Rev. Latino-Am. Enfermagem
2012 Nov.-Dec.;20(6):1024-32
www.eerp.usp.br/rlae

Original Article

Nutritional status of children with congenital heart disease[1]

Flávia Paula Magalhães Monteiro[2]
Thelma Leite de Araujo[3]
Marcos Venícios de Oliveira Lopes[4]
Daniel Bruno Resende Chaves[5]
Beatriz Amorim Beltrão[5]
Alice Gabrielle de Sousa Costa[5]

Objective: to characterize nutritional status and variables that predict nutritional changes in children with congenital heart disease. Method: a cross-sectional study undertaken in two health institutions between January and June 2009, using a questionnaire with questions about nutrition, applied to 132 children under two years of age who had congenital heart disease. Children who had additional serious illnesses were excluded. Result: the predominant percentile values and Z scores were concentrated within the range of normal levels. The Z scores, however, presented negative variations with a deviation to the left. In the analysis of predictive factors, the occurrence of immediate and acute malnutrition was related to a decrease in skinfold thickness (decrease in subscapular skinfold thickness, while immediate malnutrition was related to a high Apgar score. Chronic malnutrition was related to female children with higher ages. Conclusion: it is evidenced that it is necessary to carry out nutritional strategies which improve prognosis, so as to widen the nursing care directed at these children.

Descriptors: Child; Heart Defects; Nutritional Status; Nursing.

[1] Paper extracted from Master's Dissertation "Estado nutricional de crianças portadoras de cardiopatias congênitas: avaliação de medidas antropométricas" presented to Universidade Federal do Ceará, Brazil. This research was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), process # 551337/2008-7.

[2] Doctoral Student, Universidade Federal do Ceará, Brazil.
[3] PhD, Associate Professor, Universidade Federal do Ceará, Brazil.
[4] PhD, Adjunct Professor, Universidade Federal do Ceará, Brazil.
[5] Master's Students, Universidade Federal do Ceará, Brazil.

Corresponding Author:
Flávia Paula Magalhães Monteiro
Rua Raul Pompéia, 12
Bairro: Carlito Pamplona
CEP: 60335-420, Fortaleza, CE, Brasil
E-mail: flaviapmm@yahoo.com.br

Estado nutricional de crianças com cardiopatias congênitas

Objetivo: caracterizar o estado nutricional e verificar variáveis que predizem alterações nutricionais em crianças portadoras de cardiopatias. Método: trata-se de estudo transversal, realizado em duas instituições de saúde, de janeiro a junho de 2009, utilizando formulário com questões nutricionais. Selecionaram-se 132 crianças menores de dois anos e que apresentavam cardiopatia congênita, excluindo-se aquelas com outras doenças graves. Resultado: os valores de percentis e escores Z predominantes concentraram-se dentro da faixa de normalidade. Entretanto, os valores de escores Z apresentaram variações negativas com desvio para a esquerda. Na análise de fatores preditores, a ocorrência de desnutrição imediata e aguda esteve relacionada à diminuição da prega cutânea subescapular, a desnutrição imediata relacionou-se ao elevado escore de Apgar. A desnutrição crônica referiu-se às crianças do sexo feminino com idademaior. Conclusão: evidencia-se a necessidade de realizar estratégias nutricionais que possibilitem melhor prognóstico, na tentativa de ampliar os cuidados de enfermagem direcionados a essas crianças.

Descritores: Criança; Cardiopatias Congênitas; Estado Nutricional; Enfermagem.

Estado nutricional de niños con cardiopatías congénitas

Objetivo: caracterizar el estado nutricional y verificar variables que predicen alteraciones nutricionales en niños portadoras de cardiopatías. Método: estudio transversal realizado en dos instituciones de salud de enero a junio de 2009, utilizando formulario con cuestiones nutricionales. Se seleccionaron 132 niños menores de dos años y presentando cardiopatía congénita, excluyéndose aquéllas con otras enfermedades graves. Resultado: los valores de percentiles y scores Z predominantes se concentraron dentro de la banda de normalidad. Mientras, los valores de scores Z presentaron variaciones negativas con desvío para la izquierda. En el análisis de factores predictores, la ocurrencia de desnutrición inmediata y aguda estuvo relacionada a la disminución del pliegue cutáneo subescapular, la desnutrición inmediata se relacionó al elevado score de Apgar. La desnutrición crónica se refirió a los niños del sexo femenino con edades mayores. Conclusión: se evidencia la necesidad de realizar estrategias nutricionales que posibiliten mejor pronóstico, en la tentativa de ampliar las atenciones de enfermería dirigidos a estos niños.

Descriptores: Niño; Cardiopatías Congênitas; Estado Nutricional; Enfermería.

Introduction

Malnutrition is a constant phenomenon among children with congenital heart disease, irrespective of the nature of the cardiac defect and the presence or not of cyanosis[1]. The principal factor behind this is the inadequate biological use of the nutrients available, due to the elevated energy expenditure caused by the clinical conditions inherent to cardiac alterations[2].

For this reason, children born with heart disease are considered part of a nutritional high-risk group[3]. In this group, there is loss of body mass which affects the organism as a whole, including the heart and respiratory muscles, thus compromising the myocardial and ventilatory functions, healing capacity and immunological competency, with the consequent increase in risk of infection[4].

Congenital alterations of the heart may lead to a reduced growth rate, secondary to hemodynamic stability. In particular, those which progress with pulmonary hypertension, heart failure and left-to-right shunt compromise hemodynamic stability and have serious effects on the child's growth. However, the mechanisms behind this have not yet been defined[4].

To minimize this problem, the investigation of good predictors for nutritional status can guide health professionals' decision-taking, in particular on interventions whose results indicate the necessity or not for surgery and – principally to identify potential growth factors – sociodemographic determinants and clinical alterations of the heart condition itself, which may possibly interfere in the nutritional status of the child affected by the condition.

In this way, the present study aimed to verify the possible variables which predict nutritional alterations in children below two years of age with congenital heart disease, and to characterize these children's nutritional status through analysis of Z scores and percentiles.

Methods

This cross-sectional study was undertaken between January and June 2009 with a sample of 132 children below two years of age, with congenital heart disease, selected by consecutive sampling in two outpatient and hospital health institutions, specialized in cardiac illnesses, in the municipality of Fortaleza, in the state of Ceará, in the Brazilian North-East. Children who had other health problems which interfere in their anthropometric values were excluded from the study. These problems included: cutaneous (pitting) edema and massive (anasarca) edema; persistent episodes of vomiting and/or diarrhea; signs characteristic of dehydration, confirmed by medical diagnosis; comorbidities: chronic kidney disease (CKD) and decompensated congestive heart failure (CHF).

Regarding anthropometric evaluation, the following were identified: weight, length, skinfolds (triceps and subscapular), and head, thoracic, abdominal and mid-upper arm circumferences. To measure the child's weight, she must be undressed, barefoot and positioned in the center of the scales, on a flat surface, lying down or sitting, depending on her stage of development. The child's length was obtained by use of a scientific anthropometer placed on a flat, rigid surface. The measurements of the head, mid-upper arm, thoracic and abdominal circumferences were taken on the child in the supine position, with a measuring tape marked in centimeters. To measure the skinfolds, the child was sat on the bed or in the arms of the parents or guardians[5]. All measuring was undertaken with the children wearing as little as possible, following the same protocol.

Measurements were obtained in triplicate (in three uninterrupted sessions) for each child, with pre-calibrated equipment which included analog tabletop scales for weighing infants, adipometer, scientific anthropometers and non-stretch tape measures marked in centimeters. The averages for each anthropometric variable obtained were calculated later.

For this, the variability inherent to the moment of evaluation and the performance of the equipment was considered acceptable. Differences were accepted of up to 50g for weight and 0.5cm for length and the head, thoracic, mid-upper arm and abdominal circumferences, and of 2 to 10 mm for the triceps and subscapular skinfolds. When exorbitant discrepancies (values above those pre-established) were found between the values obtained in each measurement, each evaluator carried out another measurement, that is, a fourth measurement, and later excluded the most discrepant measurement, and then calculated the final average.

Finally, the data was compiled into spreadsheets, and statistical analysis was undertaken with the aid of the SPSS© software. The anthropometric analysis was accomplished through the calculation of percentiles, with the support of the Nutstat© programs, developed by the Center for Disease Control and Prevention[6], and Z scores, with the support of the Anthro 2007© software[7], made available by the W.H.O. Z scores were calculated for the following rates: weight/age, weight/length, length/age, body mass index, triceps and subscapular skinfolds, head and mid-upper arm circumferences. Also calculated were the percentiles referent to the rates for weight/age, weight/length and length/age.

The following were adopted as cut-off points for the Z values: normal values between two units of standard deviation below and above the average value; Values between ±1 and ±2 units of standard deviation constituted the zone of risk. For the percentiles, on the other hand, values between the 3^{rd} and 97^{th} percentiles were considered normal. The children positioned between the 3^{rd} and 10^{th} percentiles were classified as 'imminent risk'; those between the 0.1 and 3rd percentile as 'below the expected'; and those below the 0.1 percentile as 'much below the expected'[8].

The values resulting from the calculation of the Z scores were used to classify the children's type of malnutrition. The length/age rate was used for linear growth, indicating chronic malnutrition; the rate for weight/length was considered an indicator for acute malnutrition, while that for weight/age was an indicator for poor nutritional status, and reflected an immediate deterioration of the state of health. In all cases, a Z score of less than -2[9] was considered as the cut-off point for malnutrition.

To evaluate the predictive factors for nutritional status, a logistic regression analysis was carried out. The results' variables were dichotomized as 0 or 1, indicating the absence or presence of immediate, acute or chronic malnutrition. For the construction of the models, variables were selected with high partial correlations and a level of significance of <0.20.

The Kolmogorov-Smirnov test was applied for verification of the normality of the numerical data. The Pearson or Spearman correlation coefficient tests were used to analyze the correlation between the variables, taking into account the statistical assumptions necessary for the tests' application.

The Wald test was used to analyze the significance of the logistic equation's coefficients; the Omnibus test, to analyze the significance of the model developed; the Hosmer and Lemeshow Chi-square test to evaluate the differences between the expected frequencies and those observed; and the Nagelkerke R^2 measure, to calculate the model's capacity for determination and the maximum likelihood ratio logarythm (-2 log) to evaluate the model's capacity for prediction. Values of $p<0.05$ were considered significant[10].

The project was approved by the Research Ethics Committee of the institution responsible for the research, and consent for the study was requested from the children's parents/guardians, through signing the Terms of Free and Informed Consent.

Results

A total of 132 children who had been born with heart disease were evaluated. The majority of these were male (51.5%), had acyanotic congenital heart disease of the interatrial communication type, and had an average age of 9.43 months (±6.08). Half of the children were aged 8.5 months. Many were from families with low acquisitive power and little schooling, and 50% of the families received at the most one minimum salary, having up to four people dependent on that money*. Of the mothers, half had less than nine years of schooling. Most of the children had been born via caesarian and were classified as newborn at term, and presented high Apgar scores at the fifth minute of life.

The percentiles referent to the rates for length/age and weight/age had asymmetric distribution ($p<0.05$) and were below the expected values in 25% of the children evaluated. This relationship was also observed in the Z scores for the same indicators (Table 1).

Table 1 – Distribution of anthropometric indicators in children with congenital heart disease by percentiles and Z scores. Fortaleza, Ceará, Brazil, 2009 (n=132)

Variables	Average	SD	Percentiles			K - S (sig)
			P_{25}	P_{50}	P_{75}	
Percentile length/age	26.05	27.97	1.81	14.70	46.98	0.000
Percentile weight/age	26.94	30.52	1.37	10.06	47.97	0.000
Percentile weight/length	37.82	29.70	10.60	30.26	65.10	0.098
Z score length/age	-1.08	1.85	-2.09	-0.92	0.21	0.618
Z score weight/age	-1.09	2.99	-2.41	-0.98	0.03	0.001
Z score weight/length	-0.40	6.82	-2.00	-0.58	0.19	0.000
Z score BMI/age	-0.45	6.67	-2.02	-0.61	0.18	0.000
Z score head circ.	-0.51	1.75	-1.86	-0.23	0.60	0.503
Z score MUAC	-0.36	1.79	-1.45	0.10	0.80	0.014
Z score tricipital skinfold	-0.40	1.44	-1.25	-0.24	0.74	0.395
Z score subscapular skinfold	-0.38	1.53	-1.37	-0.07	0.74	0.066

BMI: Body Mass Index; Circ.: Circumference; SD: Standard Deviation; P25: 25th percentile; 50th percentile or median; P75: 75th percentile; K-S (sig): Kolmogorov-Smirnov test. MUAC: mid-upper arm circumference

In comparison with the anthropometric indicators at birth, significant positive correlations were found between the Z scores referent to the rates of weight/age, length/age and measurement of head circumference, and the anthropometric measurements weight and length at birth ($p<0.05$). These correlations demonstrate that the children affected by congenital heart disease maintain a certain gain in weight and length over time. Further, the value of length at birth is positively correlated with the Z score of the head circumference measurement. (Table 2).

* R$622 per month at time of writing. Translator's note.

Table 2 – Correlations between the Z scores and the anthropometric measurements. Fortaleza, Ceará, Brazil, 2009 (n=132)

Variables	Weight/birth - R (p- Value)	Length/birth - R (p Value)
Z score weight/length	0.059 (0.508)	0.088 (0.348)
Z score weight/age	0.227 (0.010)	0.281 (0.002)
Z score BMI/age	0.070 (0.434)	0.087 (0.353)
Z score MUAC	0.091 (0.342)	0.082 (0.424)
Z score length/age	0.223 (0.011)	0.332 (0.000)
Z score head circ.	0.208 (0.018)	0.287 (0.002)
Z score tricipital skinfold	- 0.021(0.830)	- 0.044 (0.667)
Z score subscap' skinfold	0.058 (0.540)	0.030 (0.767)
Head circ.	0.023 (0.800)	0.073 (0.435)
MUAC	-0.022(0.806)	0.022 (0.819)
Tricipital skinfold	- 0.013 (0.888)	0.036 (0.700)
Subscapular skinfold	0.076 (0.394)	0.096 (0.309)

BMI: Body Mass Index; Circ.: Circumference; R (p value) for Pearson and Spearman correlations. MUAC: mid-upper arm circumference

The model developed to identify the predictive factors for immediate malnutrition included the variables: subscapular skinfold and Apgar score in the first minute; the model for acute malnutrition included the variable subscapular skinfold and the last model – referent to chronic malnutrition – included the variables age (in months), sex and length (in cm).

For the logistic regression analysis, the Hosmer and Lemeshow test indicated that the model for immediate and chronic malnutrition presented the best adjustment. The likelihood ratio value, that evaluated the model's predictive capacity, was considered high. This may suggest the influence of other variables outside the model and/or individual nutritional aspects of the child with congenital heart disease. The model's coefficient of determination (R^2) was low for all three models, which evidences the above-mentioned models' limited explanatory capacity, as shown in Table 3.

Table 3 – Logistic regression analysis of predictive factors for immediate, acute and chronic malnutrition in children with congenital heart disease. Fortaleza, Ceará, Brazil, 2009 (n=132)

Type of malnutrition	Coefficient	Standard error	χ^2	Significance
1. Immediate malnutrition				
Wald test				
Subscapular skinfold (mm)	- 1.035	0298	12.038	0.001
Apgar at 1st minute	1.088	0.530	4.220	0.040
Constant	- 3.218	4.259	0.571	0.450
Hosmer and Lemeshow test			12.916	0.115
Omnibus test			26.981	0.000
-2 Log likelihood	52.518			
Nagelkerke R2	0.484			
2. Acute malnutrition				
Wald test				
Subscapular skinfold (mm)	- 1.317	0,261	25.512	0.000
Constant	6.536	1, 437	20.698	0.000
Hosmer and Lemeshow test			30.408	0.000
Omnibus test			49.200	0.000
-2 Log likelihood	99.256			
Nagelkerke R^2	0.461			
3. Chronic malnutrition				
Wald test				
Age (months)	0.426	0.098	18.894	0.000
Sex (0-female; 1- male)	- 0.773	0.457	2.865	0.091
Length (cm)	- 0.261	0.063	17.075	0.000
Constant	13.497	3.456	15.250	0.000
Hosmer and Lemeshow test			7.580	0.476
Omnibus test			29.850	0.000
-2 Log likelihood	122.841			
Nagelkerke R2	0.295			

χ^2: Chi-squared.

The subscapular skinfold value showed statistical significance ($p<0.05$) in the evaluation of immediate malnutrition and acute malnutrition, indicating that the reduction of the subscapular skinfold value increases the probability of the occurrence of this type of malnutrition. In addition to this variable, another presented by the Apgar score in the first minute, used to verify the relationship with immediate malnutrition, also showed statistical significance ($p<0.05$), evidencing that children born with a high Apgar score show a higher probability of developing immediate malnutrition. It was observed that the occurrence of chronic malnutrition was related to female children, with higher ages, and who had deficits in length (Table 3).

Discussion

The values of the rates of the percentiles for length/age, weight/age and weight/length of the children with congenital heart disease are included in the values considered to be within the range of nutritional normality, located between the 3rd and 97th percentiles. Even so, 25% of the children were observed to have values below the 3rd percentile for the rates of weight/age and length/age, denoting that some of them have low weights and lengths in relation to their ages, indicating some degree of malnutrition.

In a previous study which evaluated the growth of hospitalized children below 12 months of age and with heart defects, 50% of the children had values below the 10th percentile for the rates of length/age, weight/length and weight/age, indicating that a high proportion of values are within the nutritional risk group, in view of the fact that the values considered 'at-risk' are found between the 3rd and 10th percentiles[11]. In a similar way, another study carried out with 89 hospitalized children in Turkey, aged between one and 45 months, all with cyanotic or acyanotic heart disease and with or without pulmonary hypertension, used the cut-off points of percentiles between 5 and 95, determining that 65.2% of the children were below the 5th percentile for weight and 41.6% were below the same percentile for the rate weight/length[12]. Differently, the present study – as it considered lower cut-off points for the percentiles (3rd and 97th) – found a lower proportion of children who deteriorated nutritionally for the same rate evaluated.

On the other hand, it is noteworthy that the present study's findings provide evidence which differs from that found in the literature, due to its classifying the children born with heart disease in percentiles considered predominantly normal. This may possibly be related to the peculiar characteristics of the biotype of children from the North-East of Brazil, a region where nutritional deprivation predominates and whose population presents a differentiated biotype: relatively low length and weight. Another explanation could be the criteria adopted for the lower and higher cut-off points for the percentile values used in the growth curves. Because they are distant, these may make it difficult to identify values considered nutritionally 'at-risk'.

As is the case with the percentile classifications, the values of the Z scores predominant in this study are concentrated within the range of nutritional normality. However, negative variations with deviations to the left predominated. It follows that even when they are included in the nutritional range considered as adequate, the children are at imminent risk of developing nutritional alterations. Their Z score values are also discrepant in relation to the scores of children without cardiac alterations.

In a separate, North-American, study, undertaken with children born with heart disease, in the pre-operative period, there was a predominance of Z scores for weight/age equal to -2 standardized units on admission to hospital[13]. For this same client group in the hospital setting, another study identified infants with scores lower than or equal to -2 standardized units for the anthropometric rates of weight/age, weight/length and length/age[14].

Regarding the evolution of Z score values before and after the surgical procedure, (five days), one study concluded that there had been no significant changes in the rates for weight/length and weight/age in the groups of cyanotic and acyanotic children during this period[15]. As proved in a previous study, significant improvements in weight and growth in this infant client group occur only some months after the surgical correction[16]. According to the literature, the causes attributed to malnutrition in children with heart disease seem to be multifactorial and, in general, are related to the heart disease's hemodynamic repercussions[14]. Even the mildest congenital heart disease is reflected in some degree of adverse effect on child growth[17].

In a similar way, another study found Z scores equal to -2 standardized units for the three anthropometric rates of weight/age, weight/length and length/age, associated with children with previous episodes of hospitalization, low consumption of food, low birth weight, low levels of schooling of the parents, presence of congestive heart failure and pulmonary hypertension[18].

In relation to the correlations between the 'at-birth' indicators and the anthropometric rates, it was observed that the alterations in the general configuration of the body result from the variations in growth rates of the different segments of the body. Thus, as pointed out in the literature, the head grows more rapidly in the first year of life and, in this period, the cephalic circumference has greater proportions in relation to the trunk[19].

In the multivariate regression analysis carried out in the present study, the decrease in the value of the subscapular skinfold increases the probability of the occurrence of the immediate or acute types of malnutrition. The subscapular skinfold denotes a good correlation with total body fat, and the quantity of fat deposited in the trunk region provides support for the early detection of malnutrition and obesity[20]. In the face of this, in congenital heart disease, the presence of energy imbalance, the feeding problems and an increased metabolic rate resulting from poor cardiac function may lead to smaller reserves of central adiposity, with congenital heart disease being considered a predictive factor for malnutrition.

In addition to this, children born with heart disease with a high Apgar score in the first minute present a greater probability of developing immediate malnutrition. In particular, the children with congenital heart disease have values for weight and length which are appropriate to their gestational age[14,16], and generally progress well in the first hours after birth according to high Apgar scores.

Even the more complex forms of heart disease do not usually bring signs of dysfunction during the intra-uterine period, do not present changes which indicate the presence of cardiac alterations, and do not predict cardiac distress in the immediate neonatal period[21]. After birth, however, these children's anthropometric rates decrease rapidly, as a result of energy problems in the metabolism (increase in cardiac work, increase in basal temperature, and of the activity of the sympathetic nervous system) and in gastro-intestinal function (mal-absorption resulting from edema and the persistent crises of hypoxia) and reduction in energy consumption (anorexia and early satiety)[16], principally in the presence of cyanotic heart disease[3,22-23]. In this way, even presenting adequate birth conditions, the child affected by heart disease is not able to keep up with growth patterns established for children in general and, as a result, will be more prone to the development of alterations in weight during his or her evolutive process.

However, the occurrence of chronic malnutrition was related to female children of higher ages and reduced length. If chronic malnutrition represents alterations in the length/age rate, the girls have compromised growth in a process of long duration.

It is known that female children have smaller bodily dimensions at birth in relation to the boys. Thus, one important aspect to be investigated refers to the recognition of morphological types, based in the relationship between the percentiles for height and weight. Such relationships may be harmonious or inharmonious, offering various biotypological alternatives of clinical importance, and which may be erroneously confused with deprivational states[24]. Therefore, genetic factors relating only to being of the female sex cannot explain the inferior level of growth for the height of children in the Brazilian North-East. The deficit of growth in height as a result of age strongly reflects deeper and more insidious alterations, persisting over the growth period.

Furthermore, even applying considerable methodological rigor in the study, in the logistic regression analysis, variables from outside the model, or, even, from the composition of the sample, characterized by the relative heterogeneity of the children under outpatient and hospital treatment, may have influenced the children's individual aspects of growth or nutritional status.

In addition to this, the children born in the North-East of Brazil have distinct characteristics, such as the different biotype: weight and length which are inferior to the values obtained for children in other parts of the country and, above all, to those of children born in developed countries. In addition to this, in this study, no association was verified between the types of heart disease and the anthropometric measurements investigated, whereas the literature evidences cyanotic heart disease as a cause of greater repercussions on the child's weight and length. Hence, the study indicates that the development of malnutrition in these children depends on the type and severity of the congenital cardiac malformation[17].

In the face of the magnitude of cardiac defects and their profound repercussions on the child's nutritional status, studies of this type may improve the knowledge of health professionals who work in the cardiovascular area and support new strategies for intervening in the monitoring of growth, which may allow better prognoses for these children.

Conclusion

In summary, it was determined in the present study that the children with congenital heart disease present high Z score values which are discrepant in comparison with the scores of children who do not have cardiac alterations. Further, the study evidences that the anthropometric rates in percentiles and Z scores are within the range of what is nutritionally normal. On the other hand, these children present an imminent risk of developing nutritional alterations.

Based in the statistical analysis, it was noted that the children with a high score in the predictive variable of the Apgar score in the first minute present a greater probability of developing immediate malnutrition. Considering this, it is observed that even demonstrating good progression in the first hours of life, these children's anthropometric rates rapidly decrease, in the face of the health condition and metabolic alterations that this involves.

Another variable was also considered predictive, that is, the subscapular skinfold, which showed an inverse relationship with the occurrence of malnutrition of the immediate and acute type. Specifically, this relationship evidences that children born with heart disease who present reduction in the value of the subscapular skinfold have a greater probability of experiencing immediate malnutrition and acute malnutrition, respectively.

It is noteworthy that the present study's nutritional classification of the children with heart disease may have been a limiting factor, as the reference values used are those adopted internationally for healthy children, there not yet being standardized reference values for the comparison of children born with heart disease with other children in the same situation.

Furthermore, it is necessary to take into account – in addition to climatic conditions - the factors to do with socio-economic structures and chronic nutritional alterations arising from heart disease which definitively alters the children's physical development (length and weight). The largely endemic character of poor nutrition in the North-East of Brazil and the worsening of the height deficit in relation to age involves reforming the nutritional intervention programs.

Thus, knowledge of the principal variables involved in the early identification of nutritional deficit in a specific group can guide the health professional in relation to the implementation of nutritional strategies which allow better prognosis, in the attempt to extend the care directed at these children.

Acknowledgements

I would like to express my gratitude to the children with congenital heart disease, to the caregivers and to the health institution.

References

1. Mitchell M, Logan RW, Pollock JCS, Jamieson MPG. Nutritional status of children with congenital heart disease. Br Heart J. 1995;73:277-83.

2. Sarni ROS, Souza FIS, Catherino P, Kochi C, Oliveira FLC, Nóbrega FJ. Tratamento de crianças com desnutrição grave utilizando o protocolo da OMS: experiência de um centro. Arch Latino-am Nutr. 2005;55(4):1-16.

3. De Staebel O. Malnutrition in Belgian children with congenital heart disease on admission to hospital. J Clin Nurs. 2000;9(5):784-91.

4. Oba J. Terapia nutricional na criança com cardiopatia congênita. In: Ebaid M. Cardiologia em pediatria: temas fundamentais. São Paulo: Rocca; 2000. p. 495-512.

5. Jarvis C. Exame físico e avaliação de saúde. 3 ed. Rio de Janeiro: Guanabara Koogan; 2002. p. 120-50.

6. Control of Disease Center (CDC). [Internet] Epi-Info. [acesso 15 jul 2009]. Disponível em: http://www.cdc.gov/epiinfo/.

7. World Health Organization (WHO). Anthro software for PC. Geneva, 2009.

8. Ministério da Saúde (BR). Saúde da criança: acompanhamento do crescimento e desenvolvimento infantil. Brasília (DF): Ministério da Saúde; 2002. (Série Cadernos de Atenção Básica, nº. 11)

9. World Health Organization. Training course on child growth assessment: interpreting growth indicators. Geneva: WHO; 2008.

10. Hosmer DW, Lemeshow S. Applied logistic regression. 2nd ed. New York: John Wiley; 2000.

11. Silva VM, Lopes MVO, Araujo TL. Evaluation of the growth percentiles of children with congenital hearth disease. Rev. Latino-Am. Enfermagem. 2007;15(2):298-303.

12. 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(1):49-52.

13. Kelleher DK, Laussen P, Teixeira-Pinto A, Duggan C. Growth and correlates of nutritional status among infants with hypoplastic left heart syndrome (HLHS) after stage 1 Norwood procedure. Nutrition. 2006;22:237-44.

14. Villasís-Keever MA, Pineda-Cruz RA, Halley-Castillo E, Alva-Espinoza C. Frecuencia y factores de riesgo asociados a desnutrición de niños con cardiopatía congénita. Salud Pública Méx. 2001;43(4):313-23.
15. Avitzur Y, Singer P, Dagan O, Kozer E, Abramovitch D, Dinari G, et al. Resting energy expenditure in children with cyanotic and noncyanotic congenital heart disease before and after open heart surgery. JPEN J Parenter Enteral Nutr. 2003;27(1):47-51.
16. Nydegger A, Bines JE. Energy metabolism in infants with congenital heart disease. Nutrition. 2006;22:697-704.
17. Steltzer M, Rudd N, Pick B. Nutrition care for newborns with congenital heart disease. Clin Perinatol. 2005;32:1017-30.
18. Vaidyanathan B, Nair SB, Sundaram KR, Babu UK, Shivaprakasha K. Malnutrition in children with congenital heart disease (CHD): determinants and short-term impact of corrective intervention. Indian Pediatr. 2008;45(7):541-6.
19. Marcondes E, Setian N, Carrazza FR. Desenvolvimento físico (crescimento) e funcional da criança. In: Marcondes E, Vaz FAC, Ramos JLA, Okay Y. Pediatria básica. 9. ed. São Paulo: Sarvier; 2002.
20. Duquia RP, Dumith SC, Reichert FF, Madruga SW, Duro LN, Menezes AMB, et al. Epidemiologia das pregas cutâneas triciptal e subescapular elevadas em adolescentes. Cad Saúde Pública. 2008;24(1):113-21.
21. Zielinsky P. Malformações cardíacas fetais. Diagnóstico e conduta. Arq Bras Cardiol. 1997;69(3):209-18.
22. Chen CW, Li CY, Wang JK. Growth and development of children with congenital heart disease. J Adv Nurs. 2004;47(3):260-9.
23. Schuurmans FM, Pulles-Heintzberger CFM, Gerver WJM, Kester ADM, Forget P-PH. Long-term growth of children with congenital heart disease: a retrospective study. Acta Pædiatr. 1998;87:1250-5.
24. Marcondes E. Normas para diagnóstico e a classificação dos distúrbios de crescimento e da nutrição – última versão. Pediatria. (São Paulo). 1982;4:307-26.

Received: Jan. 19th 2012
Accepted: Oct. 12th 2012