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ALTITUDE AND GROWTH AMONG VENEZUELAN SCHOOLDCHILDREN OF THE ANDEAN REGION

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Abstracts: *The results of a cross-sectional growth study of Venezuelan schoolchildren of both sexes (n = 3020) from high and low altitude areas in the Andean region are presented. The study reveals no statistical significance in body dimensions in altitude (130–3200 m) neither urban or rural condition at the end of growth (18 yr), however, there were differences when compared between ages. Nutritional patterns were different between high and low altitude populations, but the total calories intake were deficient in both cases. Cormic index was 52 between 8 to 16 yrs. shown our poliethnic origin. We concluded that enviromental (nutrition) and genetic factors seems to be responsible for growth variation observed in high altitude and low altitude children in a higher degree than does hypoxia.*

Key words: *Growth and development; Altitude; Nutrition; Hypoxia.*

Introduction

Children's growth varied between countries to another and even in the same country or area (Eveleth and Tanner 1976). It is influenced by genetic, endocrine and enviromental factors which characterize individual phenotype. Many studies have been published to shown altitude impact on men in the Andes, West Africa and India, only a very few studies are known on Venezuela and even fewer in the Andean region (Pereira 1988). Frisancho (1969) postulated the developmental adaptation hypothesis (DAH) on the basis of data collected on Quechua highlanders from Nuñoa, Peru (Frisancho 1969, 1976, Frisancho and Baker 1970), propose that the supply of metabolic energy which can be utilized for body maintenance and growth is limited by the availability of oxygen, assuming that the metabolic energy required for optimal musculoskeletal growth is not available for highland children. The state of Merida presents the widest variation in altitude of the whole country: from 5 to 3500 m under sea level. It is the object of this paper to characterize growth of Venezuelan children living at high altitudes and test the predictions of DAH for other Andean regions.

Material and Methods

In a cross-sectional growth study of 3020 Andean children (1460 boys and 1560 girls) aged 6 to 18 years 21 anthropometric measurements were made by the author according to IBP suggestions (Weiner and Lourie 1969). In this paper we present height, weight, sitting height, subischial lenght, biacromial and biiliac diameters. Haemoglobin and haematocrit determinations were done as well as a nutritional survey firstly using the 24 hour recall method and secondly the method of weighing the food. Data of children and adolescents living at 130 meters (El Vigia) using a *t*-test were contrasted to those living at 3200 meters (San Rafael de Mucuchies).

Results

Children from El Vigia (low altitude) and San Rafael de Mucuchies (high altitude) in all ages show a *height* below the 50th centile of the Merida reference (Pereira 1980) except boys from high altitude after 16 yrs. Adult height was reached at 16 years. Lowland girls were taller than highland ones at all ages (except at 9 yrs), differences obvious but not significant between 6 to 8 yrs and practically disappeared at age 15. Boys show an opposite pattern: highland boys are taller than lowland ones (*Fig. 1*).

In *weight* the same pattern was found as in height. Lowland boys were heavier until 13 year than highland ones. They finished their growth at near the 50 percentile of Merida's standards while girls does above it but differences were not statistical significant (*Fig. 1*).

Both sexes have larger *sitting height* (*Fig.* 2) between 5 to 11 yr than Merida schoolchildren, and highland boys had a larger values after the age 15 and finished above the 50th centile of Merida values and girls after the age 16. Variation was great in *subischial lenght* (*Fig.* 2) after 13 yrs in both sexes but always below the 50th centile of Merida values, except at 10 yrs of age. The mean of the relation height/sitting height *100 or *Cormic index* for both sexes was 52 in Merida, 53 in low-altitude and 55 in high-altitude. In general, girls had a bigger *biacromial diameter* (*Fig. 3*) than boys until 14 yrs; differences seemed greater between highland and lowland girls after 15 yrs and lowland girls had bigger values. Boys in both groups had approximately the same values at all ages, and under the 50th centile for Merida and reached approximately the same values at age 18. Lowland boys had a larger biiliac diameter (*Fig. 3*) than girls until 9 yrs. Adolescent girls presented greater values. After the age 15 highland girls were bigger, both groups were finishing up their growth at the 50th centile for Merida. Differences in all measurements were not statistical significant in both sexes.

The nutritional pattern was different in each community studied, the main *protein intake* of people living at high altitude came from milk, while that of people living at low altitude derived from the meat. In both cases the diet was qualitatively and quantitative bad, and fruits, vegetables were consumed less. *Haemoglobin* values were different in boys and girls living at high and low altitude, they were 14.94 ± 0.84, and 14.42 ± 1.03, and 13.68 ± 1.10, and 13.08 ± 1.41 g%, respectively Merida children (medium altitude) were 13.90 ± 1.01 and 13.20 ± 0.98 g%.

Discussion

Most researchers have concluded that the growth of highland children is delayed relative to that of lowland children, as a result of hypoxia, an interpretation supported by animal experimentation data (Hunter and Clegg 1973, Shaw and Basset 1976). This pattern of slow and prolonged growth resulting in smaller adult size, has been interpreted as an adaptative response to atmospheric hypoxia (Frisancho 1981). However, the magnitude of the effect of hypoxia in human linear growth vary considerably between studies and there are contradictions. Such findings are presumably due to confounding of comparisons by differences between altitude zones in enviromental agents other than the partial concentration of oxygen. Although physical enviromental agents, such as cold, may be involved (Rothammer and Spielman 1972), it is more likely, given the magnitude of the variability, that the primary cause of confounding is variation in general socioeconomic conditions (Frisancho 1981).

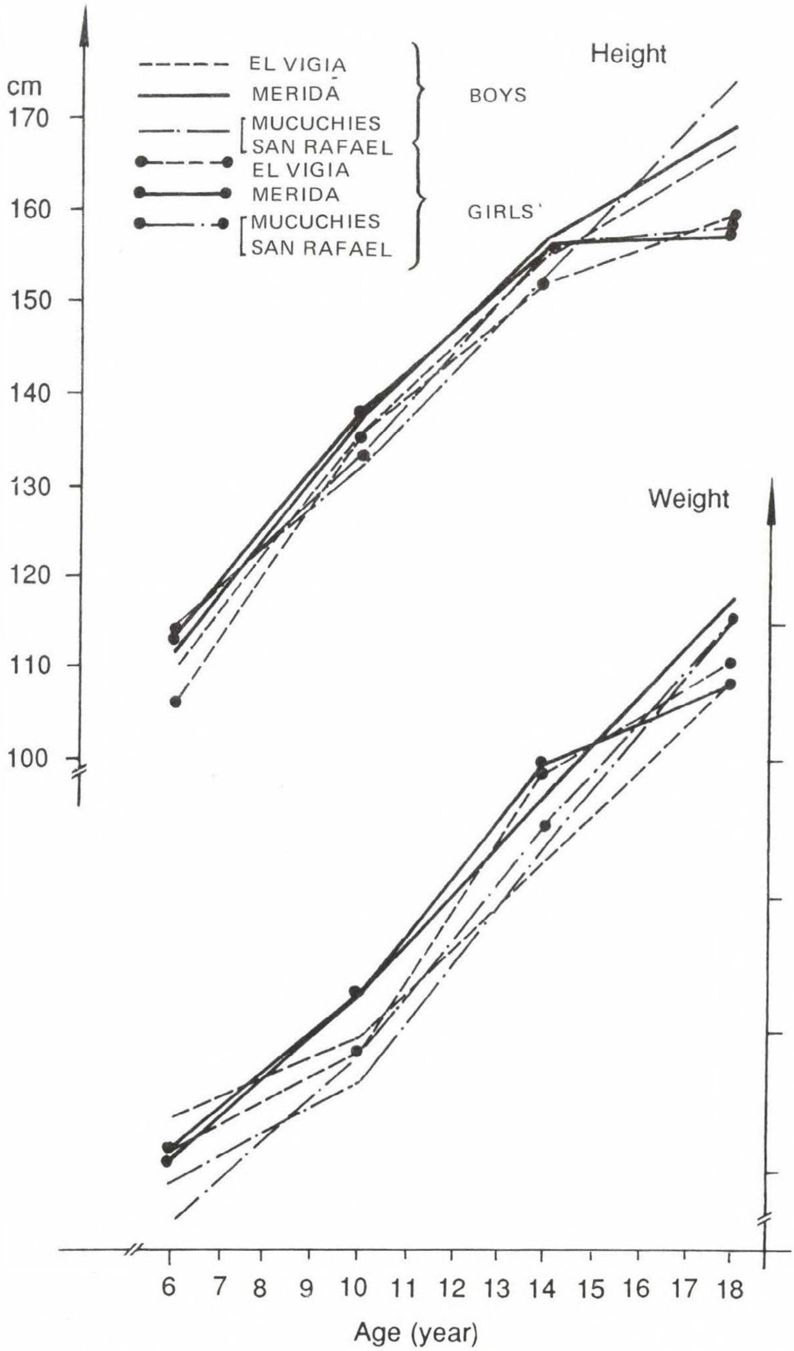

Fig. 1: Distance curves for height and weight: high altitude (San Rafael de Mucuchies) and low altitude (El Vigia) Venezuelan schoolchildren; males and females compared with the 50th centiles of Merida Reference

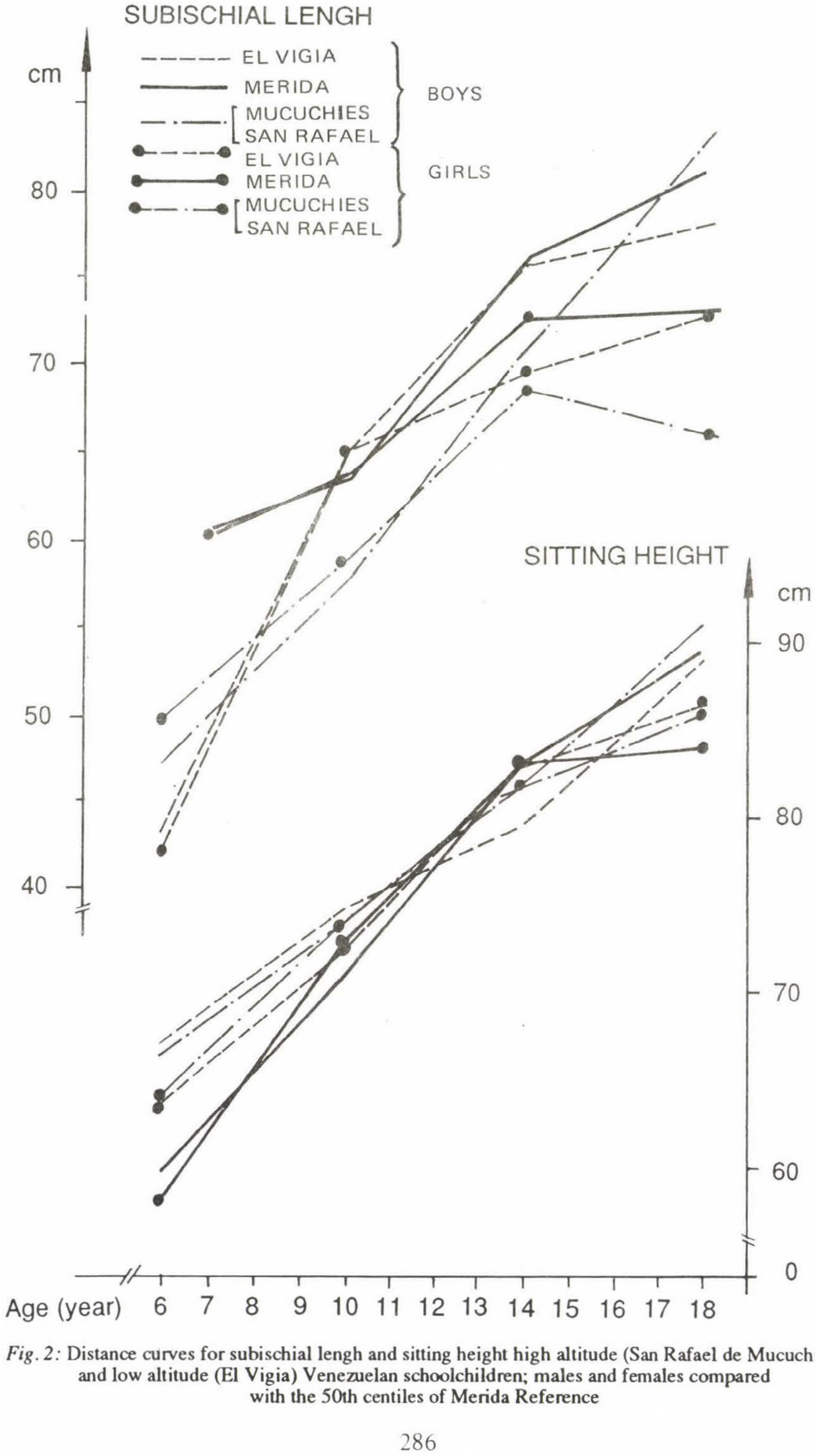

Fig. 2: Distance curves for subischial lengh and sitting height high altitude (San Rafael de Mucuchies) and low altitude (El Vigia) Venezuelan schoolchildren; males and females compared with the 50th centiles of Merida Reference

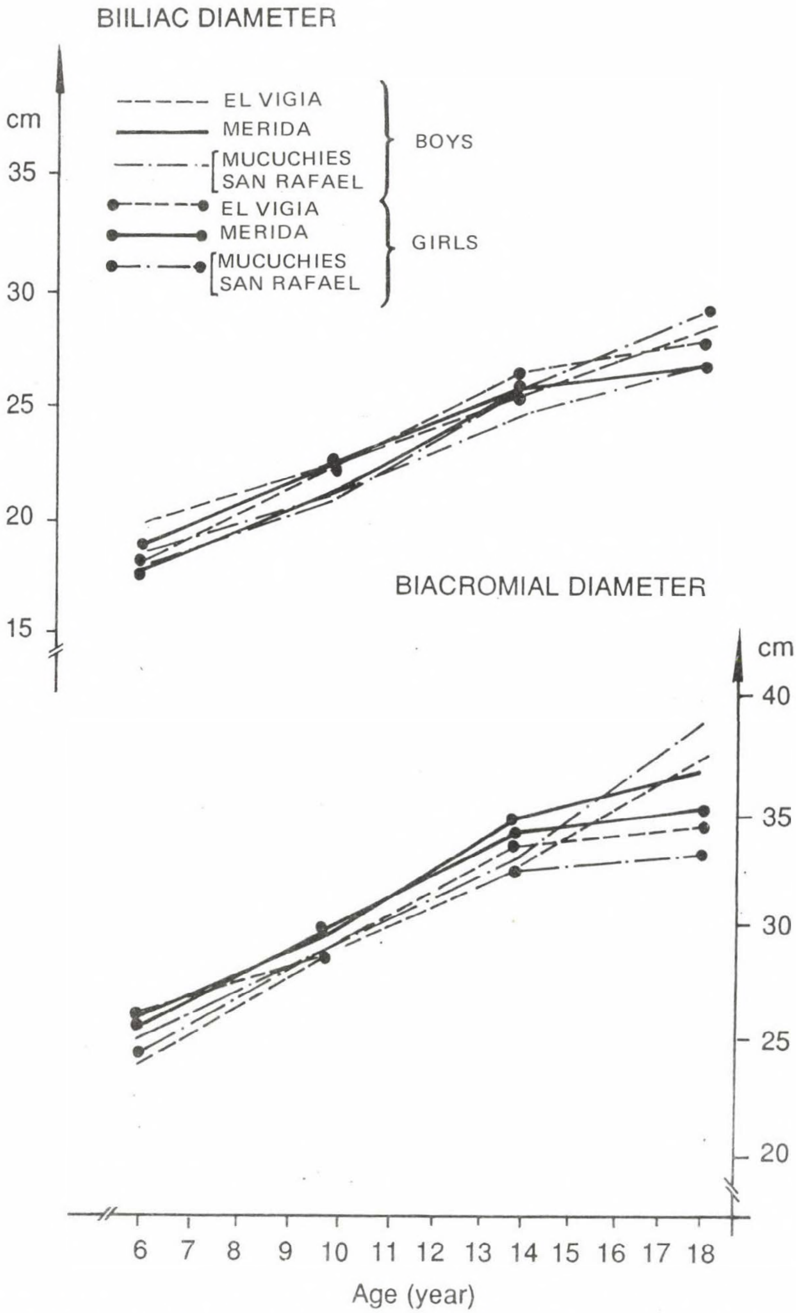

Fig. 3: Distance curves for biiliac and biacromial diameter: high altitude (San Rafael de Mucuchies) and low altitude(El Vigia) Venezuelan schoolchildren; males and females compared with the 50th centiles of Merida Reference

Our findings showed that height, weight, sitting height, subischial lenght and biiliac diameter values were higher in high altitude boys; however the biacromial diameter was lower.

Among girls the differences between those living at high altitude and those living at low altitude were less and only sitting height and biacromial diameter were higher in highland girls. It must be stated that the variation in all body dimensions were during the growth period, that is to say for boys under 16 yrs of age and for girls under age 15. Similar resuts have been reported in other regions of Venezuela (López et al. 1987). These differences tended to disappear when reaching adult values and it is different of that reported by other authors (Gupta 1981, Harrison 1969, Hoff 1974, Beall 1981, Frisancho 1981) for Sherpas and Peruvians and it is coincident with that reported by Pawson (1977) and Greksa (1984, 1990). The fact that differences tended to disappear in adults support the idea that it may be due to genetic factors more than the effect of altitude on growth, Cormic index usually ranges from 47–57, at least between 8 years to age 16 (Cruz-Coke 1977) and it also varies with ethnic group. Our children have a mean index of 53.8 at the mentioned ages, this figure is half way the index registered for European and African populations and suggest our hybrid extraction. On the other hand, enviromental factors seemed to play an important role in growth of children as has been stated recently. Leonard (1989, 1990) has demonstrated that health and nutritional status may have influenced Nuñoa growth patterns to a greater extent that was originally recognized. In our study both high and low altitude children had a deficient diet not only in quantity but quality, haemoglobin and haematocrit values showed that deficiency in food but not in a great extent as we could expected. Growth before 15 years in both sexes reflects the clear pattern of delay in growth and puberty that has been described previously for high altitude children. In a previous report the author (Pereira et al. 1987) showed that puberty was early in lowlanders and late in highlanders and differences seemed to reflect more the urban-rural characteristics than diet and socioeconomic conditions.

We can concluded that variations in growth of Venezuelan schoolchildren may be due to differences in the "tempo" of growth between populations and to genetic and enviromental conditions, specially nutrition than only an effect of hypoxia on growth.

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