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REGIONAL DIFFERENCES IN GROWTH OF VENEZUELANS

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Abstract: *Patterns of growth were studied in 29283 subjects, aged 1 to 18 years, from the Caracas Metropolitan Area (CMA), Northeastern (NER), Midwestern (MWR) and Zulia (ZR) regions, who were measured as part of a cross-sectional survey (Project Venezuela) between 1981–1985. A one-way analysis of variance was used to contrast means and Preece-Baines Model I (PBI), to fit the height data and estimate the biological parameters. Significant differences between the (CMA) and the (MWR) and (ZR), from age 2 onwards and with the (NER) until puberty, were maximal during puberty and minimal in adult height (AH), with the exception of Zulianos, 3.3 cm shorter than (CMA) men. Variation in tempo was greater in girls, with Zulianas maturing earlier, so that they were large for their age independent of final size. Differences during growth reflect disadvantageous environmental conditions of the regions, while the similarity in (AH) is explained by the influence of genetic factors at the end of growth.*

Key words: *Growth; Height; Curve-fitting; "Tempo" of growth; Maximal annual increment.*

Introduction

Worldwide population differences in body size and rate of growth result from the interaction of genetic and environmental factors, so that the former may predispose towards a greater or lesser ecosensitivity (Eveleth 1986). Nutrition and hygiene, among other environmental factors, determine the "quality of life". Thus, physical growth is considered a good indicator of the latter and as such, has been used to assess and monitor the socioeconomic status of a community (Bielicki 1986). On the other hand, the height of individuals is expected to reflect the genetic potential for size in those environments that do not limit growth. Studies on the growth pattern of populations have indicated that genetic differences become more obvious as growth progresses and most evident at the end of growth (Martorell and Habicht 1986).

Venezuela is characterized by large geographical and demographic differences. The ethnic composition is mestizo: results of immunogenetic studies show an admixture of the whole population, with high frequencies of caucasoid-derive antigens, frequencies of Amerindian-derived antigens intermediate between the Amerindian communities and the Spanish population, and low frequencies of African-derived antigens. Caucasoid-derived antigens were significantly higher in the Caracas Metropolitan Area as compared to other regions (Fundacredesa 1985, Echerverría-Pérez 1988).

Growth studies conducted in Venezuela between 1936 and 1978, has shown similarities in size between upper strata children as compared to international standards and large differences between lower strata children and these last (Limongi et al. 1974, López-Contreras et al. 1981). In fact, upper strata children measured in 1976 in the Caracas Metroppolitan Area (Méndez-Castellano et al. 1986a), follow the British median for height throughout growth.

Project Venezuela, a National Human Growth, Nutrition and Family Survey, was designed to assess the health and nutritional status of the population, in order to establish policies and priorities and to serve as baseline for the evaluation of government programmes, as well as to collect data for the construction of national standards. Preliminary reports have been published in which differences between the social strata in size, maturation (age at menarche) and certain biological variables (body iron) are presented. These reports have shown Caracas children to be heavier, taller and to mature earlier than children from other parts of the country; the better living conditions, health and nutritional status have been suggested as explanations (López-Contreras et al. 1981, Farid-Coupal et al. 1981, López-Contreras et al. 1982, Taylor et al. 1988). However, regional differences as such have not been properly studied.

This report deals with the comparative growth of Venezuelan boys and girls from four regions; variations solely due to differences in maturation as opposed to those in final height have been considered. The Preece-Baines Model I (Preece-Baines 1978), designed for fitting longitudinal adata in individuals, was used for the comparison between populations. Tanner et al. (1982) showed that it can be used to fit cross-sectional data and produce efficient estimates of tempo of growth and adult final height and consider it most adequate for the comparison of growth between populations (Tanner 1986).

Materials and Methods

The study was conducted from 1981 to 1985 as part of Project Venezuela. Sample size was fixed using height at age seven for a precision of ± 0.3 cm at the 3rd and 97th centiles fora total of seven administrative regions, two localities (urban and rural) and five social strata, according to Graffar's method modified for Venezuela by H. Méndez-Castellano (1986b). Random sampling was taken from well-baby clinics, schools and household sampling. The age range of 1.0 to 18.0 years was chosen for this analysis: 8874 from the Caracas Metropolitan Area (CMA), 6647 from the Northeastern Region (NER), 8683 from the Midwestern Region (MWR) and 5179 from the Zulia Region (ZR). In the (NER) and (MWR), 14% belonged to the higher and middle strata (I + II + III), 31 to 40% to stratum IV and 45 to 54% to the lowest stratum V, whereas in the (ZR), 19% belonged to strata I + II + III, 55% to stratum IV and 34% to stratum V. The Caracas Metropolitan Area social structure was 28% in the (ZR) and 100% in the (CMA).

The Caracas Metropolitan Area (CMA) contains 20% of the population of Venezuela and is totally urbanized; 12% of its inhabitants are immigrants and 40% are migrants from other parts of the country. The Midwestern Region (MWR) contains 7.3% of the population, is 75% urban, with only 1.4% of immigrants. The Northeastern Region (NER) contains 12.8%of the population; it is 80% urban with 3.6% of immigrants. The Zulia Region (ZR) represents 12% of the population, is 84% urban with 8% of immigrants (OCEI 1987).

Data collection included nineteen anthropometric measurements; only height will be presented in this paper. All subjects were measured by three teams of trained anthropometrists, according to Tanner et al. (1969), using a Harpenden infantometer for supine length up to age 2 and a portable Harpenden stadiometer for stature afterwards. A 0.3 cm mean deviation between measurers was recorded.

A one-way analysis of variance (ANOVA) was conducted and significance measured with an F ratio for a confidence level of 5%. Subsequently, the Preece-Baines Model I (PBI) (1978) was fitted to the original means, using the Growth Package Programme (Brown 1983). The biological parameters derived from the function coefficients were: Age at take-off (ATO), age at maximal increment (AMI), maximal increment (MI), height at take-off (HTO), height at maximal increment (HMI), adult height (AH), gain in height from (ATO) to (AMI) Δ(HTO–HMI), gain in height from (AMI) to (AH) Δ(HMI–AH), and adolescent gain in height Δ(HTO–AH). The following formula was used for studying the components of the differences in adult height Δ(AH): Δ(AH) = Δ in height at take-off (HTO) corrected+ Δ in adolescent gain ± Δ due to the delay in spurt. The difference Δ in (HTO) was corrected for the corresponding height at the earliest age at take-off of the two populations. In the case of sex dimorphism in height, Δ(AH) = Δ in height at girl's take-off + Δ in adolescent gain + Δ due to the boys' delay in spurt (Hauspie et al. 1980b, Brown et al. 1982). The pooled residual variances obtained by fitting the curve were 0.518 for boys and 0.203 for girls asnd the Runs Test was non significant at a 5% level. Finally, the means and yearly increments derived from the PBI fit were compared to the British population values (Tanner et al. 1966, Tanner et al. 1982).

Results

Significant differences were found at most ages between the (CMA) and the (MWR) and (ZR), and also from 2 to 12 years in boys and 3 to 12 years in girls between the (CMA) and the (NER). Children from the (MWR) and (ZR) were similar in height throughout growth, yet statistically different with regard to the (NER). The fitted mean constant distance and increment curves for height in boys from the four regions are shown in *Figures 1* and *2*, where a gradient from highest to lowest: CMA > NER > YR > MWR, between ages 2 and 11 in girls and 2 to 14 in boys is observed with the change at age 12 in girls and 16 in boys, to CMA > NER > MWR > YR. The differences between the mean values obtained in the (CMA) and the other regions, were already present at age 3±, reaching a maximum of 2 cm with the (NER) boys and girls between ages 10 and 12 and 8 and 11, respectively, of 2.5 to 3 cm between 7 and 13 years of age in boys and between ages 5 to 14 and 6 to 11 in the Zulia and Midwestern girls, respectively, while after puberty, differences between the (CMA) and the other regions diminished, although with Zulia differences of 3 cm in men and 1.8 cm in women were still evident at age 18.

Boys were approximately 1 cm taller than girls until 8 years of age; between 9 and 13 years of age, girls were taller than boys, from 14 years onwards, boys became progressively taller. Sex dimorphism in adult height was 13.8 cm in the (CMA) and (NWR), 12.9 cm in the (NER) and 12.2 cm in the (ZR) (*Table 1*).

The biological parameters derived from the PBI are summarized in *Table 1*. The pattern of tempo in boys is characterized by an earlier maturation in Zulia, specially at

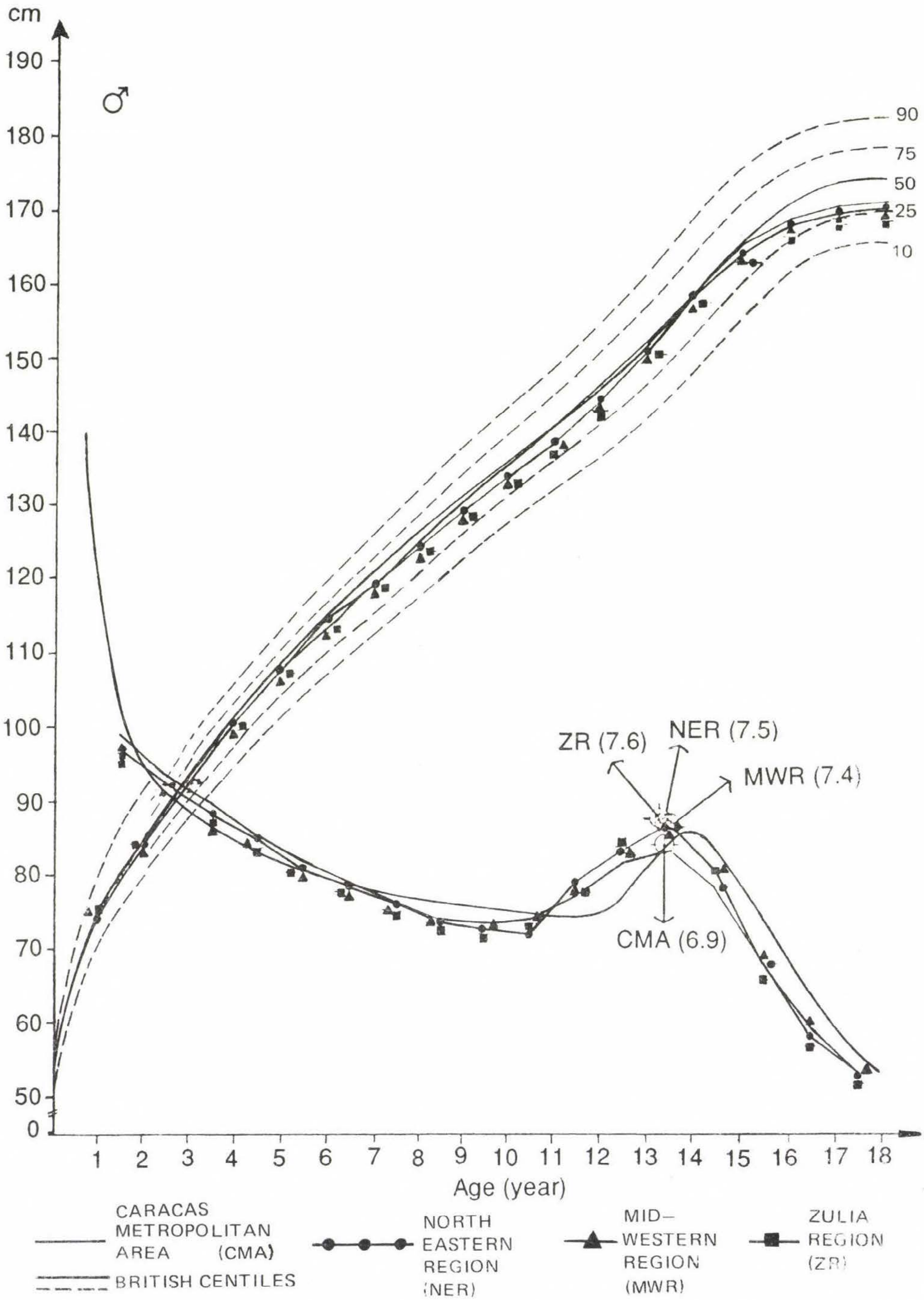

Fig. 1: Mean constant curves obtained by fitting the (PBI) Model to cross-sectional height data of Venezuelan boys from CMA (n: 4465), NER (n: 3128), MWR (n: 4251) and ZR (n: 2549), plotted on British Population Centiles

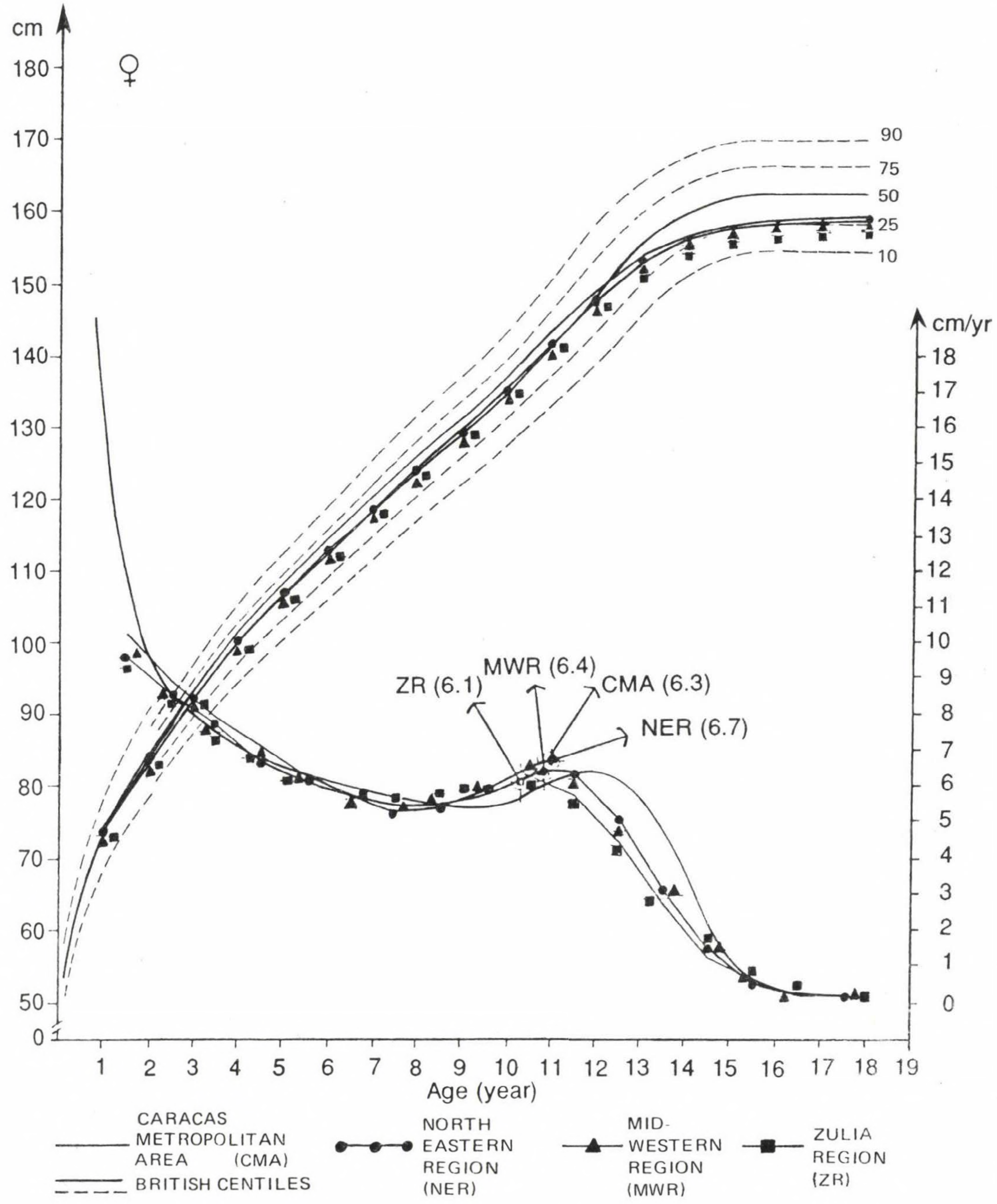

Fig. 2: Mean constant curves obtained by fitting the (PBI) Model to cross-sectional height data of Venezuelan girls from CMA (n: 4409), NER (n: 3519), MWR (n: 4432) and ZR (n: 2630), plotted on British Population Centiles

Table 1. **Derived biological parameters in four regions of Venezuela (PBI)**

Characteristics	Caracas Metropolitan Boys	Caracas Metropolitan Girls	Northeastern Region Boys	Northeastern Region Girls	Midwestern Region Boys	Midwestern Region Girls	Zulia Region Boys	Zulia Region Girls
ATO (yrs)	9.6	7.9	9.6	7.8	9.6	7.8	9.3	7.7
AMI (yrs)	13.4	10.7	13.4	11.0	13.5	10.9	13.3	10.3
MI/cm (yr)	6.9	6.2	7.5	6.7	7.4	6.4	7.6	6.1
HTO (cm)	134.4	125.3	132.2	122.5	131.3	121.5	131.1	121.1
HMI (cm)	155.6	141.4	154.5	141.3	153.9	139.5	152.9	136.9
AH (cm)	172.5	158.7	171.3	158.4	170.9	157.2	169.2	157.0
ΔHTO–HMI (cm)	21.2	16.1	22.3	18.8	22.6	18.0	21.8	15.7
ΔHMI–AH (cm)	16.9	17.4	16.8	17.2	17.1	17.6	16.3	20.2
ΔHTO–AH (cm)	38.1	33.5	39.1	36.0	39.7	35.6	38.1	35.9

take-off. Maximal increment was lower in the Metropolitan Area than in the other regions and the adolescent gain in height less than in the Northeastern and Midwestern regions. (HTO), (HMI) and (AH) followed a similar gradient to that described before: CMA > NER > MWR > ZR. At age 18, Metropolitan Area men were 3.3 cm taller than the Zulianos: 1.8 cm attributable to differences at take-off and 1.5 cm due to the delay in the spurt of the former.

The pattern in girls was also characterized by the earlier maturation in Zulia, specially at the moment of maximal increment (AMI), at 10.3 years, much earlier than in the other regions. Maximal increment in the (NER) was higher than in the other regions, and the adolescent gain was the greatest, in fact, 2.5 cm superior to that of the (CMA). (HTO), (HMI) and (AH) followed a similar gradient to that of boys. With regard to adult height, (CMA) women were 1.7 and 1.5 cm taller than the Zulia and (MWR) women: 1.0 cm because of the delay in the spurt of the former and the rest due to differences at take-off, modified by the adolescent gain, while the (AH) of the (CMA) and (NER) women was similar (*Table 1*).

Differences in tempo between boys and girls were most evident at the maximal increment (2.4 to 3 years earlier in girls), while the magnitude of the spurt was greater in boys, as was their adolescent gain. Adult sex dimorphism was 12.2 to 13.8 cm; this cannot be explained solely by the boys' greater adolescent gain: 4.6 cm in the (CMA), 3 to 4 cm in the (NER) and (MWR) and 2.2 cm in Zulia, nor by the differences in the girls'take-off: 0.7 to 0.9 cm, so that 8.5 to 9.1 cm of the dimorphism in adult height was due to the boy's delay in the pubertal spurt (*Table 1*).

Figures 1 and 2 show the similarity of the Metropolitan Area boys' mean heights with the British median until age 14, and the similarity to the 25th centile at the end of growth as well as the position of the means of the other regions around the 25th centile throughout growth. Metropolitan Area girls' mean heights were also similar to the British median until age 12, while those of the other regions followed a channel between the 25th and 50th centiles; at the end of growth, means corresponded to the 25th and 10th centiles. With regard to tempo, (ATO) in Venezuelan boys occurred 1 to 1.4 years earlier and (AMI) 0.5 to 0.7 years earlier; in Venezuelan girls, both of these parameters occurred 1 to 1.7 years earlier. Maximal increment in boys was, in general, above the British population value, whereas in girls it was lower, with the exception of the (NER).

Discussion

The PBI Model used for fitting the cross-sectional values of the four regions proved to be adequate; pooled residual mean squares compared favourably with other authors (Hauspie et al. 1980a, 1980b, Brown and Townsend 1982, Billewicz 1982). The raw differences were systematized and gradients were not altered; also, estimates of tempo of growth and adult height were provided, so that variations due to a dissimilar tempo were separated from adult size.

Metropolitan Area children were significantly taller than children from the Northeastern Region until puberty and significantly taller than children from the other regions throughout growth. This may reflect the social structure and the overall better living conditions of the capital and also to the fact that Caracas is a "melting pot" of migrants from the other regions (López Contreras-Blanco et al. 1987). The interregional differences observed were smaller than those between the upper and lower strata of Venezuela (López Centreras-Blanco et al. 1987), and similar to the values reported by Rona and Altman (1977). The changes in the height gradient with the adults from Zulia ending up the shortest, are the result of changes in tempo of the latter, especially of girls who mature faster, so that they were large for their age independent of their final size. Differences in adult height between the Metropolitan Area and Zulia were due, in a high proportion, to the delay in the spurt of the former. On the other hand, the similarities in height between the Metropolitan Area and the Northeastern Region adults, particularly women, can be explained by the fact that these exhibit a partial "catch-up". Sex differences in height during growth were as expected, but the period of the girl's prevalence occurred earlier, due to the faster maturation of Venezuelan females. Sex dimorphism of adults fell within the expected variability and was due primarily to the delay in the boy's adolescent spurt; other authors have found similar results (Hauspie et al. 1980a, Brown and Townsend 1982).

Finally, with regard to the British, Venezuelans, specially girls, behaved like early maturers; these differences in tempo are in accord with the larger differences in height observed after puberty in contrast to the smaller differences observed during growth. Similar results have been reported by others, sustaining the statement that genetic differences between populations are most evident after puberly (Martorell and Habicht 1986). The earlier maturation of Venezuelans has been reported before with regard to onset of puberty, age at menarche and skeletal maturity (Farid-Coupal et al. 1981, López Contreras et al. 1986a, 1986b, and 1987). This supports the need for recommending national norms.

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