similar to the results by Ukoha *et al*. (2020). In the reports from Chawla *et al*. (2013), 22.4% and Halpern 25% are quite higher than that of this study. Also, findings from Akodu *et al*. (2012) was lower as it was reported that 2.5% of the respondents were obese. On the contrary, Kotue *et al* 2020 suggested nutritional inadequacy existed more in the younger participants as 100% of the participants less than 16 years were underweight whereas 57.41% of the participants greater than 16 years had normal BMI. This implies that nutritional interventions need to be targeted right early in life.

Concerning the adequacy of food consumption, total calorie expected was not met by the majority of the respondents. Although majority of the respondents had adequate carbohydrate but less than had protein adequacy in the consumed food. The findings by Kotue *et al* 2020, is similar with adequacy of carbohydrates but contrast with protein intake, the respondents were reported to have adequate dietary intake of protein, carbohydrate and lipid but observed a negative energy balance, as the energy output was more than the input of energy.

Vitamin D is essential to maintain calcium balance and support bone mineralization. Its deficiency is prevalent in individuals with sickle cell disease which results from diminished sun exposure due to dark skin pigmentation, heightened nutrient and energy expenditure through metabolism. This deficiency affects up to 8% of SCD patients and it contribute to the occurrence of osteopenia and osteoporosis (Umeakunne and Hibbert, 2019). It was discovered that dietary intake of vitamin D among the SCD patients were inadequate, this is consistent with the findings of Osei-Yeboah and Rodrigues (2011).

In conclusion, the study shows that over 75% of the participants did not meet the total caloric intake while slightly over 80% minerals and vitamins showed inadequate intake, most especially, folate, retinol, beta carotene and vitamin D. The results indicate that nutritional intake should play a significant role in the management of sickle cell disease. This study opens an avenue to additional research as to the management of SCD.

There is a need for nutritional management to go with medical care in SCD patients. The nutritional management should focus on the conscious selection of food to ensure the adequacy of macro and micronutrients necessary for optimal functioning of the body and maintaining good nutritional status.

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