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Physical growth of Children with Congenital Malformations of the Heart and Great Vessels

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Summary

Janes, Margaret D. and Antia, Asuquo U. (1975). *Nigerian Journal of Paediatrics*, 2 (1), 1. **Physical growth of Children with Congenital Malformations of the Heart and Great Vessels.** The present prospective study of physical growth of Nigerian children with congenital malformations of the heart and great vessels has revealed a high incidence of, as well as a marked degree of, growth retardation among these children. The average height and weight percentiles of the majority of the patients were well below the British 50th percentile. The heights and weights of most of these patients were also markedly below those of normal Nigerian children drawn from good and poor socio-economic backgrounds. It is suggested that malnutrition contributes significantly to the profound growth retardation observed in the majority of our patients.

IT is a common clinical observation that congenital malformations in general are often associated with varying degrees of growth retardation in children. In the last two decades, workers in Europe and America (Campbell and Reynolds, 1949; Mehrizi and Drash, 1962; Linde, *et al.*, 1967; Bayer and Robinson, 1969; Feldt, Stickler and Weidman, 1969) have confirmed this observation by studies on the height and weight of children with congenital malformations of the heart and great vessels. With some congenital malformations of the heart, retardation of both height and weight have been shown to occur, while in others either the height or the weight is more affected.

The present study was carried out as part of comprehensive studies on various aspects of congenital malformations of the heart in indigenous Africans. In undertaking the study, no attempt was made to elucidate the pathogenesis of growth retardation in congenital cardiac children, nor to assess the effectiveness of corrective surgery on the growth pattern of these children.

Subjects and Methods

The subjects were 110 children with congenital malformations of the heart and great vessels, aged 2 months to 12 years, who attended the Paediatric cardiac clinic, University College Hospital, Ibadan, from 1966 to 1970. Children with Down's and congenital rubella syndromes, in whom growth retardation is part of the syndrome-complex, were excluded from the study. The diagnosis of the malformations was based on the clinical findings, chest radiographs, 12-lead electrocardiograms, and in many cases, angiocardiography as well.

The height and weight of each patient were obtained using measuring techniques described by Falkner (1960). Each child was weighed nude on a steel-yard type of scale; the weight was recorded to the nearest ounce and then converted to kilogram. The height of children up to the age of three years was measured with the child lying in a supine position on an "Infant Measuring Table". Briefly, the measuring technique consists of the child lying supine on the table and one of two observers holding the child's head against the fixed head piece, with the lower border of the orbit and the external auditory meatus in the same plane perpendicular to the table. The other observer grips the ankles with the left hand, stretching the child as much as possible, and with the right hand moves the moveable foot piece to rest against the soles of the feet. Above the age of three years, the height was measured in a standing position with a stadiometer. The observer's left hand is placed below the mandible and with gentle upward pressure the child is stretched as much as possible.

The heights and weights of all the subjects were plotted on growth charts of British children (Tanner, 1958), and percentiles obtained for each subject. For children under the age of seven years, heights and weights were also plotted on growth charts of two groups of apparently normal Nigerian children of Yoruba ethnic origin. These growth charts were composed from data obtained between 1962 and 1968 by one of us (M.D.J.) in a longitudinal study of growth and development of two groups of apparently normal Nigerian children (Janes, 1970). These 2 groups of children were:

(*a*) the "Elite" ("E") group, comprising children from the most educated and well-to-do families. The mothers of these children have had a minimum of four years' secondary education.

(*b*) the "Oje" ("O") group, included children from the poorest section of the population. Polygamy, poor environmental sanitation and nutrition, and a high level of illiteracy are common among this group.

Results

The average height and weight percentiles of the 110 subjects, grouped according to the types of malformation, and based on British standards are summarised in Table I. It will be seen that the average height and weight percentiles in all the types of malformations were considerably below the fiftieth percentile, ranging between 7.2 and 34.7 for height and 3.1 and 21.2 for weight. A few children were however, above the fiftieth percentile. Also in each group of malformations, the average of the weight percentiles was lower than that of the height. The average height and weight percentiles (7.2 and 3.1 respectively) of children with cyanotic types of malformation were the lowest of all the groups followed by those with pulmonary stenosis. The difference between the average weight and height percentiles of the children in these two groups was only slight, whereas in all other types of malformations the differences were much more pronounced.

Table II summarizes the individual height and weight percentiles of 12 children above the age of 7 years. It will be observed that in the majority of the cases, the weight percentiles were lower than the height percentiles.

Figures 1 to 4 show the individual heights and weights of the patients under the age of 7 years, plotted against:

(*a*) the mean height and weight of the 2 groups of apparently normal Nigerian children ("E" and "O");
(*b*) the "O" mean weight and height minus 2 standard deviations (−2SD); and
(*c*) the British fiftieth percentile weight and height (Tanner, Whitehouse and Takaishi 1966).

TABLE I

Average Height and Weight Percentiles of 110 Nigerian Children with Congenital Malformations of the Heart and Great Vessels using British Growth Standards

Malformations	*No. of Patients*	*Average Height Percentile*	*Average Weight Percentile*
Ventricular Septal Defect	26	34.7	21.2
Persistent Ductus Arteriosus	25	20.8	9.9
Pulmonary Stenosis	21	16.3	10.6
Atrial Septal Defect	21	21.8	12.5
Cyanotic Defects (T/F, TGA)	17	7.2	3.1
Total	110	20.2	11.5

T/F = Fallot's Tetrad

TGA = Transposition of the Great Arteries.

TABLE II

Individual Height and Weight Percentiles of 12 Children, Aged 7 years and Above, Using British Growth Standards

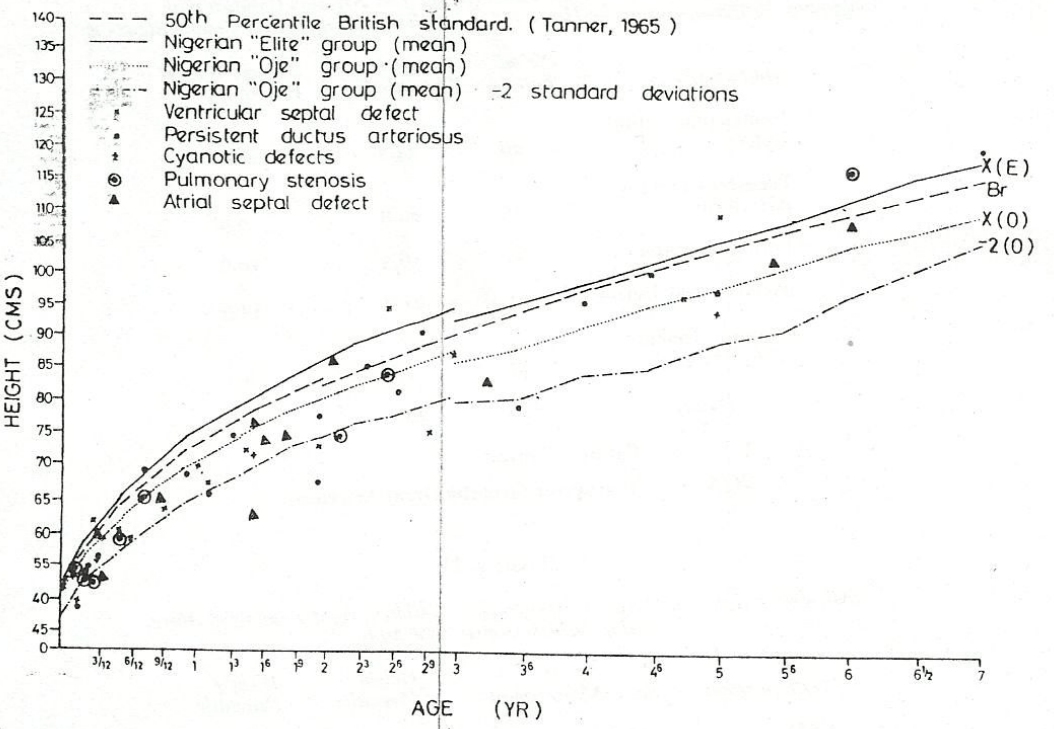
Malformations	*Sex*	*Age at Measurement*	*Height Percentile*	*Weight Percentile*
VSD	M	7 years. 3m.	Above 97th	Above 97th
PDA	M	9 years.	4th	Below 3rd
PDA	F	8 years. 10m.	10th	Below 3rd
T/F	M	8 years	9th	Below 3rd
PS	M	12 years. 7m.	Below 3rd	Below 3rd
PS	M	13 years	18th	Below 3rd
PS	F	9 years. 7m.	12th	4th
PS	M	9 years. 1m.	16th	9th
ASD	F	11 years	Below 3rd	Below 3rd
ASD	F	10 years	9th	17th
Coaractation of the Aorta	M	14 years	Below 3rd	Below 3rd
Dextrocardia with Situs Inversus	M	8 years	4th	Below 3rd

VSD = Ventricular Septal Defect

PDA = Persistent Ductus Arteriosus

PS = Pulmonary Stenosis

ASD = Atrial Septal Defect.



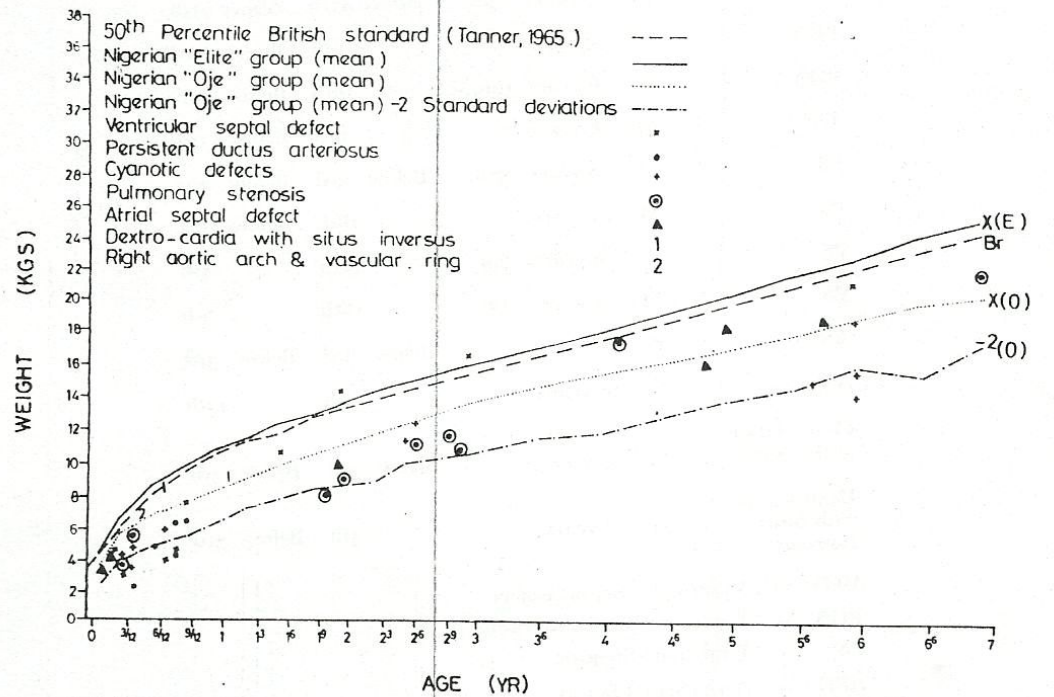


Fig. 1–2. Individual heights and weights of 44 male patients under the age of 7 years plotted against: (a) the mean heights and weights of two groups of apparently normal Nigerian children, "Elite" ("E") and "Oje" ("O"); (b) the "O" mean height and weight minus 2 standard deviations (−2SD); (c) the British 50th percentile height and weight. Note that the heights and weights of a majority of the patients are below the "O".

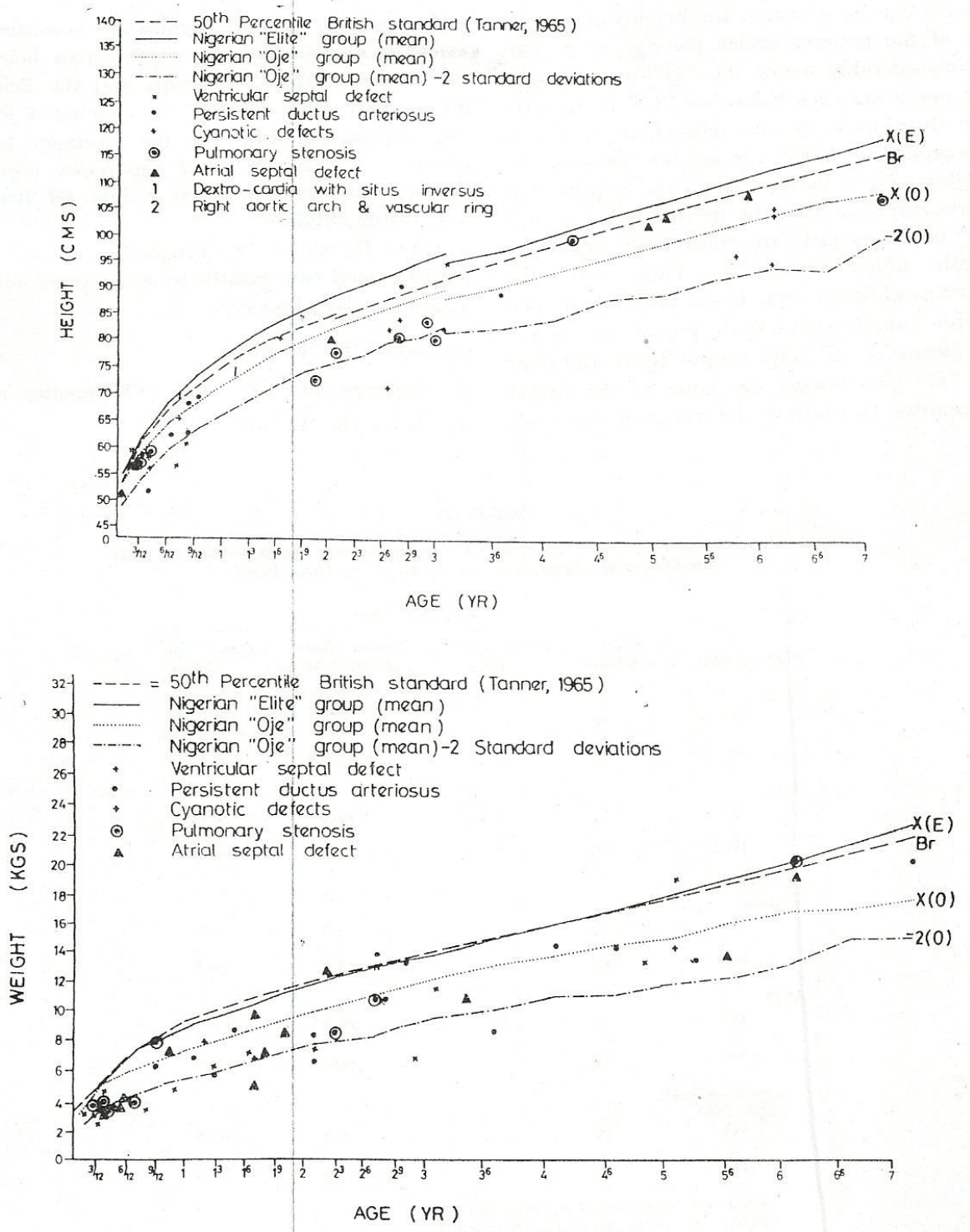


Fig. 3–4. Individual heights and weights of 54 female patients under the age of 7 years plotted against (a) the mean ***heights*** *and weights of two groups of apparently normal Nigerian children, "Elite" ("E") and "Oje" ("O"); (b) the "O" mean heights and weights minus 2 standard deviations (–2SD); (c) the British 50th percentile height and* ***weight.*** *Note that as in the males, the heights and weights of a majority of the patients are below the "O"*

First, it can be seen that the heights of a majority of the patients under the age of 7 years are considerably below the "O" mean height, and many are even below the "O" mean–2SD. The distribution of the individual weights is also similar to that of the heights, although the weights tend to be lower than the heights. The charts also show that the mean heights of both "E" boys and girls are consistently above the British fiftieth percentiles. Thus, the "E" Nigerian children tend to be taller than their British counterparts. With regard to weight, the means for "E" boys are just above and those for "E" girls almost the same as the British percentiles. In contrast, the means of the height and weight of the "O" group are consistently below (more marked for weight than height) the means of the "E" group and the British fiftieth percentile. It may be concluded from this comparison that on the average, both groups ("E" and "O") of apparently normal Nigerian children have less weight for height than British children.

Table III shows the proportion of the 102 patients aged two months to seven years whose heights and weights were:

(*a*) above the "E" mean,

(*b*) between the "E" and "O" means, and

(*c*) below the "O" mean.

TABLE III

Percentage Distribution of Heights and Weights of 102 Nigerian Children Aged 2 Months to 7 Years with Congenital Malformations of the Heart and Great Vessels

Malformations	*No. of Children*	*Percent of Cases*		
		Above "Elite" Mean	*Between "Elite" and "Oje" Means*	*Below "Oje" Mean*
VSD				
Wt	26	19.2	7.7	73.1
Ht	26	19.2	15.4	65.4
PDA				
Wt	23	4.4	17.4	78.3
Ht	23	8.7	34.8	56.5
Pulmonary Stenosis				
Wt	17	–	23.5	76.5
Ht	17	5.9	23.5	70.6
ASD				
Wt	19	5.3	26.3	68.4
Ht	19	–	44.4	55.6
Cyanotic Defects (T/F, TGA)				
Wt	17	–	6.3	93.8
Ht	17	–	12.5	87.5

VSD = Ventricular Septal Defect
PDA = Persistent Ductus Arteriosus
T/F = Fallot's Tetrad
TGA = Transposition of the Great Arteries
ASD = Atrial Septal Defect

It can be seen that the heights of 56–88 percent, and the weights of 68–94 percent of all the patients are respectively below the mean height and weight of the "O" group. A very small number of patients with ventricular septal defect, persistent ductus arteriosus or pulmonary stenosis had heights and weights above the means of the "E" group of normal children. However, if the group of patients who fall below the "O" mean is broken down further into those above or below the mean –2SD, it becomes evident that in the group with cyanotic malformations the discrepancy between height and weight is exaggerated, weight tending to be much lower than height for age.

Discussion

All previous studies on physical growth of children with congenital malformations of the heart and great vessels have revealed a high incidence of growth retardation among this group of children. Whether findings are presented in terms of means and standard deviations (Feldt, Stickler and Weidman, 1969; Bayer and Robinson, 1969) or in terms of percentiles (Mehrizi and Drash, 1962), the results have in every instance shown a high incidence and varying degrees of growth failure among children with these congenital malformations of the heart.

In the present study, first, the average height and weight percentiles derived from standard growth charts of British children were used in assessing the growth pattern of the children. With few exceptions, all the subjects irrespective of the anatomical type of malformations, had heights and weights below the fiftieth percentile. The lowest height and weight percentiles occurred in children with the cyanotic types of malformation as has been reported by other workers (Campbell and Reynolds, 1949; Mehrizi and Drash, 1962; Feldt, Stickler and Weidman, 1969; Linde, 1974).

Secondly, the weights and heights of individual subjects compared with the mean weights and heights of apparently normal Nigerian children ("Elite" and "Oje") show that the heights and weights of a majority of the subjects are considerably below the mean of the "Oje" group. This was more marked for the weights than heights, especially amongst the cyanotic children. Our findings have also confirmed those of Campbell and Reynolds (1949), Mehrizi and Drash (1962), who showed that in general, both heights and weights were retarded among their non-African subjects, the weight more so than height. Thus, growth retardation occurs in a high proportion of our subjects, irrespective of the type of heart malformation and furthermore, the incidence of growth failure among our subjects is higher, and the degree more profound than among caucasian children.

Previous authors have suggested various causes for growth retardation in congenital cardiac patients, and these causes include haemodynamic changes which accompany the malformations (Neil, 1968); tissue hypoxia (Cheek and Cooke, 1964), and relative hypermetabolism (Lees *et al.*, 1965). The evidence in favour of the haemodynamic hypothesis is satisfactory growth attainment in a number of patients following successful surgical repair of the malformations. The conclusion by Lees and his colleagues that hypermetabolism is a cause of growth retardation has been challenged by Brasel (1968) who showed that there was no significant difference between the metabolic rates of normal subjects and congenital cardiac children.

The more marked growth retardation of the children in the present study, compared to similarly affected caucasian children, seems to be due to a combination of factors. The first group of factors (haemodynamic changes, tissue hypoxia, and perhaps, hypermetabolism, etc.) is fundamental, and would, as it were, be responsible for growth retardation in congenital

cardiac children anywhere in the world. An additional factor which plays a significant role in the aetiology of growth retardation among our patients is malnutrition, which by itself, is a potent cause of growth retardation. The apparently normal children of the "Oje" group used for comparison in this study were from the poorest class of the population. Their poor environment and nutrition seem to be responsible for their being stunted and lighter than the children of the "Elite" group.

About 7 percent of the children in the present study were from well-to-do families and about 93 percent probably of similar socio-economic status to that of the "Oje" group, (Antia, A. U. unpublished data). The heights and weights of the children in the well-to-do class would be expected to approximate to those of the "Elite" group if these children had no congenital malformations of the heart. As so many of the children were well below the "Elite" growth pattern and indeed, below the "Oje" means, it seems reasonable to conclude that in some of these children, growth retardation was due to the heart malformation *per se*. In the case of children with poor socio-economic background, it is likely that part of their growth retardation was due to malnutrition. Indeed, some of the patients showed overt signs of kwashiorkor or marasmus. It is, therefore, concluded that both the fundamental factors mentioned above and malnutrition are responsible for the marked growth retardation found in the present study.

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