NUTRITIONAL STATUS AND BODY COMPOSITION IN VENEZUELAN CHILDREN UNDER 6 YEARS OF AGE

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Abstract: *Differences in body composition were evaluated according with nutritional status in 677 Venezuelan children aged 2 to 6 years of low socioeconomic status. Nutritional assessment was performed through height-for-age and weight-for-height using WHO guidlines. Arm muscle and fat area, energy/protein index, body mass index, humerus and femur diameters were taken as indicators of body composition. Results revealed 18.5% and 11% malnourished children for height-for- age and weight-for-height. Differences were shown according with cutt-off points, degree of deficits, sex and age. Applying a stepwise analysis to groups of malnourished children reveals body mass index, energy/protein index and femur width in girls, and energy/protein index, humerus and femur width in boys, as significantly related to malnutrition. These data suggest that estimates of bone growth and muscle reserves of the arm, provide a useful indication of nutritional status especially for boys.*

Key Words: *Body composition; Nutritional status; Transverse growth; Venezuela.*

Introduction

Poverty is widely recognized as a major cause of malnutrition, whose moderate and mild forms have became a world public health problem. The sociodemographic environment surrounding children from the lowest economic strata of the Venezuelan population, accounts for a poor quality of life which favors different manifestations of malnutrition. Recent studies show in the last decade the growing process of poverty in Venezuela, and its tight negative relationship with nutrition (Jaén 1994).

Effects of the environmental conditions of Venezuelan children on body size has been well documented (Méndez- Castellano, López Blanco, Méndez, Fossi, Landaeta-Jiménez and Bosch 1990). Data on anthropometric parameters of body composition of children of low socioeconomic strata are not as extensive as stature and weight, and few studies have evaluated nutritional status using body composition indicators, especially those which measure bone and muscle tissues. The present investigation provides the results of an anthropometrical survey, were we examined selected indexes of growth and body composition to test the effects of the unfavorable social and economic conditions, in a group of children who live in a deprivated area of Caracas, Venezuela.

Materials and methods

The cross-sectional study conducted during 1992, used data derived from four slummed areas of Caracas. The sample comprises 677 children, boys and girls aged 2 to 6 years of age. Socioeconomic characteristics of the whole group have been analyzed in a previous work

(Ledezma, Landaeta-Jiménez, Pérez, and Mancera 1992) according to Graffar's method modified for Venezuela by Méndez Castellano (Méndez- Castellano, López-Blanco, Méndez, Fossi, Landaeta-Jiménez and Bosch 1990) and the Map of poverty in Venezuela (PNUD-MINFLIA 1990). In brief, about 72 % of the families had incomes below the poverty level, and the occupations of the heads of households fell mostly into the nonskilled craft categories.

A series of anthropometric dimensions was measured on each child, following classical standardized anthropometric techniques.(Lohman, Roche and Martorell 1988). Before measurements, all children were "landmarked" by reference to specific points on the skeleton, and a single observer always measured a given dimension in order to eliminated interexamined error. Body weight was measured to the nearest 0.05 with a portable weight scale frequently calibrated, body lenght was measured to the nearest 0,1 cm with a Broca plane and tape calibrated in millimeters, mid-arm circumference was measured with an anthhropometric tape taken to the nearest 0.1 cm; triceps skinfold thickness was measured with a Slim guide precision caliper which permits reading to the nearest 0.5 mm. Humerus and femur width were measured to the closest 0.1 cm using a modified vernier caliper. From the four first variables, arm muscle area and arm fat area were derived (Frisancho 1990), as well as body mass index that could identify subjects at risk of malnutrition (Hammer, Kraemer, Wilson, Ritter and Dornbusch 1991) and energy-protein index , used to distinguish between constitutionally thin and undernourished children. (Amador, Bacallao, Hermelo, Fernández and Tolón 1975). Nutritional assessment was performed through height for age and weight for height as primary indicators of nutritional status in children, as recommended by, and using WHO guidelines (Waterlow, Buzina, Keller, Nicchman and Tanner 1977). Cutt off points and reference data for arm muscle and arm fat areas are derived from Frisancho (Frisancho 1990) and from energy-protein index according with Cuban national reference population (Amador, Bacallao and Flores 1980). For humerus and femur width the reference data are those of the value of mean ± 1 S.D. of the same population of the study.

Children were placed into three groups: the "normal" or average group was integrated with children situate between the 10th and 90th percentile, the "low" group was conformed by children that presented different degree of deficit. Height for age cutt- off point was set at the 3th percentile, while for weight for height , percentile 10 was the off point. The "high" group was formed by children located above the 90th percentile. The small number of children prevented statistical analysis in this latter group.

A first step established differences by means of a "t" test between children classified as normal or low nutritional status according with height for age and weight for height. Secondly a linear correlation was applied between a battery of auxological dimensions in malnourished children. Finally a stepwise analysis was set using height for age and weight for height as dependent variables, and arm muscle area, arm fat area, body mass index, energy protein index, and humerus and femur width as the independent ones.

Results

Figure 1 depicts sex and nutritional status differences. Low Height-for-age is present in 21.0% of the boy sample, vs 16.0% found for girls. Deficit according with weight for height was observed in 12.0% in boys and 8.0% for girls. Overall, children were more stunted than wasted and boys are shown as a more vulnerable group. Mild protein energy malnutrition was more common in all children, beeing ages 4 and 3 in boys and girls respectively, of greatest prevalence.

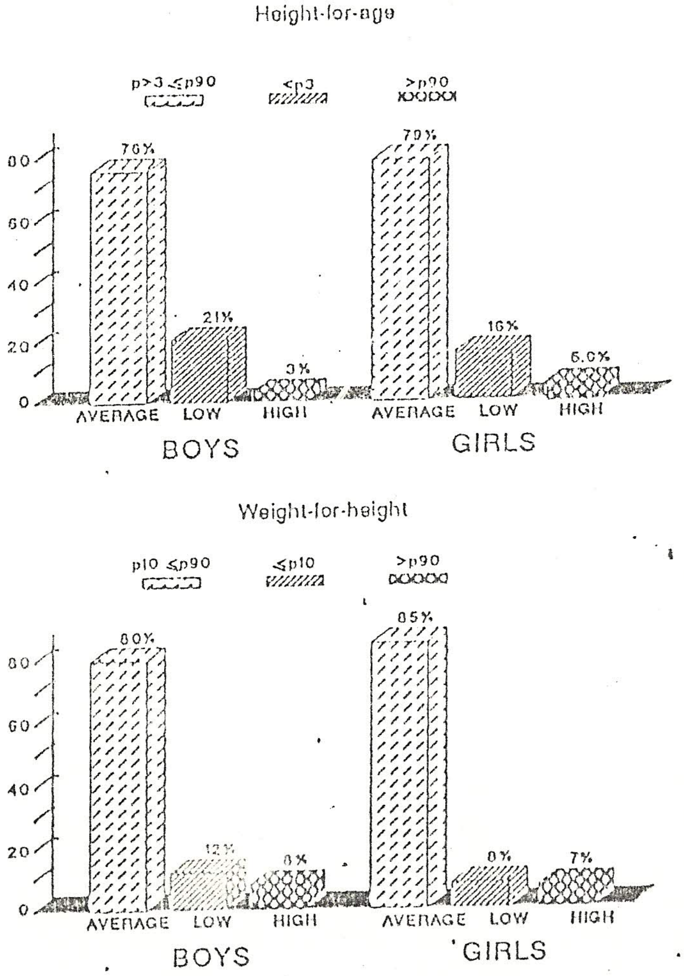

Fig. 1

Table 1 exhibits statistical differences (= 0,01 and = 0.05) according with height for age, for all groups of sex and age, for weight, height and femur width between average and low nutritional status children. Arm muscle area also emerges as a significant variable in boys from 3 to 5years of age. For girls, arm fat area and body mass index were significant at 2 and 4 years of age respectively.

According with weight for height statistical differences were found for weight, mid arm circumference and body mass index, especially at age 3 in boys and age 4 in girls.

Correlations between the anthropometrical variables used, are recorded in table 2 for boys and girls at the 0.05 and the 0.01 level. All correlations between weight and indicators of fat tissue are negative or very low . Weight correlates best with skeletal breadths. Energy protein index correlates negatively with all variables except for those that measure fat and to a lesser extent with body mass index.

Results of the stepwise analysis indicates according with height for age, that only arm muscular area predicts malnutrition in boys as a whole group. Note, however, that the variation its explains is very low (R^2=0.0617). For girls body mass index was the only variable included in the model, which accounts for 25% of the variation in the nutritional status (R^2= 0.253318). By age groups, the best models included femur width in 2 years old girls, body mass index along with energy/protein index at 3 years , and the combination of arm fat area with body mass index in 4 years old girls. In every situation they explained 68%, 71% and 82% of the variation in the nutritional status respectively.

In relation to weight for height, best model was formed by arm fat area and body mass index for boys. Together, they explained the variation in the nutritional status in a 59% of the sample (R^2=0.586624). For girls body mass index was the only variable that comprises the model, it explained 18% of the variation.

According to age groups humerus width, arm fat area and body mass index explained nutritional condition in a 95% of children 2 years of age. The combination of energy protein index, arm fat area and femur width was the best model for children 3 years old, all together they explained 97% of the variation. At 6 years femur width and arm muscular area conformed the best model explaining 87% of the variation. On the other hand body mass index was the most powerful variable in girls, since it explained 77% of the variation in nutritional status.

Discussion

It is evident through the anthropometric and nutritional assessment of the Venezuelan children reported here that a delay in height for age is accompanied with a meaningful deficit in weight , in femur width and arm musculature in boys. Girls presented a similar behavior, showing in some cases a low body mass index.

Regarding weight for height deficit, the most important alteration is focused on those indicators that measures total body mass, fact which agrees with the characteristics of the indicator utilized. The weight of evidence at present study also suggests an early apparition of growth retardation in height and weight, equally acompanied with other physical components deficiencies such those above described. These findings warrants comment, since this could be a result of a deficit situation that start in the uterus and it is enhaced by poor environmental

TABLE 1

Age means of anthropometrical variables and statistical significance of diffferences between normal (upper line) and undernourished children (botton line) for boys and girls assessed by height for age

BOYS

AGE	N	W	H	A.C	T.S	H.W	F.W	A.M.A	A.F.A	B.M.I	E.P.I
2	62	13,03**	89,08**	14,92	9,18	4,13	5,13**	1160,94	621,33	16,41	1,57
	11	11,59	81,85	14,93	10,0	4,04	5,81	1115,09	671,12	17,27	1,63
3	61	14,42**	96,55**	14,98	8,49	4,26*	6,42**	1213,13**	579,42	15,47**	1,52*
	17	12,66	67,35	14,49	9,59	4,08	6,09	1053,97	623,85	16,67	1,62
4	65	17,12**	104,07**	15,64*	8,68	4,53	6,88**	1337,00**	626,51	15,75	1,52
	13	14,27	93,49	14,61	8,31	4,18	6,22	1150,61	549,91	16,31	1,54
5	54	18,34**	110,07**	15,90*	7,56	4,74*	7,05**	1462,59**	558,67	15,11	1,45
	24	15,63	100,25	15,29	8,04	4,35	6,63	1302,56	566,64	15,52	1,50
6	52	19,31**	114,57**	15,83	7,17	4,71	7,19	1474,87	528,72	14,68	1,43
	11	17,16	106,23	15,67	7,73	4,42	6,76	1408,49	560,29	15,20	1,46

GIRLS

EDAD	N	W	H	A.C	T.S	H.W	F.W	A.M.A	A.F.A	B.M.I	E.P.I
2	43	12,49**	87,63**	14,82	9,74	3,96	5,93**	1109,71*	651,94**	16,27	1,61
	8	10,25	79,65	14,13	10,50	3,80	5,46	939,42	657,71	16,15	1,68
3	49	13,96*	94,52**	15,21*	9,90	4,06	6,13**	1172,60*	679,07	15,60*	1,60
	12	12,17	85,90	14,44	9,25	4,03	5,86	1065,45	602,69	16,52	1,61
4	49	16,27**	103,54**	15,64	9,27	4,31	6,47*	1297,44*	658,99	15,10	1,56
	13	14,15	93,55	15,05	9,62	4,26	6,28	1156,73	649,78	16,27**	1,58
5	42	17,85**	109,0**	16,00	8,96	4,46	6,70**	1391,01	659,78	15,01	1,53
	6	14,42	100,17	15,33	8,00	4,30	6,24	1316,76	568,62	14,34	1,50
6	47	19,74**	115,40**	16,23	8,74	4,62**	6,95**	1454,51	652,43	14,79	1,50
	8	15,94	105,66	15,74	8,63	4,32	6,39	1353,11	621,23	14,27	1,50

W = Weigth, **H** = Heigth, **A.C** = Arm Circumference, **T.S** = Triceps Skinfold, **H.W** = Humerus Width, **F.W** = Femur Width, **A.M.A** = Arm Muscle Area, **A.F.A** = Arm fat Area, **B.M.I** = Body Mass Index, **E.P.I** = Energy Protein index

TABLE N 2

Observed correlations between anthopometrical variables for boys (rigth side) and girls (left side)

	H - for - A	W	H	A.C	T.S	H.W	F.W	A.M.A	A.F.A	B.M.I	E.P.I	
	W		0,9094*	0,6890**	-0,3390**	0,7058**	0,8716**	0,8019**	-0,0576	-0,555	-0,5853**	G
	H	0,9101**		0,5301**	-0,4284**	0,3575**	0,8468**	0,6976**	-0,1964	-0,4524**	-0,6082**	
B	A.C	0,8486**	0,776**		0,0807	0,3985**	0,6313**	0,8817**	0,4411**	0,1976	-0,3376	I
	T.S	0,1343	-0,267	0,3842**		0,0550	-0,3167**	-0,3941**	0,9264**	0,3336**	0,8950**	
O	H.W	0,8310**	0,8452**	0,7558**	0,736		0,4958**	0,3379**	1,995*	0,0486	-0,1341	R
	F.W	0,9049**	0,9173**	0,8004*	0,0442	0,9382**		-0,7346**	-0,0579	-0,1408	-0,5593**	
Y	A.M.A	0,8764**	0,8601**	0,9054**	-0,0368	0,7820**	0,8444**		-0,0314	0,0311	-0,7268**	L
	A.F.A	0,4710**	0,3060**	0,7074**	0,9136**	0,3742**	0,3690**	0,3513**		0,3763**	0,6757**	
S	B.M.I	0,142	-0,3628**	-0,0921	0,2038	-0,1963	-0,2100	-0,1744	0,1430		0,2095*	S
	E.P.I	-0,3497**	-0,4716**	-0,1962	0,7914**	-0,3590**	-0,4209**	-0,5620**	0,4963**	0,2505*		

W = Weigth, H = Heigth, A.C = Arm Circumference, T.S = Triceps Skinfold, H.W = Humerus Width, F.W = Femur Width, A.M.A = Arm Muscle Area, A.F.A = Arm fat Area, B.M.I = Body Mass Index, E.P.I = Energy Protein index

* P < 0,005 ** P < 0,001

TABLE N° 2
Continuation

	W - for - H	W	H	A.C	T.S	H.W	F.W	A.M.A	A.F.A	B.M.I	E.P.I	
G	W		0,9768**	0,7802**	-0,2126	0,8208**	0,8707**	0,7698*	-0,650	-0,3493*	-0,2091	G
	H	0,8678**		0,7481**	-0,2690*	0,3932**	0,9021**	0,7830*	-0,0144	-0,5353**	-0,2902*	
I	A.C	0,8955**	0,7858**		0,209	0,5200**	0,7140**	0,8911*	0,3237*	-0,3538**	-0,2378	I
	T.S	0,3121*	0,0686	0,5522**		0,0575	-0,3567**	-0,4278**	0,9488**	0,3220**	-0,7930**	
R	H.W	0,8516**	0,8746**	0,8087**	0,1219		0,4999**	0,4332*	-0,2356	-0,5250**	-0,1228	R
	D.F	0,8992**	0,9264**	0,8439**	0,1486	0,9384**		0,7945**	-0,1128	-0,5295**	-0,3773**	
L	F.W	0,9213**	0,8853**	0,9249**	0,1992	0,8894**	0,9162**		-0,1373	-0,4456**	-0,5677**	L
	A.M.A	0,5816**	0,3528*	0,7874**	0,9389**	0,4087**	0,4362**	0,5015**		0,2072	0,6850**	
S		0,2627	-0,2039	0,1232	0,3101*	-0,518	-0,0662	0,307	0,2892*		0,5256**	S
		-0,2455	-0,4325**	-0,0455	0,7507**	-0,4043**	-0,3911**	-0,3815**	0,5020**	0,2342		

W = Weigth, H = Heigth, A.C = Arm Circumference, T.S = Triceps Skinfold, H.W = Humerus Width, F.W = Femur Width, A.M.A = Arm Muscle Area, A.F.A = Arm fat Area, B.M.I = Body Mass Index, E.P.I = Energy Protein index

* $P < 0{,}005$ ** $P < 0{,}001$

conditions, which limit an adequate catch up of their physical growth. This fact has been highlighted in Venezuela by other authors (Henríquez and Guerrero 1992). Percentage of deficit according with height for age points out in this group of high social risk , the presence of children with an incomplete and partial recovery in their physical growth characterized by a low muscle reserve accompained in some instances with a high or normal weight, these are Ramos Galván homeorretic children, called survival or "adapted" children at lower level by other authors (Ramos Galván 1966) (Amador and Hermello 1985).

Results equally suggest that at this ages nutritional status assessment requires participation of other body composition indicators especially that of the bone component, given the important role that humerus and femur diameters play in the models and the percentage of explanation they provided for.

Although a similar pattern to that of linear growth seems to exist (Gasser,Kneip, Ziegler, Largo, Molinari and Prader 1991), little is known on the influence of a poor nutrition on transverse growth . However the reported data (Malik, Parkash and Mookherjee 1986) in school children from India seems to demonstrate that the effects of a poor nutrition and inadequate hygienic conditions affect not only height and weight but also transverse growth. Our findings lend to support this interpretation.

Few differences between normal and undernourished for fat arm arose in these children, this could reflect a Venezuelan characteristics since it has been found that fat component is low when we compare them with U.S. and English children (Pereira-Colls and Landaeta-Jiménez 1993), (López Contreras-Blanco, Landaeta-Jiménez and Méndez-Castellano 1994), and/or that these children have in fact few caloric reserves to cover their energetic needs, added to the physical activity pattern, which favors leanness.

Children of the study could face nutritional deficiences growing less in order to maintain a harmonic relationship between height and weight, many of them are possible adapted, situation that could be expected since children of the same community benefited by a development programme of the government, were equally found with a highly nutritional deficit (Pérez, Landaeta-Jiménez and Ledezma in press).

Results identify these children as a target group for a social aid programme. They are characterized mainly by a mild and moderate under nutrition expressed in a shortness in height, condition frequently associated with functional disadvantages (Martorell, Rivera, Kaplowitz and Pollit 1992), highly prevalent in developing countries (Neumann and Harrison 1994) low fat and muscular reserve and alterations in bone diameters as well, which make them a vulnerable group.

Acknowledgements: We are grateful to Drs. *Manuel Amador* and *Mirta Hermelo* for criticizing the Spanish version of the manuscript. This project has been supported by research grant F-146 from Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICIT) of Venezuela. The computatational assistance of *Angel Prado* and *Zuleima Rodríguez* is greatly appreciated.

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