Original Article

Sociodemographic determinants and anthropometric characteristics of the iron status of Lagos children with cyanotic congenital heart disease

Barakat Adeola Animasahun, Jumoke O. Itiola, Motunrayo O. Adekunle, Olisamedua Fidelis Njokanma

Department of Paediatrics, Lagos State University Teaching Hospital, Ikeja, Lagos, Nigeria

Contributions: (I) Conception and design: BA Animasahun, JO Itiola; (II) Administrative support: BA Animasahun, MO Adekunle; (III) Provision of study materials or patients: BA Animasahun, JO Itiola; (IV) Collection and assembly of data: BA Animasahun, JO Itiola, MO Adekunle; (V) Data analysis and interpretation: BA Animasahun, OF Njokanma, JO Itiola; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Dr. Adeola Animasahun. Department of Paediatrics, Lagos State University Teaching Hospital, Ikeja, Lagos, Nigeria.
Email: deoladebo@yahoo.com.

Background: Cyanotic congenital heart disease (CCHD) contributes to morbidity and mortality among children all over the world. Stunting and poor weight gain are common among these children.

Methods: The study was part of a large prospective cross sectional and analytical study, involving consecutive children with CCHD confirmed by echocardiography. Subjects and controls were matched for gender, sex and socioeconomic class. Level of significance was set at P<0.05.

Results: A total of 150 children, 75 with CCHD and 75 apparently healthy controls were studied over a period of 6 months (May 2015 to October 2015). Overall, the age of the subjects ranged from 6 months to 12 years with a mean age and standard deviation of 47.5 (±2.9) months. The mean weight of the subject who were less than 2 years was significantly lower than those of controls (P=0.000). Similarly, the weight of the subjects older than 5 years were also significantly lower than those of controls (P=0.041). Similarly, the height of subjects less than 5 years was significantly lower than those of the controls (P=0.000) using the independent *t*-test.

Conclusions: Wasting and stunting are common in children with CCHD hence we recommend a routine monitoring of the nutritional status of children with CCHD using the weight and height measurements to ensure prompt nutritional rehabilitation among these children.

Keywords: Cyanotic congenital heart disease (CCHD); stunting; wasting; nutritional status

Received: 10 May 2019; Accepted: 21 June 2019; published: 23 July 2019.
doi: 10.21037/jxym.2019.06.03
View this article at: http://dx.doi.org/10.21037/jxym.2019.06.03

Introduction

Uncorrected congenital cyanotic heart lesions may potentially have adverse effects on iron balance (1). These cardiac lesions keep the body in a state of constant hypoxia (1). Unabated hypoxia and attendant secondary erythrocytosis lead to polycythemia and depletion of iron stores (1). An additional cause of iron depletion in is the bleeding tendency consequent upon thrombocytopenia and haemostatic abnormalities (2).

Worldwide, few studies have documented the socio-demographic determinants and anthropometric characteristics of children with cyanotic congenital heart disease (CCHD) with iron deficiency anaemia. Published prevalence values of iron deficiency among children with CCHD range from 12.6% to 63.6% (3-5). The highest prevalence was documented by Onur *et al.* (3) in Turkey in 2003. In that study, 48 children with uncorrected CCHD aged 6 to 48 months were investigated. Mean corpuscular

volume (MCV), mean corpuscular haemoglobin (MCH), red cell distribution width (RDW), serum iron (SI), total iron binding capacity (TIBC) and serum ferritin levels were assayed. The documented prevalence of iron deficiency was 63.6% (3). An earlier study conducted in the same country by Olcay *et al.* (4) documented a prevalence of 52.2%. The difference between the studies lies in the difference in the study methods. It is known that iron deficiency is more common in children younger than 5 years of age (6,7). The earlier study by Olcay *et al.* (4) recruited older subjects up to 9 years, compared to the more recent one by Onur *et al.* (3). Other authors in Europe who recruited older children documented a lower prevalence rate of 36.5% (6) and 12.5% (8) in Germany and Italy respectively.

In Africa, Lang'o *et al.* (5) in Nairobi investigated the prevalence of iron deficiency in 112 children with uncorrected CCHD aged 1 month to 17 years. The prevalence of iron deficiency documented was 16.9%. Aside from the report from Kenya, Ogunkunle (9) in Nigeria investigated the prevalence of Iron deficiency in children with uncorrected CCHD. The prevalence documented by the Nigerian author was 35%, which is higher than the report from Kenya. Iron deficiency was defined using a combination of RDW and MCV, without serum ferritin. It is known that the use of erythrocyte indices may overestimate iron deficiency (10), thus it was not surprising that the value documented by the Nigerian author was higher than the report by the Kenyan authors.

Iron deficiency occurs in children with CCHD as a result of excessive consumption of iron stores during erythropoiesis (11), progressive loss of iron due to repeated phlebotomy (12) and bleeding diathesis (13). There is paucity of studies on iron deficiency among children with CCHD in Nigeria. It is expected that the data generated will further describe the magnitude of iron deficiency in children with CCHD, and increase the awareness on the need for routine monitoring of iron status and prompt treatment, as this will improve morbidity in the subjects.

General aim

The general aim of the study is to describe the socio-economic determinants and anthropometric characteristics of the iron status of Lagos children with CCHD.

Specific objectives

The specific objectives of the study are to:

(I) describe the anthropometric characteristics of Lagos children with CCHD;
(II) describe the socio-demographic characteristics of Lagos children with CCHD;
(III) determine the relationship between iron deficiency and socioeconomic status in children with CCHD and controls;
(IV) determine the relationship between iron deficiency and the anthropometry of children with CCHD and controls.

Methods

Study site

The study was carried out among children with CCHD attending the Paediatric cardiology clinic of Lagos State University Teaching Hospital, Ikeja, Lagos, Nigeria from May 2015 to October 2015. The study was prospective and cross-sectional involving consecutive children with CCHD and their age, sex and socioeconomically matched apparently healthy controls whose parents consented as part of a large study.

Ethical considerations

Approval for the study was obtained from the Ethics Committee of Lagos State University Teaching Hospital, Ikeja, Lagos State. The parents/caregivers of the subjects for the study were fully briefed on the research protocol, in the language they understood. After that, written informed consent was obtained, and assent was obtained from study subjects who were 7 years and older. Those found to be iron deficient were treated appropriately.

Sample size determination

The estimated sample size was determined using the standard statistical formula for comparative design studies (14). The standard normal deviation corresponding to 95% confidence level, from the normal distribution table which is equal to 1.96 was used. The power for the study was set at 80% and the value obtained from a normal

distribution table was 0.84. The average of previously reported prevalence rates of iron deficiency in children with congenital cyanotic heart disease and in controls. To accommodate for possible attrition, or unforeseen errors in completing the study questionnaire. The non-response rate was set at 10%.

Social class classification

Social classification was done using the scheme proposed by Oyedeji (15), dividing subjects into five groups I to V in descending order of privilege. Socio-economic index scores (one to five) were awarded to each subject, based on the occupational and educational levels of parents. The mean of four scores (two for the father and two for the mother) to the nearest whole number, was the social class assigned to the child. For the study, classes I and II were grouped together as upper social stratum, class III was taken as the middle stratum and classes IV and V as lower social stratum.

In measuring the weight, the researcher explained the procedure to the mother and child. The mother helped the child remove shoes and talk to the child in a non-frightening way about the need to stand still. The SECA® weighing scale model 7906B was adjusted to the zero mark and the subject was asked to stand in the middle of the scale and remain still while the researcher read off the child's weight to the nearest 0.1 kilograms (16). Infants were measured after clothes were removed using a SECA® infant weighing scale model 374. The scale was adjusted to the zero mark and the infant gently lied on the scale. The weight was read off when the infant was fairly still to the nearest 0.1 kilograms (16).

Recumbent length was measured using a SECA 210® infantometer for children younger than 24 months of age while height was measured for children 24 months of age or older. The patients below 24 months of age were laid on the infantometer on a hard surface with the lower limbs fully extended. The highest point on the head was made to touch the inflexible board at one end of the infantometer lightly; gentle pressure was applied to the legs to prevent flexion at the knees. The moveable footboard was then adjusted till it was brought to rest against the heels. This point was read off as the length of the patient to the nearest 0.1 cm (17).

The standard SECA stadiometer code ESE213® was used to measure the height of subjects who were ≥24 months of age. The patient was asked to stand erect in the anatomical position with the head in the Frankfurt plane. The back of the head, the spine of the scapulae, the buttocks and the heels were made to touch the axis of the stadiometer. The patient was supported in this position while the moveable arm of the stadiometer was made to touch the crown of the head, and the height read off to the nearest 0.1 cm (17).

Venepuncture done by the researcher according to the WHO guidelines (18). The SI status of the subjects and control were documented by measuring the serum ferritin, SI, TIBC and transferrin saturation.

The diagnosis of iron deficiency was established based if serum ferritin is less than 12 ng/L for study subjects less than 5 years or less than 15 ng/L for subjects aged 5 years or more (19). Iron deficiency anemia was diagnosed if serum ferritin was less than 12 ng/L for study subjects less than 5 years or less than 15 ng/L for subjects aged 5 years or more in the presence of low hemoglobin concentration of 2SD below the mean hemoglobin for a normal population of the same age (3).

Data analysis was done using Microsoft Excel statistical package and the Statistical Package for Social Sciences® version 20.0. Measures of statistical location like mean, median, standard deviation and range were derived for continuous variables. Categorical variables were represented using frequency and percentage. Continuous variables were compared using Student *t*-test, while test of association for categorical variables were tested with Fisher exact test. Probability value (P value) less than 5% (0.05) was accepted as statistically significant.

Results

A total of 150 children who met the study criteria were recruited over a period of 6 months (May to October 2015): 75 with CCHD and 75 apparently healthy controls respectively.

Socio-demographic characteristics of the study population

The demographic characteristics of the study subjects are given in *Table 1*. By study design the gender, age and socio-economic class were equally matched for subjects and controls. There were 45 males and 30 females with a male to female ratio of 3:2 for both subjects and controls. Overall, the mean age and standard deviation of the subjects was 47.4 (±2.9) months. As displayed on *Table 1*, the ages of the patients were further categorized into subgroups.

Thirty-eight (25.4%) study subjects belonged to the upper socioeconomic stratum (Socio economic indices I and II), while 68 (45.3%) and 44 (29.3%) belonged to the middle (Socio economic index III) and lower (Socioeconomic index

Table 1 Socio-demographic characteristics of the study population

Variables	Study subjects		Total, n=150 (%)	Statistics
	CHD, n=75 (%)	Controls, n=75 (%)		
Gender				P=1.0
Male	45 (50.0)	45 (50.0)	90 (100.0)	
Female	30 (50.0)	30 (50.0)	60 (100.0)	
Age group (months)				P=1.0
<24	26 (50.0)	26 (50.0)	52 (100.0)	
24–60	30 (50.0)	30 (50.0)	60 (100.0)	
>60	19 (50.0)	19 (50.0)	38 (100.0)	
Socio economic status				P=1.0
I	5 (6.7)	5 (6.7)	10 (6.7)	
II	14 (18.7)	14 (18.7)	28 (18.7)	
III	34 (45.3)	34 (45.3)	68 (45.3)	
IV	15 (20.0)	15 (20.0)	30 (20.0)	
V	7 (9.3)	7 (9.3)	14 (9.3)	

Values in parenthesis are % of column total. Statistics done using Fisher exact test.

Table 2 Family background of study subjects

Variables	Study subjects		Total, n=150 (%)	Fisher exact P value
	CHD n=75 (%)	Controls n=75 (%)		
Marital status of parent				0.119
Single	2 (2.7)	0 (0.0)	2 (1.3)	
Married	71 (94.7)	75 (100.0)	146 (97.3)	
Widow	2 (2.7)	0 (0.0)	2 (1.3)	
Primary care giver				0.666
Mother	64 (85.3)	60 (80.0)	124 (82.7)	
Father	6 (8.0)	7 (9.3)	13 (8.7)	
Grandmother	5 (6.7)	8 (10.7)	13 (8.7)	
Family structure				1.000
Monogamous*	67 (94.4)	70 (93.3)	137 (93.8)	
Polygamous	4 (5.6)	5 (6.7)	9 (6.2)	
Family size				0.530
<4	59 (78.7)	63 (84.0)	122 (81.3)	
≥4	16 (21.3)	12 (16.0)	28 (18.7)	
Birth order of subject				0.305
1	23 (30.7)	30 (40.0)	53 (35.3)	
2–4	52 (69.3)	45 (60.0)	97 (67.7)	

Values in parenthesis are % of total * = based on number of subjects whose parents were married.

Table 3 Anthropometry distribution of participants

Age groups	Study subjects		*t*-value	P value
	CHD, n=75	Control, n=75		
Weight (kg) ± SD				
6–23 months	7.5±3.5	10.9±2.1	4.130	0.000
24–59 months	14.3±8.8	17.0±8.5	1.163	0.250
60–144 months	21.1±7.1	28.9±15.9	2.105	0.041
Height/length (cm) ± SD				
6–23 months	68.6±10.9	86.9±5.6	7.363	0.000
24–59 months	89.9±12.3	96.7±7.1	2.544	0.014
60–144 months	114.7±18.4	123.5±19.0	1.545	0.130
BMI (kg/m^2) ± SD				
6–23 months	12.0±7.9	14.4±2.6	0.95	0.359
24–59 months	17.7±9.9	18.0±7.6	0.145	0.885
60–144 months	16.3±5.5	17.9±5.9	0.99	0.374

SD, standard deviation; BMI, body mass index.

IV and V) socioeconomic strata respectively.

Family background of study subjects

The distribution of study subjects by family setting and parental marital status is shown in *Table 2*. In more than 90% of respondents, the parents of the subjects were married. Similarly, 137 (93.8%) of the study subjects were from a monogamous setting. The mother was the primary care giver in 124 (82.7%) of the subjects. Majority (81.3%) of the study subjects had family size of less than four and 67.7% of them were of birth order between two and four. Concerning the family background of the study subjects, there was no significant difference between subjects and controls (P>0.05 in all circumstances).

Anthropometric measurements of study subjects

Table 3 shows the mean weight, height, and BMI across the age subcategories of the study subjects. The mean weight was significantly lower in children less than 2 years and older than 5 years respectively amongst the cases compared to the control (P=0.000 and 0.014 respectively). Similarly, the height of children less than 5 years was significant lower in the cases compared with the controls (P=0.000 and 0.014 respectively). Concerning the BMI, although the values were lower in the cases compared to the controls the difference was not significant (P≤0.05).

Test of association between iron status and socio demographic variables among CCHD subjects

There was no significant difference in the gender, age group and socioeconomic class between the subjects who were iron deficient and those who were iron sufficient (P<0.05). This is shown in *Table 4*.

Discussion

CCHDs accounts for a quarter (25%) of all cases of congenital heart diseases (20). Similar to previous documentations, TOF is the commonest CCHD in the present study. A higher proportion of subjects in the present study are males. Male preponderance has been reported for TOF in affected individuals (21,22). In the present study, TOF accounts for over half of the studied cases which explain the gender difference. However, some studies have reported no gender disparity in occurrence of TOF or cyanotic CHD (23,24).

The mean age of subjects with CCHDs who are yet to have surgical intervention in the present study is 47.4 months. This age at diagnosis is higher than 11.5 months

Table 4 Test of association between iron status and socio-demographic variables of children with cyanotic congenital heart disease

Variables	Iron deficient, n=7(%)	Iron sufficient, n=68(%)	Total, N=75	P value
Gender				0.358
Male	3 (6.66)	42 (93.3)	45 (60.0)	
Female	4 (13.3)	26 (86.6)	30 (40.0)	
Age group (months)				0.427
<24	4 (15.3)	22 (84.6)	26 (34.7)	
24–59	1 (3.33)	29 (96.6)	30 (40.0)	
>60	2 (10.5)	17 (89.4)	19 (25.3)	
Socio economic status				0.40
Upper	1 (5.26)	18 (94.7)	19 (25.3)	
Middle	5 (14.7)	29 (85.2)	34 (45.3)	
Lower	1 (4.54)	21 (95.4)	22 (29.3)	

P<0.05. Statistical test used was Fisher exact test.

reported by Chinawa *et al.* (25) in the Eastern part of Nigeria on reported data on children with complex heart diseases. Definitive surgery for children with CCHDs was carried out at a mean age of 2.4 years in a hospital in Japan (26). Delay in diagnosis and surgical intervention of in our environment could possibly be due to inaccessibility to specialized care, lack of surgical facilities and a wide reliance on traditional medicine. No significant difference was observed in the socioeconomic classes of the subjects with CCHDs who were yet to have surgical interventions. Irrelevance in the social classes to the time of diagnosis of CHD was reported by Animasahun *et al.* (27). Delay in identification of a child with CHD, poor referral system and lack of adequate skilled personnel and equipment are probably major factors in delay diagnosis and institution of surgical interventions in our environment and not just poverty.

The subjects with CCHD had a significantly lesser weight compared to the controls. Also, subjects with CCHD had lower mean height compared to the controls. This observation was in children below 2 years and the older age strata. This finding is not surprising because malnutrition is a common clinical manifestation in these children. Several authors have reported that the anthropometric measures of children with CCHD are usually lower than controls (5,28,29). The aetiology of low anthropometry in CCHD is multifactorial (30,31). Chronic hypoxia reduces the oxygen available to tissues for metabolism thus reducing the energy available for cell growth (32). Other contributory factors include inadequate caloric intake, increased energy requirement due to increased metabolism and malabsorption (30). Other factors responsible for malnutrition in children with congenital heart diseases include frequent respiratory infections, cyanosis, heart failure and delay in surgical interventions (29,33).

In the present study, there was no significant difference in iron status of subjects with CCHD according to age strata. This is contrary to report by Lang'o *et al.* (5) in Nairobi were iron deficiency was solely seen in under-5s with CCHD. In apparently healthy children, nutritional iron deficiency is commoner in under-5s, whereas in cyanotic congenital heart defects, depletion of iron stores occurs from excessive erythropoiesis in response to chronic hypoxemia (5), a response that is not age dependent which may account for no relationship in iron status with age in the present study.

In the current study, no significant difference was observed in iron status of subjects and gender. This was similarly observed by Lang'o *et al.* in Kenya (5). The present study sought to determine the relationship between iron status and socioeconomic class of the subjects. While it has been documented that iron deficiency is commoner in children from low socioeconomic class (34,35) the current study showed that iron status was not significantly affected by socioeconomic class. It would have been of interest to compare this finding with other studies among children with CCHD. However, no other similar study was found for the purpose of this comparison.

In conclusion, children with CCHD are more likely to be malnourished than their healthier counterparts. There is need for routine monitoring of the nutritional status of children with CCHD using weight and height with the provision of optimal nutritional support in affected children. There is no relationship between iron status of subjects with gender, age or socioeconomic classes.

Acknowledgments

We gratefully acknowledge all the participants in this study, their parents, guardians and all the healthcare workers involved in their care.
Funding: None.

Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/jxym.2019.06.03). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Approval for the study was obtained from the Ethics Committee of Lagos State University Teaching Hospital, Ikeja, Lagos State. Informed consent was taken from all subjects.

References

1. Rosove MH, Perloff JK, Hocking WG, et al. Chronic hypoxaemia and decompensated erythrocytosis in cyanotic congenital heart disease. Lancet 1986;2:313-5.
2. Verel D. Blood volume changes in cyanotic congenital heart disease and polycythemia rubra vera. Circulation 1961;23:749-53.
3. Onur CB, Sipahi T, Tavil B, et al. Diagnosing iron deficiency in cyanotic heart disease. Indian J Pediatr 2003;70:29-31.
4. Olcay L, Özer S, Gürgey A, et al. Parameters of iron deficiency in children with cyanotic congenital heart disease. Pediatr Cardiol 1996;17:150-4.
5. Lang'o MO, Githanga JN, Yuko-Jowi CA. Prevalence of iron deficiency in children with cyanotic heart disease seen at Kenyatta National Hospital and Mater Hospital Nairobi. East Afr Med J 2009;86:S47-51.
6. Fajolu IB, Grange OA, Renner JK, et al. Prevalence of iron deficiency in children 6-24 months in Lagos. Nig Q J Hosp Med 2007;17:97-100.
7. Akodu OS, Disu EA, Njokanma OF, et al. Iron deficiency anaemia among apparently healthy pre-school children in Lagos, Nigeria. Afr Health Sci 2016;16:61-8.
8. Drossos C, Thanapoulos B, Papadimitrou T, et al. Incidence of anaemia in congenital heart diseases (author's transl). Pediatr Med Chir 1981;3:309-12.
9. Ogunkunle O. Erythrocyte indices of iron status in children with cyanotic congenital heart disease at the University College Hospital, Ibadan. Niger J Paediatr 2012;40:75-8.
10. Kaemmerer H, Fratz S, Braun SL, at al. Erythrocyte indexes, iron metabolism, and hyperhomocysteinemia in adults with cyanotic congenital cardiac disease. Am J Cardiol 2004;94:825-8.
11. Robach P, Cairo G, Gelfi C, et al. Strong iron demand during hypoxia-induced erythropoiesis is associated with down-regulation of iron-related proteins and myoglobin in human skeletal muscle. Blood 2007;109:4724-31.
12. Conrad ME, Crosby WH. The natural history of iron deficiency induced by phlebotomy. Blood 1962;20:173-85.
13. Tempe DK, Virmani S. Coagulation abnormalities in patients with cyanotic congenital heart disease. J Cardiothorac Vasc Anesth 2002;16:752-65.
14. Kirkwood BR, Sterne JA. Essential Medical Statistics. 2nd edition. Oxford: Blackwell, 2003:422-8.
15. Oyedeji GA. Socio-economic background of hospitalised children in Ilesha. Niger J Paediatr 1985;12:111-7.
16. Kronenberg HM. Williams Textbook of Endocrinology. 11th edition. Philadelphia: Saunders/Elsevier, 1998.
17. Rosenfield RG, Cohen P. Disorder of Growth Hormone and Insulin-like Growth factor secretion and action. Pediatric Endocrinology. Philadelphia: W.B. Saunders, 1996:254-334.

18. WHO guidelines on drawing blood : best practices in phlebotomy. Available online: https://www.who.int/infection-prevention/tools/injections/drawing_blood_best/en/
19. Kochanowski BA, Sherman AR. Cellular growth in iron-deficient rats: effect of pre- and post weaning iron repletion. J Nutr 1985;115:279-87.
20. Patra S, Rama Sastry UM, Mahimaiha J, et al. Spectrum of cyanotic congenital heart disease diagnosed by echocardiography evaluation in patients attending Paediatric cardiology clinic of a tertiary cardiac care centre. Cardiol Young 2015;25:861-7.
21. Animasahun BA, Madise-Wobo AD, Kusimo OY. Cyanotic Congenital Heart Diseases among Nigerian children. Cardiovasc Diagn Ther 2017;7:389-96.
22. Sharmin LS, Haque MA, Bari MI, et al. Pattern and Clinical Profile of Congenital Heart Disease in a Teaching Hospital. TAJ 2008;21:58-62.
23. O'Brien P, Marshall AC. Tetralogy of Fallot. Circulation 2014;130:e26-9.
24. Bailliard F, Anderson RH. Tetralogy of Fallot. Orphanet J Rare Dis 2009;4:2.
25. Chinawa JM, Obu HA, Eke CB, et al. Pattern and clinical profile of children with complex cardiac anomaly at University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu State, Nigeria. Niger J Clin Pract 2013;16:462-7.
26. Sakamoto T, Nagase Y, Watanabe H, et al. Open heart surgery without blood transfusion for cyanotic congenital heart defects. Jpn J Thorac Cardiovasc Surg 1998;46:138-44.
27. Animasahun BA, Adekunle MO, Kusimo OY. Time to diagnosis, socioeconomic and clinical features of patients with congenital heart diseases in a teaching hospital in Nigeria. J Public Health Emerg 2018;2:1-7.
28. Balogun F, Omokhodion S. Nutritional profiles and selected parental factors among children with congenital heart diseases in Ibadan, Nigeria. Niger J Cardiol 2015;12:89.
29. Okoromah CA, Ekure EN, Lesi FE, et al. Prevalence, profile and predictors of malnutrition in children with congenital heart defects: a case-control observational study. Arch Dis Child 2011;96:354-60.
30. Varan B, Tokel K, Yilmaz G. Malnutrition and growth failure in cyanotic and acyanotic congenital heart disease with and without pulmonary hypertension. Arch Dis Child 1999;81:49-52.
31. Pittman JG, Cohen P. The Pathogenesis of Cardiac Cachexia. N Engl J Med 1964;271:453-60.
32. Gilger M, Bindslev-Jensen C, Kessler B, et al. Nutrition, growth, and the gastrointestinal system: basic knowledge for the pediatric cardiologist. Available online: https://www.scienceopen.com/document?vid=60cd64f7-258c-48f9-a1b7-4bd50ed7cf52
33. Sjarif DR, Anggriawan SL, Putra ST, et al. Anthropometric profiles of children with congenital heart disease. Med J Indones 2011;20:40-5.
34. Kim JY, Shin S, Han K, et al. Relationship between socioeconomic status and anemia prevalence in adolescent girls based on the fourth and fifth Korea National Health and Nutrition Examination Surveys. Eur J Clin Nutr 2014;68:253-8.
35. Lozoff B, Jimenez E, Smith JB. Double burden of iron deficiency in infancy and low socioeconomic status: a longitudinal analysis of cognitive test scores to age 19 years. Arch Pediatr Adolesc Med 2006;160:1108-13.

doi: 10.21037/jxym.2019.06.03
Cite this article as: Animasahun BA, Itiola JO, Adekunle MO, Njokanma OF. Sociodemographic determinants and anthropometric characteristics of the iron status of Lagos children with cyanotic congenital heart disease. J Xiangya Med 2019;4:29.