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Research Article

Assessment of nutritional status of sickle cell patients in Yaounde, Cameroon

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Abstract: Nutrition research in sickle cell disease (SCD) has clearly demonstrated the impact of the physiopathology of this disease on the various nutritional elements essential of the health. SCD has also been associated with decreased dietary intake which results in poor nutritional status and impaired growth. The objective of this work was to assess dietary intake, body composition, and diet quality and blood macronutrients level of sickle cell patients in Yaounde, Cameroon. Height, weight, waist and hip circumferences were measured to get the Body Mass Index (BMI), waist to hip ratio (WHR) and daily energy expenditure. A 24-hour food recall, a weekly food consumption recall and a 7-day food record were done via questionnaires to get the food diversity scores, food consumption scores, daily macronutrient intakes and daily energy intakes. Blood serum was analysed for total proteins, albumin, globulin, glucose, triglyceride, total cholesterol, HDL cholesterol and LDL cholesterol content using colorimetric methods. Sickle cell patients were found to be underweight with an average BMI of 18.48 ± 2.02 kg/m^2 and an overall ratio of 42.59% of underweight against 57.41% normal. Comparing gender, average BMI for males (19.00 ± 1.84 kg/m^2) fell in the normal range of BMI and was statistically higher ($P<0.05$) than that of females (17.80 ± 2.07 kg/m^2) corresponding to underweight. Waist to hip ration had an average value of 0.89 ± 0.05, with more than half of the participants (53.49%) suffering from figurative abdominal obesity corresponding to splenomegaly. Concerning the food quality, more than half (58%) had a low food diversity score. However, all participants (100%) had an acceptable food consumption score. The participants had abnormally low levels of total protein, globulin and albumin in blood with no significant difference ($P>0.05$) according to age or to gender.Proteins intake were normal, carbohydrates intake was slightly higher than the normal whereas the biochemical analysis showed low level of blood total proteins and albumin.

Keywords: nutrition; sickle cell disease; anthropometry, nutrients intake.

INTRODUCTION

Nutritional is the intake of food, considered in the relation of the body's dietary needs. It deals with the interaction between metabolic demand and dietary intake. Under-nutrition a common form of malnutrition, has been identified as a critical feature of several disease among with SCD that should be treated as part of required clinical care (WHO, 2019a). In fact, SCD is a genetic disorder of haemoglobin. A point mutation in the beta-globin gene causes an amino acid substitution at position 6 in the beta-globin protein from glutamic acid to valine. Red (Moheeb *et al.*, 2007). Blood cells become sickle-shaped and fragile. This results in haemolytic anaemia and recurrent vaso-occlusion in the microvasculature due to increased red blood cell adhesion and retention. Acute vaso-occlusion causes severe pain in the musculoskeletal system, abdomen, and other areas (Edwards *et al.*, 2005). Despite measures taken to reduce the spread of SCD, it remains a major problem world-wide. Indeed, SCD affects 20 to 25 million people globally and 50 to 80 percent of infants born with SCD in Africa die before the age of 5 (Aygun and Odame, 2012). It is estimated that 240,000 children are born with SCD annually in the sub-Saharan Africa (Makani *et al.*, 2011). In Cameroon the carrier rate is estimated between 20-25% while the reported prevalence of SCD is between 2-3% and the disease is tending to become a public health problem (WHO, 2008b).

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Several means have been used for the management of SCD among which the use of natural products (Kotue *et al*., 2016), drugs such as hydroxyurea (Wiles and Howard 2009), blood transfusion (Ohene-Frempong, 2001) and nutritional complements (Silva and Viana, 2002). However, medullar transplantation is the only sure treatment but very expensive (Mpiana *et al*., 2008). Finding a widely available cure for sickle cell anaemia remains a challenge one hundred year after its discovery as a genetically inherited disease. However, growing interest in the nutritional problems of the disease has created a body of literature from researchers seeking nutritional alternatives as a means of decreasing morbidity and improving quality of life among SCP. Over the past years, the role of protein/energy deficiency in HbSS has been more clearly defined via direct measurements, leading to the concept of a relative shortage of nutrients for growth and development, despite apparently adequate dietary intakes **(**Badaloo *et al.*, 1989). Hence to overcome this, there is need to find an adequate diet or adequate supplements for patients suffering from SCD.

In Cameroon, the Ministry of Public Health officially began it activities within the healthcare and social services platform for people with SCD. The program put in place included: educational talks, systematic screening on birth, developing equitable access to essential medicines, training of medical staff to diagnose and care for patients, and the setting up of preventive actions among a young audience (IECD). Educational talks included dietary advice to sickle cell patients such as: to drink a lot of water, eat balance diet, avoid alcohol, smoking among others in other to remain healthy and avoid crisis (Mbuye, 2018). Apart from these advices, no specific dietary measures have been proposed for better management due to insufficient information on their nutritional status in Cameroon. Hence, this work was carried to study the nutritional status of sickle cell patients in Yaounde, Cameroon in order to bring in the future forth an adequate diet or food item that will cover those deficiencies, and therefore help them live a better life.

METHODOLOGY

Ethical clearance consideration and informed consent

An ethical clearance was obtained under the number CEN°00698/CRERSHC/2018 for the study to be done. Afterwards, all patients willing to participate in the study signed a clarified consent form after being detailed informed of the research objectives.

Anthropometric measurements

Anthropometric measurements describe body composition and functional measures indicate the extent to which the diet has been adequate to meet the needs of the body. Anthropometric information collected through the measurement schedule and the observation schedule was made to collect the clinical information. For that, body mass index (BMI) was calculated as body weight (kg), divided by height (m) squared. Body Build Index (Waist to hip ratio) was calculated as waist circumference (cm) divided by hip circumference (cm) (WHO, 2008a). Harris Benedict Formula was used to calculate total energy expenditure (FAO, 2001).

Dietary survey

When recalls or records are being used to estimate usual intake of individuals to describe eating patterns or to examine relationships between diet and disease, more than one day of dietary information is usually needed. For the dietary record approach the following was done. Dietary survey was carried out through food diversity scores (FAO, 2013); food consumption score (PAM, 2014); nutrients intake and daily energy intake (Todd et *al.*, 1983).

Blood samples collection

Blood samples (4.5 ml) were collected from 65 confirmed sickle cell patients, both males and females, attending routine clinic visits at the Central Hospital of Yaounde, ensued with the assistance of the medical personnel using vein puncture method at a steady state with new syringes and needles, spirit swaps and a tourniquet into sodium fluoride tubes for glucose analyse and dry tube for the others analyses and transported to Laboratory of Biochemistry, of the University Health Center of Yaounde, Cameroon. Blood collection in dry tube was centrifuged at 3500 rpm for 15 min, the serum obtained was use for the various biochemical parameters.

Determination of the biochemical parameters

Biochemical parameters were evaluated through the determination of total protein (Gornall et *al.*, 1949); albumin (Doumas and Biggs, 1972); glucose (Trinder et *al.*, 1969); total cholesterol (Allain et *al.*, 1974); triglyceride (Fossati and Prencipe, 1982); HDL cholesterol (Mathews, 2014). Globulin fraction was determined by subtracting the albumin from the total protein (Jolles et *al.*, 2014) and LDL cholesterol concentration was obtained using Friedewald equation after performing total cholesterol, triglyceride, and HDL level assay (Friedewald et *al.*, 1972). All kits used were obtained from Biolabo.

Statistical analysis

Statistical analysis was performed using SPSS software version 20.0. Continuous data were expressed using mean ± standard deviation. P-value of < 0.05 (two-tailed) was used to establish statistical significance. Unpaired independent T-test was used.

RESULTS AND DISCUSSION

Table I represent the average BMI and WHR of participants respectively. The results obtained show that more than half of the participants (52.31%) suffer from underweight, the remaining have a normal body mass index (47.69%) and none suffer from overweight

(0%). Waist to hip ratio had an average value of 0.89 ± 0.05, with more than half of the participants (53.49 %) suffering from figurative abdominal obesity corresponding to splenomegaly.

Table I: General anthropometric parameters

Parameters	Groups	Cut-off values	participants (n=65)
Body Mass Index (BMI) (kg/m^2)	Underweight	<18.5	52.31 %
	Normal	18.5-24.9	47.69 %
	Overweight	25-29.9	0 %
Waist to Hip Ratio (WHR)	Abdominal obesity	Man >0.90 Woman>0.85	53.49 %
	Normal	Man ≤0.90 Woman ≤0.85	46.51 %

According to age (Table II), all participants aged 16 and less were underweight with 81.81% suffering from splenomegaly. Half (50%) of those having over 16 years of age had splenomegaly and 41.59% were underweight.

Table II: Anthropometric parameters of participants according to their age

Parameters	Groups	Cut-off values	≤16 years old (n=11)	>16 yearsold (n=54)
Body Mass Index (BMI)	Underweight	<18.5	100%	42.59%
	Normal	18.5-24.9	0%	57.41%
	Overweight	25-29.9	0%	0%
Waist to Hip Ratio(WHR)	Abdominal obesity	Man >0.90 Woman>0.85	81.81%	50%
	Normal	Man ≤0.90 Woman ≤0.85	18.19%	50%

According to gender (Table III), a smaller portion of male participants (40.54%) were underweight compared to 67.86% for females. Waist to hip ratio showed that 36% of males had splenomegaly compared to 77.78% for females.

Table III: Anthropometric parameters of participants according to gender

Parameters	Groups	Cut-off values	Male%	Female%
Body Mass Index (BMI)	Underweight	<18.5	40.54%	67.86%
	Normal	18.5-24.9	59.46%	32.14%
	Overweight	25-29.9	0%	0%
Waist to Hip ratio (WHR)	Abdominal obesity	Man >0.90 Woman>0.85	36%	77.78%
	Normal	Man ≤0.90 Woman ≤0.85	64%	22.22%

To achieve optimum health, the median body mass index for an adult population should be in the range of 21 to 23 kg/m2, while the goal for individuals should be to maintain body mass index in the range 18.5 to 24.9 kg/m2. (WHO, 2019b). However the mean BMI of SCP (18.48 ± 2.02 kg/m2) was similar to 17.11 ± 13.76 kg/m2 obtained by Mandese et *al*., 2016 and lower than 20.8 ± 3.1 by Awab and Lamis in 2018. The low BMI is as a result of elevated energy expenditure related to physiological adaptations to haemolysis, changes in body composition and inflammation. This may also be as a result of insufficient dietary intake, anorexia and disease conditions. According to age young participants were all underweight (63.64 %) than adults. This ratio is higher compare to 5.2 % obtained by Blessing et *al*. (2017). This can be due to frequent illnesses compared to adults. According to gender females were the most affected by underweight unlike Odutola et *al*. 2016 who had more males being underweight than females. This may be explained by the fact that females were frequently hospitalized hence food intake reduced. The mean WHR was 0.89 ± 0.05 similar to 0.86 ± 0.49 of Awab and Lamis (2018) and slightly lower than 0.92 ± 0.1 obtained by Uche (2017). This is normally explained by the deposition fats in the lower part of the body, but in this case however a phenomenon called splenomegaly frequently seen in sickle cell patients explains the abnormally high waist to hip ratio.

Concerning the food quality, more than half (58%) had a low food diversity score (Figure 1) and this means that they neglect several food groups thus a diet not sufficiently varied. However, all participants (100%) had an acceptable food consumption score (Figure2).

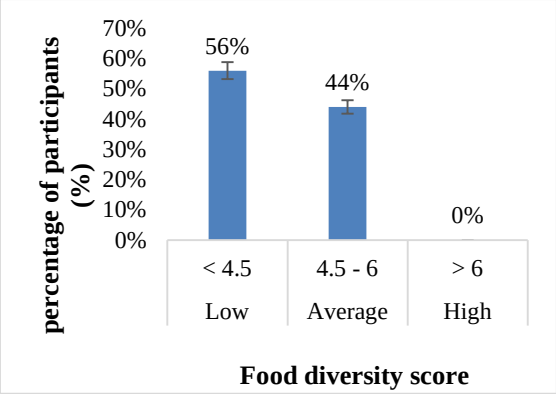

Figure 1: % of participants in function of Food diversity score

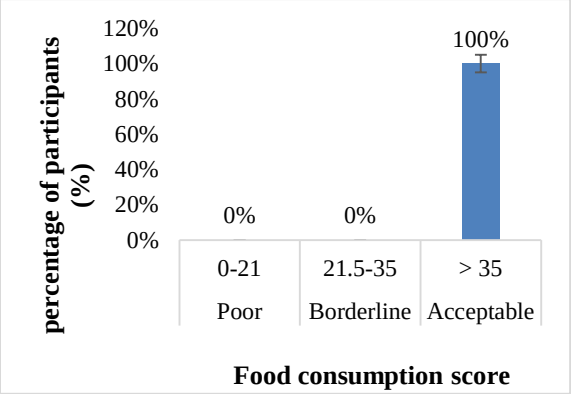

Figure 2: % of participants in function of Food consumption score

Concerning the food quality, more than half (58%) had a low food diversity score and this means that they neglect several food groups thus a diet not sufficiently varied. However, all participants (100 %) had an acceptable food consumption score.

Table III: Daily nutrient intake of participants

Parameters		Normal range	Participants
	Proteins	28 - 66	59.37 ± 12.26
	Lipids	≤70	38.53 ± 8.30
	Carbohydrates	>260	337.92 ± 65.03

They had adequate intakes for proteins, lipids and carbohydrates. However, the energy balance (difference between daily energy intake and total energy expenditure) is negative for both male and female participants (Table IV). This implies that the energy they spend daily is not fully compensated by the energy intake.

Table IV: Energy balance of participants

Parameters	Male(calories/day)	Female(calories/day)
Total Energy Expenditure (TEE)	2337.52 ± 251.23	1833.10 ± 233.23
Daily Energy Intake (DEI)	2097.49 ± 370.39	1731.25 ± 293.89

Dietary diversity and food frequency capture the number of different kinds of food groups that people eat and the frequency with which they eat them. The low FDS may be caused by anorexia in SCP due to loss of appetite. The negative energy balance obtained from the difference between DEI and TEE may be due to the low FDS that showed low lipid intake. Indeed, lipids are a high source of energy hence a low intake will make a diet deficient in energy. Even though this difference is not so high, the incidence on SCP is high because increased hemolysis results in decreased red cell count and anaemia. As a compensatory mechanism to maintain tissue oxygenation, the heart rate is increased, leading to increased myocardial energy demand (Hibbert et *al*., 2006), with the net effect of an increase in myocardial energy requirement and thus total energy requirement.

Table V shows that the participants had abnormally low levels of proteins, globulin and albumin in blood. The participants had abnormally low levels of total protein, globulin and albumin in blood with no significant difference ($P > 0.05$) according to age or gender.

Table V: Macronutrients blood level of participants

Parameters	Normal range	Participants (g/L)
Glucose	0.60 to 1.10 g/L	0.93 ±0.27
Albumin	38 to 51 g/L	34.12 ±6.09
Globulin	23 to 35 g/L	22.67 ±7.16
Total protein	68 to 88 g/L	56.78 ±9.38
Total cholesterol	< 2 g /L	1.17 ±0.27
Trigyceride	< 1.30 g/L	0.74 ±0.36
HDL cholesterol	man > 0.40 g/L woman > 0.50 g/L	0.43 ±0.15
LDL cholesterol	< 1.60 g/L	0.58 ± 0.24

The macronutrients intakes were good however, compared to the blood macronutrients level, total proteins, albumin and globulin were lower than normal. The results imply that sickle cell patients have a higher need for proteins than normal individuals. This increased requirement is poorly understood but it has been suggested that hypermetabolism due to shortened life-span of erythrocytes places an increased demand on protein stores, accelerates whole body protein turnover and consequently increases energy expenditure. This increase in the metabolic demand has to be met from the diet in order to maintain body cell mass. As stated earlier, thepatient with SCD is in a state where catabolism exceeds anabolism, resulting in an energyrequirement that exceeds the apparently adequate nutrient intake in the absence of SCD. Our study shows that this demand was not met by the patient's intakes hence accounting for their low body mass index and low blood nutrients level.

CONCLUSION

Study findings revealed that participants suffered from undernutrition with the female gender and the young group being the most affected. They had an overall medium diet quality characterised by appropriate nutrient intakes, acceptable Food consumption scores, low Food diversity scores and a low caloric intake. Sickle cell patients had appropriate protein intakes; however they had low average blood level of total proteins, globulin and albumin. Formulate food stuffs rich in bioavailable proteins for sickle cell patients to overcome their deficiencies will be the next step of this work.

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