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Serum vitamin A and other nutritional parameters in children with congenital heart disease

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Abstract *Objective:* To compare the weight for age, the serum albumin and vitamin A of children with congenital heart disease (CHD) with those of age and sex matched controls without CHD.
Methods: Consecutive children diagnosed to have CHD by echocardiography who were afebrile two weeks prior were recruited. Subjects who had bronchopneumonia were noted. Their weights, haematocrit, serum albumin and vitamin A were measured. Variables were compared between subjects and controls. Vitamin A was measured by high performance chromatography.
Results: Thirty eight subjects with mean age of 3.6 ± 4.3 years and 40 controls with mean age of 3.6 ± 4.8 years were recruited. Fifteen (39.5 %) subjects had bronchopneumonia while 14/38 (36.8 %) and 4/36(11.1 %) subjects and controls respectively were undernourished, p = 0.014. The mean serum vitamin A values in subjects 0.86 ± 0.13 mmol/l and controls 0.87 ± 0.16 mmol/l was not significantly different, P = 0.76. Serum albumin of subjects and controls were 3.5 ± 0.5 and 3.6 ± 0.43 respectively, p = 0.60
Conclusion: There was no significant difference in serum vitamin A and albumin in subjects and controls. However, significantly more children with CHD than controls were undernourished.

Keywords: congenital heart disease; vitamin A; serum albumin;

Introduction

Congenital heart diseases (CHD) are manifestations of abnormal cardiovascular embryogenesis resulting in variable degrees of circulatory dysfunction. The prevalence of CHD is between 3 and 10 per 1,000 live births.[1,2] Congenital heart diseases is a common cause of morbidity and mortality and poses economic challenge to both the affected families and the Nation as the medical costs associated with its management are substantial. This is more so in developing countries where access to treatment is poor.[3] Congenital heart disease account for more than one-third of infant deaths due to congenital anomalies and approximately one-tenth of all infant deaths.[4] Without appropriate treatment, about half of those born with haemodynamically significant congenital heart disease will die in infancy or early childhood, a third of them within the first month of life.[5]

The aetiology of majority of CHD is multifactorial, which include chromosomal anomalies, single-gene disorders and teratogens which account for about 15% of cases.[6] The CHD can broadly be classified into cyanotic heart defects (e.g Tetralogy of Fallot, Truncus arteriosus and Transposition of the great arteries) typically present with cyanosis while acyanotic heart defects (e.g Ventricular septal defect, Atrial septal defect, Pulmonary stenosis) do not normally manifest with cyanosis.

Children with CHD have impaired growth and development as shown in higher prevalence of underweight and severe malnutrition compared to their controls without CHD.[7] Other complications of CHD include, congestive heart failure, proneness to infection, mostly pneumonia and occasionally infective endocarditis amongst others.[7,8] Congenital heart disease have been associated with recurrent episodes of pneumonia in children, it is ranked third and is responsible for 9.2% of causes of recurrent pneumonia in children in Toronto.[9]

Infections, especially when severe have been associated with loss of vitamin A from body stores.[9] Helminthic infestations, diarrhoea and respiratory infections such as pneumonia and malnutrition are most notable in this regards.[10,11] Conversely, deficiency of vitamin A has been associated with proneness to infection including pneumonias. Reyes et al[12] reported a 17.8% prevalence rate of vitamin A deficiency among children less than 5

years with community acquired pneumonia in Mexico. Children with CHD who are prone to recurrent pneumonias and impaired growth and development might be at risk of developing vitamin A and other nutritional deficiencies. This study aims at comparing the vitamin A (serum retinol) status and other nutritional parameters of children with congenital heart disease with those of age and sex matched controls.

Subjects and Materials

The study was carried out in the Paediatric Cardiology out- patient clinic of the University of Benin Teaching, Benin City, Nigeria. The subjects were consecutive clinically stable children with congenital heart disease (CHD) attending the clinic with an inclusion criterion that the last febrile illness was at least two weeks before the day of recruitment. The study was conducted over six months, from March to August 2012. Ethical approval was obtained from the University of Benin Teaching Hospital Ethics Committee. An informed verbal consent was obtained from the accompanying parent (s) or caregivers. The diagnosis of the CHD was made on clinical ground, typical findings on chest radiograph and electrocardiogram. The diagnosis was confirmed on echocardiography done by one of the investigators (WES). The controls were age and sex matched children either attending or accompanying their parents to the immunization clinic and patients who were being followed up in the clinics for illnesses such as malaria, pharyngitis and acute otitis media. In all cases, fever would have resolved at least two weeks prior to the day of recruitment. The controls also had echocardiography to exclude CHD.

The subjects who also had chronic heart failure were placed on hydrochlorthiazide and spironolactone. Captopril and Digoxin were included in severe cases. It was documented if the patient had bronchopneumonia within two to four weeks prior to recruitment. The subjects were being seen on a monthly clinic schedule to other time interval as deemed appropriate. Other treatments were offered as required. A proforma was used to collect information on biodata, socioeconomic class (SEC) and the presence and time since last febrile illness. The SEC was determined by the methods described by Olusanya et al.[13] It was noted if the patient had cyanotic or acyanotic CHD.

The patients' weight was measured using a bassinet weighing scale for infant and an appropriate weighing scale for older children, using standard methods. The Z scores of the weight for age were computed using the WHO growth charts for children.[14] Malnutrition was defined thus; children with z scores < -2 SD were undernourished, well nourished children were those with Z score between -2 and +2 SD and overweight children had z scores > +2 SD.

Following aseptic procedures, 3 ml of blood was drawn from each patient, it was spun, the serum decanted and stored in a freezer at a temperature of -4^0. Once recruitment was completed, retinol analysis was done using high performance liquid chromatography method.[15] The analysis was done by a laboratory scientist.

Statistical analysis

The data were analyzed with SPSS version 16.0. IL Chicago. The means of continuous variable such as age, weight, and height and serum retinol were compared with student's t test, multiple means were compared with one way ANOVA. The association between non parametric variables was tested with Pearson's chi square test. Statistically significant p value was taken as <0.05.

Result

There were 38 subjects and aged between 6 weeks and 18 years while their weight ranged between 3 and 50 kg. The controls were 41 children without CHD, aged between 6 weeks and 19 years with a weight range of 3 – 61 Kg. All the 64(81%) subjects and controls who were old enough to receive vitamin A, had received it. Of the 38 subjects, 14(36.8 %) were undernourished while 24 (63.2 %) were well nourished. Data on weight was available for 36(90%) of the 40 controls. Only 4(11.1 %) of the 36 controls were undernourished and 32(88.9 %) were well nourished. The difference in the nutritional status between the subjects and controls was statistically significant, p = 0.014. None of the subject or control was overweight. The other characteristics of the subjects and controls are shown in table 1.

Table 1: Socio-demographic characteristics of study Population

Characteristics	Subject	Control	P value
Mean Age (year)	3.6 ± 4.3	3.6 ± 4.8	0.97
Mean wt (kg)	13.3 ± 10.8	14.4 ± 13.1	0.68
Gender			
Male	18	21	
Female	20	20	0.73
Socioeconomic status			
High	14	12	
Middle	12	16	0.72
Low	12	13	

Most of the subjects 28(73.7 %) had acyanotic CHD while 10(26.3 %) had cyanotic CHD. The types of CHD in the subjects are shown in table 2. Fifteen (39.5 %) of the subjects had bronchopneumonia within two to four weeks prior to recruitment.

The PCV of the subjects ranged from 27 – 78%, with a mean of 44.2 ± 13.6%. The mean PCV of the subjects with acyanotic CHD and cyanotic CHD were 34.0 ± 4. 3 % and 60.8 ± 10.7 % respectively. The difference was statistically significant, P = 0.<0.0001 (CI = 23.09 to 30.51). The PCV of the controls was 36.5 ± 5.1%.

Table 2: Type of congenital heart disease in subjects

Type of CHD	Number	%
Isolated VSD	17	44.7
VSD and ASD	1	2.6
VSD and PDA	2	5.2
TOF	7	18.4
AVSD	5	13.2
Isolated ASD	2	5.2
TA	2	5.2
TGA	1	2.6
Isolated PDA	1	2.6

VSD = ventricular septal defect, ASD = atrial septal defect, PDA = patent ductus arteriosus, TOF = tetralogy of Fallot, AVSD = atrio-ventricular septal defect, TA = truncus arteriosus and TGA = transposition of great arteries.

Table 3 shows the comparison of the PCV, serum albumin and retinol between subjects and controls. The PCV of the controls was significantly higher than that of the subjects with acyanotic CHD, P = 0.038 (CI = 0.14 to 4.86). There was no significant difference in the levels of serum retinol and albumin between subjects and controls. The mean PCV, serum albumin and retinol values of the subjects who were under nourished, were not significantly different from those who were well nourished, see table 4.

Table 3: Comparison of mean PCV, serum albumin and retinol values between the subjects and controls

Characteristics	Subject	Control	P value
Mean serum vitamin A (mmol/l)	0.86 ± 0.13	0.87 ± 0.16	0.76
Mean serum albumin (mg/dl)	3.5 ± 0.5	3.6 ± 0.43	0.60
Mean PCV (%)	34.0 ± 4.3	36.5 ± 5.1%.	0.038

Table 4: Comparison of mean PCV, serum albumin and retinol values between the malnourished and well nourished subjects

Characteristics	Undernourished	Well nourished	P value
Serum vitamin A (mmol/l)	0.93 ± 0.20	0.84 ± 0.12	P = 0.14
Serum albumin (mg/dl)	3.45 ± 0.43	3.64 ± 0.47	P = 0.21
PCV (%)	42.7 ± 11.72	45.2 ± 15.3	P = 0.71

The difference in serum albumin between the subjects with bronchopneumonia 3.48 ± 0.40 and those without bronchopneumonia 3.56 ± 0.51, was not significant, P = 0.61, (CI = -0.24 to 0.40). However, the mean serum retinol level in subjects with bronchopneumonia 0.80 ± 0.11 mmol/l was significantly lower than the value obtained in those without Bronchopneumonia 0.93 ± 0.19 mmol/l, P = 0.022, (CI = 0.02 to 0.24).

Discussion

The mean serum retinol level in children with CHD was not significantly lower than in those without CHD. This result indicates that children with CHD on the average were not vitamin A depleted. Of note is the fact that the mean serum retinol values in both the subjects and controls were above the value for vitamin A deficiency. This finding also indicates that the studied children may have had adequate dietary sources of vitamin A. Most cereals available for the infants are fortified with vitamin A and other micronutrients. Nigeria has in place regulations to fortify cooking oils, sugar, and cereal flour with vitamin A.[16] The older children, who are on adult diet, may consume palm oil which is a common constituent of their diet and is known to be rich in vitamin A.[17]

However, the subjects who also had bronchopneumonia had significantly lower mean retinol value compared to subjects without pneumonia. In pneumonia, retinol values are known to be depleted. Pneumonia has been identified as one notable disease associated with reduced vitamin A in earlier studies.[10,11] In situation of recurrent pneumonia as is known to be associated with CHD with increased pulmonary blood flow, the repeated reduction in vitamin A may become significant. In this study, there were few cases of recurrent pneumonia, and thus the effect of recurrent pneumonia on vitamin A deficiency could not be adequately evaluated due to the small sample size. This association would be properly elucidated in a study involving a larger sample size.

In comparing the PCV of the subjects, the PCV of the children with cyanotic CHD is expected to be higher than those with acyanotic CHD because of the associated desaturation and polycythaemia. Thus the PCV of subjects with acyanotic CHD were compared with the controls, this was significantly different. It is expected that since most of the children with CHD compared to those without CHD were underweight, that their PCV and other indices of nutrition would be depressed. In this study, there was no significant difference in the, serum retinol values between subjects and controls. This may stem from the receipt of vitamin A supplementation at six months of age when children present for immunization and six monthly thereafter until five years of age.[18] In this study, 81% of the studied children had received at least the first dose of vitamin A supplementation. Thus the multiple sources of vitamin A may be responsible for the normal levels of vitamin A seen in the subject and controls. The small sample size may also have contributed to the lack of significant difference in serum retinol levels in both subjects and controls.

The mean serum albumin value in subjects was not significantly lower than in the controls. However in a study in the UK,[19] serum albumin values in children with congenital heart disease prior to surgical intervention were lower than normal in 64.6% of cases. It is possible that the small sample size in this study may have led to the non significant finding. We acknowledge that the limitation of a small sample size in this study.

Conclusion

The PCV, serum retinol and albumin values in the children with CHD were not significantly different from the

controls without CHD. There were more malnourished subjects than controls. However, subjects with pneumonia had significantly lower retinol value than those without pneumonia. Perhaps children with CHD and pneumonia may require vitamin A supplementation after each episode of pneumonia. These children may require close monitoring to prevent recurrence of pneumonia if surgical intervention is likely to be delayed.

Authors' contribution
WES, AOA: Designed the study, involved in data collection, analysis and interpretation, wrote the draft and approved the final manuscript.

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