Malnutrition in children with congenital heart defects

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ABSTRACT

Objective: To assess the frequency of malnutrition in children with congenital heart defects in a hospital outpatient setting.

Methods: One hundred and fifty-two children with congenital heart defects (patients), and an equal number of children with innocent cardiac murmurs (controls) attending the Pediatric Cardiology Outpatient Clinic at Sultan Qaboos University Hospital, Muscat, Oman from 1997 to 1998 were prospectively studied. Weight, height and head circumference were used for evaluation of nutritional status. Patients and controls were categorized into acute malnutrition (weight <3rd percentile for age, and height >3rd centile), and chronic malnutrition (weight and height <3rd centile), based on the National Centre for Health Statistics standards. Children with symptomatic congenital heart defects (Group I, number = 73) were also compared with those without symptoms (Group II, number = 79).

Results: The study patients showed a higher frequency of both acute (27%) and chronic (24%) malnutrition ($p<0.01$). Children in Group I had a significant reduction in weight ($p<0.01$), height ($p=0.02$) and head circumference ($p<0.01$) compared to controls, however for those in Group II the differences were not significant. Acute malnutrition was higher in both groups, 31% ($p<0.01$) and 16% ($p=0.04$), whilst chronic malnutrition was significantly higher only in Group I, 31% ($p<0.01$). Infants in Group I were more frequently affected (33/45) compared to older children (13/28; $p=0.02$).

Conclusion: Malnutrition remains a problem among children with congenital heart defects, especially in those with either heart failure or cyanosis, and symptomatic infants are the worst affected. Greater attention is required in the dietary management, early diagnosis and intervention to restore normal growth.

Keywords: Congenital heart defects, malnutrition, weight, height, head circumference, high energy diet.

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Congenital heart defects (CHD) are often associated with malnutrition and failure to thrive,[1] the prevalence being as high as 64% in developed countries of the world.[2] The problem is more severe in the developing regions, where malnutrition is common even in otherwise normal children.[3,4] We assessed malnutrition using anthropometric measurements in children with CHD in a hospital-based population of the Arabian Peninsula in order to ascertain the prevalence of malnutrition among these children.

Methods. One hundred and fifty-two consecutive children with CHD attending the Pediatric Cardiology Outpatient Clinic at Sultan Qaboos University Hospital and an equal number of age-matched controls formed the study subjects. Patients with history of prematurity, intrauterine growth retardation, known genetic malformations, dysmorphic features and significant neurologic disability which could all lead to malnutrition independent of CHD were not included. The study

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had the approval of the local Medical Research and Ethical Committee and prior informed consent was obtained from each parent. In addition to detailed history, physical examination, chest x-ray and electrocardiogram, all patients had echo-doppler studies to assess the type and severity of the heart disease and, in controls, to confirm normal cardiac anatomy and function. Presence of congestive cardiac failure was assessed by clinical examination and non-invasive investigations listed above and presence of cyanosis by pulse oximetry (systemic oxygen saturation <90% while breathing room air). Patients were divided into 2 groups, depending on whether they had cardiac symptoms or not. Group I included patients with CHD who had shortness of breath, recurrent chest infections, dependent edema or cyanotic spells, and Group II those who did not have any of these symptoms. Measurements recorded to evaluate the nutritional status included weight, height (or length) and head circumference.[5] Patients were weighed using a SECA delta digital pediatric scale, model 770 for those aged < 2 years (0 to 20 kg) and model 707 for those > 2 years (10 to 200 kg). Younger children were weighed in the sitting or lying position and older ones in the standing position. Scales were calibrated 3 times yearly on a regular maintenance schedule. Heights of patients older than 2 years were obtained with use of a self-calibrating stadiometer placed on a hard, uncarpeted surface, against a bare wall. Children younger than 2 years were measured by placing the child in the supine position on a flat examination table. Two examiners held the child while stretched out to make marks on paper denoting the crown and heel of the child. The distance between the marks was then measured with a disposable metal tape measure. Head circumference was measured using a metal tape and the maximum of 3 measurements was recorded. The same examiners were responsible for the measurements on all patients and all attempts were made to ensure accuracy. Children with weight and height below the 3rd percentile for age were classified as having chronic malnutrition and those who had only the weight below the 3rd percentile but height on or above 3rd centile were classified as having acute malnutrition. Weight and height centiles of the National Center for Health Statistics Standards[6] were used for the comparison. Data entry and analysis were performed using the SPSS/PC 9.0 computer software program for Windows 98. The significance of the differences in the variables was tested using the paired t-test in case of continuous variables and Chi square test in case of discrete variables, accepting $p < 0.05$ as significant.[7]

Results. There were 73 children aged one week to 12 years in Group I, and 79 children, aged one week to 12.8 years in Group II. The control group had 152 children aged one month to 12.8 years, which did not differ significantly from Group I or Group II in age or sex (Table 1). Among the entire study patients with CHD, the frequency of acute malnutrition [41/152 (27%)] and chronic malnutrition [36/152 (24%)] were significantly higher than those of the control [18/152 (12%) and 12/152 (8%), p<0.01]. The means of weight, height and head circumference of patients in Group I were significantly lower than those of control (Table 1). However there was no such difference between Group II and controls. Figure 1 compares the frequency of acute and chronic malnutrition in the 2 groups and the controls. Acute malnutrition was significantly higher in Group I and II [23/73 (31%), p<0.01; 13/79 (16%), p=0.04] compared to control [12/152 (8%)]. In contrast, chronic malnutrition was significantly higher only in

Table 1 - Comparison of symptomatic (Group I) and asymptomatic (Group II) patients with congenital heart disease and control.

Parameter	Control (n = 152)	Group I (n = 73)	p value	Group II (n = 79)	p value
Age (years) Mean (SD)	3.3 (3.6)	3.3 (3.6)	0.48	3.4 (3.7)	0.76
Sex M/F	78/74	43/30	0.35	35/44	0.38
Weight (kg) Mean (SD)	12.9 (8.8)	9.3 (6.7)	0.006	11.9 (7.5)	0.39
Height (cm) Mean (SD)	87 (29)	77 (27)	0.03	85.4 (28.6)	0.72
HC (cm) Mean (SD)	44.8 (5.5)	41 (6.2)	0.001	44.5 (5.6)	0.69

SD - standard deviation; M - male; F - female; HC - head circumference; n = number

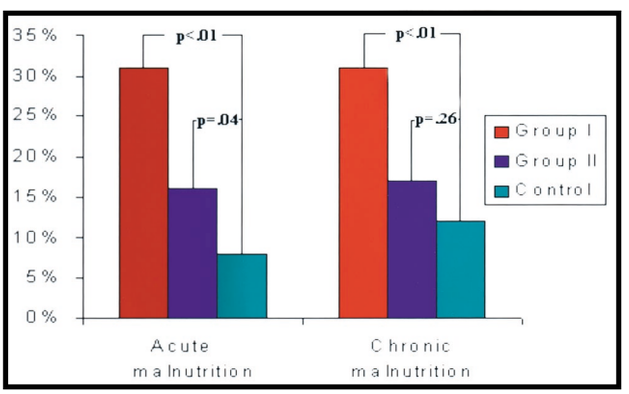

Figure 1 - Comparison of frequencies of acute and chronic malnutrition in Group I (symptomatic) patients, Group II (asymptomatic) patients and control. Group I patients had higher frequency of acute and chronic malnutrition (p<0.01) and Group II only of acute malnutrition (p=0.04).

Table 2 - Distribution of different congenital heart diseases in the study population.

Diagnosis	Group I (n = 73)	Group II (n = 79)	TOTAL (n = 152)
Ventricular septal defect	25	25	50
Atrial septal defect	19	19	38
Patent ductus arteriosus	15	10	25
Atrioventricular septal defect	5	-	5
Double outlet right ventricle	1	-	1
Tetralogy of Fallot	3	-	3
Transposition of great arteries	3	-	3
Eisenmenger syndrome	1	-	1
Pulmonary stenosis	-	20	20
Aortic stenosis	1	5	6
n = number			

Group I [23/73 (31%)] compared to control [18/152 (12%), p<0.01], while in Group II it was not different from the control [13/79 (17%), p=0.26]. In Group I, malnutrition was more common in infants [33/45 (73%)] than in the older age groups [13/28 (46%), p=0.02)] whereas in Group II malnutrition was equally distributed in the 2 age groups [20/49 (41%) in infants, 11/30 (37%) in older children, p=0.26]. Table 2 shows the distribution of the different types of CHD in the study groups. The percentage of patients with malnutrition varied among the diagnostic categories - 25/50 (50%) in ventricular septal defect, 16/25 (64%) in patent ductus arteriosus, 10/38 (26%) in atrial septal defect, 5/5 (100%) in atrioventricular septal defect and 6/20 (30%) in pulmonary stenosis. Among the 73 patients in Group I, 41 were in heart failure, 25 had recurrent chest infections, 3 had cyanotic spells, 4 had shortness of breath along with deep cyanosis.

Discussion. Malnutrition remains a major problem among children with CHD, especially those who are symptomatic with cardiac failure or cyanosis. In 1962, Mehzivi and Drash[8] reported a 55% and 52% prevalence of acute and chronic malnutrition in children with CHD. Recently, Cameron et al[2] found that both these types of malnutrition still occurred in 33% and 64% of hospitalized children with CHD in the United States. In Turkey the frequency of acute and chronic malnutrition have been reported as 65% and 42%,[4] while chronic malnutrition was documented in 76% of patients in a hospital-based study from Spain.[3] In this prospective cross sectional study of Omani children with CHD, we found prevalences of 23% and 24% for acute and chronic malnutrition. Though our prevalences are lower than those reported by Cameron et al,[2] the latter looked only at hospitalized patients who would no doubt be more severely malnourished than the outpatients we studied. We have recorded 31% and 17% prevalence of chronic malnutrition among symptomatic and asymptomatic groups, the former being statistically significant compared to matched controls. In addition, acute malnutrition was detected in another 31% and 16% in the 2 groups, and more importantly, both these values were significantly higher than the values for the controls. Thus our symptomatic patients were more severely affected, similar to the reports by Leite et al[9] and Varan et al[4] who found a higher prevalence in patients who were cyanosed or in heart failure.

Published studies on malnutrition in CHD have used different reference standards and varying anthropometric indices to define malnutrition. It has been observed that growth of children among the different ethnic populations can vary[10] and the different anthropometric indices used have limitations.[11,12] As we have used age and sex matched normal children from the same population as control, this obviated the need for more sophisticated approaches such as the use of weight for height, body mass index or standard deviations from a mean.[13] Also we used the same instruments and the same observers for all the measurements to ensure uniformity.

We could find significant malnutrition in 73% of infants with symptomatic heart disease, while the frequency in asymptomatic patients was more or less similar in the different age groups. This is understandable from the fact that symptomatic infants have severe forms of CHD, which can interfere with growth to a greater extent. Also infants were more severely affected than older children, as the symptomatic infants either undergo surgical intervention for their heart disease or have subsidence of symptoms secondary to the natural history of the CHD (for example, reduction in size of ventricular septal defect).

Mechanism and consequences of malnutrition in children with CHD. There are several possible explanations for the poor growth of children with CHD.[14] Protracted cyanosis and congestive heart failure leads to feeding difficulties and thus inadequate intake of nutrients.[15] Other possible causes for abnormal growth pattern include increased oxygen consumption,[16] increased mean total daily energy expenditure (hypermetabolism),[17] impaired absorption secondary to the chronic venous congestion of the bowel,[18] inefficient utilization of nutrients by the tissues,[14] reduced serum Insulin-like Growth Factor-I (IGF-I) levels,[19] decreased insulin

secretion[20] and associated congenital anomalies.[14] Children with CHD are also at significant risk for long-term consequences of malnutrition, including continued growth failure, delayed development, and delayed cognitive skills,[21] especially if intervention is delayed. In addition, malnutrition predisposes to higher risk of post-operative complications.[22] Correction of the defect in early infancy will usually alleviate or prevent malnutrition and result in catch-up growth,[23] and even in asymptomatic patients it leads to improved growth.[24]

Children with CHD have been referred to as a 'nutritional challenge'. Most treatment strategies aim to facilitate catch-up growth, providing extra calories (as high as 220 Cals/kg) and protein (as high as 4 gm/kg) that exceed the recommended dietary allowances.[25,26] Improved dietary intake and consequent catch-up growth have been documented in these patients even with simple nutritional counselling.[27] When oral intake is insufficient to sustain growth, continuous feeding through nasogastric tube or a gastrostomy is often helpful.[28,29]

In conclusion, despite advances in the management of children with CHD, associated malnutrition continues to be a problem. Early attention to the correction of the cardiac defect supplemented by balanced nutritional care will help children with CHD thrive better.

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