Research paper

Secular trends in growth of African Pygmies and Bantu

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ABSTRACT

OBJECTIVE: The aim of this study was to investigate whether a secular trend in growth occurred during the last century in Pygmies from Cameroon (West Pygmies) and in Bantu rural farmers, the latter being studied to serve as controls. **DESIGN:** The evolution in height of West Pygmies and Bantu farmers from 1911 to 2006 was evaluated using data from the literature as well as data gathered by our research team during an expedition to Cameroon in 2006. **RESULTS:** During the last century, no secular trend in west Pygmies is apparent, as height changed from 151 cm to 155 cm in males and from 143 cm to 146 cm in females. A small though significant ($p=0.026$), increment (about 2 cm) was observed only in female subjects during the last ten years. By contrast, Bantu heights show a significant change from 1943 to 2006 for both males (from 159 cm to 172 cm; $p=0.025$) and females (from 148 cm to 160 cm; $p=0.029$). **CONCLUSIONS:** Over the last century, the Bantu population exhibited a significant secular trend for height, whereas West Pygmies did not increase their linear growth. The lack of secular trend in Pygmies possibly suggests that their stature reflects adaptation to the forest lifestyle. We may hypothesize that not only environmental but epigenetic factors have also contributed to their growth potential.

Key words: African Bantu, African Pygmies, Height, Secular trend

INTRODUCTION

Human height is determined by various factors such as genetic predisposition, hormones as well as environmental factors, such as nutrition. Meanwhile, it is well established that secular growth trends depend upon environmental and socio-economic factors.¹ Population height has been recognized as

an index of welfare, while historical height records have been used to describe improvements in living standard.² In developed countries, improvements in socio-economic conditions and lifestyle have led to positive growth trends in the 20th century,³ while in recent years physical development has reached a plateau, suggesting that full genetic potential has been achieved and/or that socio-economic conditions have ceased to improve.⁴ Furthermore, recent studies also suggest that the magnitude of the secular trend toward an earlier age of menarche is slackening in industrialized countries.⁵ In contrast, secular trends seem to be in their early stages in some developing countries in which nutritional status and public health standards are still evolving.⁶

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Traditionally, short stature has been defined as a height below the 2 standard deviation for age when compared with sex-specific standards. Short stature is generally not associated with hormonal defects and such cases are mainly designated as idiopathic, which identifies short subjects in whom the cause has not been detected. The Pygmies are one of the shortest populations worldwide with normal body proportions, although variability among ethnic groups exists, as evidenced by the finding that Pygmies living in the Ituri forest of the Democratic Republic of Congo are on average 8 cm shorter than West Pygmies living in the Central African Republic or the Baka Pygmies of Eastern Cameroon.⁷ The physiological basis for their extremely short stature is still a subject of speculation as well as of investigation since it may significantly contribute to our knowledge of human growth processes. Most studies have concluded that the Pygmy growth pattern is normal up to the time of puberty and that their short stature is primarily due to insufficient growth acceleration at puberty.⁸ On the other hand, Bailey has suggested that impaired growth in Pygmies occurs from birth onward, since in a longitudinal study it was shown that Pygmy children were also shorter than their neighbouring Bantu controls even at birth.⁹

The aim of the present study was to determine whether or not a secular trend in height has occurred in West Pygmies and their Bantu neighbours during the period 1911–2006, using data from the literature as well as our own gathered during an expedition to South-East Cameroon in 2006.

SUBJECTS AND METHODS

Data on the adult height of West Pygmies and the Bantu (Table 1) of Cameroon were obtained from previous studies conducted from 1911 to 1996. The first study on the stature of West Pygmies living in Cameroon was carried out in 1911 by Poutrin.¹⁰ From 1938 and up to the end of the 20th century, there has been a significant number of studies on the growth of West Pygmies (Table 1). The first study on African Bantu height was carried out in 1943¹¹ followed by three others conducted in 1969,¹³ 1993¹⁴ and 2009 (Table 1).

The most recent data¹² on the adult height of these populations were gathered during an expedi-

Table 1. Height studies of West Pygmies and Bantu (1911 to 2009)

	Study	Males N	Females N
PYGMIES	Poutrin 1911 ¹⁰	51	16
	Pales 1938 ²⁸	33	19
	Vallois, 1940 ²⁹	13	10
	Lalouel, 1950 ³⁰	53	43
	Cresta 1965 ³¹	87	56
	Pennetti et al 1967 ³²	427	392
	Froment et al 1968 ³³	107	124
	Cavalli-Sforza 1969 ¹³	48	43
	Merimee et al 1987 ⁸	48	43
	Koppert et al 1993 ¹⁴	107	124
	Dulloo et al 1996 ⁷	40	27
BANTU	Bozzola et al 2009 ¹²	33	48
	Gusinde 1943 ¹¹	35	39
	Cavalli-Sforza 1969 ¹³	50	62
	Koppert et al 1993 ¹⁴	243	329
	Bozzola et al 2009 ¹²	31	48

tion to South-East Cameroon led by our research team in 2006. The expedition group reached West Pygmy villages near the boundaries of the Gabon and Congo and the Central African Republic, the Dja Reserve, at the edge of the forest near rural Bantu farmers. Little is known about this group of Pygmies. Very incomplete censuses are available and the local interpreter told us that Pygmies from the villages, with negligible contacts with other non-Pygmy populations, number a few hundred. Body weight and height were measured in a group of 81 Baka Pygmy subjects (33 males, aged 40 ± 14 years; 48 females, aged 24 ± 11 years) and in 79 Bantu (31 males, aged 30 ± 10 years; 48 females, aged 24 ± 8 years). The Bantu subjects were evaluated as controls. It was decided to consider as adults those subjects older than 18 to ensure that they have reached final height, some previous studies showing that Pygmy children enter puberty at about twelve years.⁸ The age of illiterate adults was obtained with the help of the camp chiefs and interpreters roughly calculated, in relation to important events and agricultural or gathering activities of the villagers. No information regarding births for any subject was available. Body weight was measured using electronic scales and height was determined to the nearest 0.5 cm against a vertical wall perpendicular to a surface on which the subject stood barefoot. Verbal consent from the camp chiefs and from all subjects was obtained prior

to clinical examination and anthropometric measurement, in accordance with the local ethics committee.

Statistical analysis was performed using MedCalc statistical software (MedCalc, Mariakerke, Belgium). Data were expressed as mean $\pm$ standard deviation and were normally distributed according to the Kolmogorov-Smirnov test. Means of height were compared by the t-test for comparison of means and regression lines were analyzed. A *p* value less than 0.05 was considered to be statistically significant.

RESULTS

During our expedition to Cameroon in 2006, no signs of malnutrition were observed based on standard clinical examination and the body mass index (BMI) values, the latter being in the normal range in both Pygmies (males: 20.8 ± 2.0 kg/m²; females 20.9 ± 2.0 kg/m²) and Bantu (males: 23.8 ± 2.6 kg/m²; females 22.9 ± 3.5 kg/m²). However, the BMI values of males and females in Bantu were significantly higher compared to those in Pygmies (males: $p < 0.0001$; females $p = 0.016$).

The mean heights from the studies in the literature and those of our expedition to Cameroon for West Pygmy and Bantu males and females are shown in Figure 1. No secular trend was observed in West Pygmies over the last century, as height increased

from 151 cm to 155 cm (median 152.5 cm) in males ($p = 0.320$) and from 143 cm to 146 cm (median 145.0 cm) in females ($p = 0.443$). A small but significant ($p = 0.026$) increment (about 2 cm) was observed only in female subjects during the last ten years. By contrast, the studies on Bantu heights show a secular growth trend from 1943 to 2006 for both males and females. Male Bantu heights increased by about 13 cm (from 159 cm to 172 cm) (median 163.0 cm; $p = 0.025$) and female heights by about 12 cm from 148 cm to 160 cm (median 154.5 cm; $p = 0.029$).

DISCUSSION

The present data demonstrate that during the last century no increases in linear growth of West Pygmies (both males and females) occurred, whereas a significant increase in the height of their Bantu neighbours was evident. During the same period, the genetic potential for growth was reached in Europe. In fact, in northern European countries, males attained a mean level of 179–180 cm, and in Italy mean height has increased up to 174 cm.¹⁵

It has been accepted that adult height represents the final outcome of a continuous interaction between genetic and environmental factors.¹⁶ According to Tanner, growth is a mirror of the social conditions prevailing in a given society.¹⁷ The secular trend in body size and tempo of growth are considered

Figure 1. Panel A: mean adult height (cm) of West Pygmy males (triangles) and West Pygmy females (circle) in the 20th century; panel B: mean adult height (cm) of Bantu males (triangles) and Bantu females (circles) in the 20th century.

reliable markers of health and nutrition among a population and their variation reflects changes in the socio-economic status of the population. Secular variation in height has been observed in almost all industrialized countries during the last century. However, the magnitude of change in growth is not the same in the different subgroups of a population with different socio-demographic backgrounds.¹⁸ The evidence is that in a given population, positive changes in height may cease if there is no further improvement in the environmental conditions and/or if the population reaches its genetic growth potential.¹⁹ Furthermore, growth is mainly achieved during childhood, the traditionally higher growth rate during adolescence having diminished in populations in which the secular increase in tempo of growth has slowed down or stopped.²⁰

Data on secular changes in African populations are quite scarce and mainly concern Southern Africans during the first fifty years of the last century. These data have shown a lack or sometimes negative secular trend for adult mean stature, probably reflecting poor nutrition and poverty.²¹

Since increases in height mainly take place during the first two years of life,²² the lack of a positive height trend in Pygmy adult subjects may in part be due to the high rate of infectious diseases in infancy. Furthermore, Pygmy BMI values being at the lower limit of normality indicate that Pygmies are in worse nutritional condition than Bantu. In fact, although they usually live on the edge of the forest near Bantu farmers, they have negligible contact with this group and continue to maintain their traditional lifestyle. For example, they still maintain a semi-nomadic lifestyle and frequently live for months in the deep forest gathering and hunting, thus being at increased risk for environmental infections.²³⁻²⁴ In the early 1970s, mud-houses were constructed as part of a government strategy to sedentarize the population and to phase out their nomadic lifestyle. During the last 20 years, the Cameroon Government has attempted to make a census of the Pygmy population by forcing them to live outside the forest, near the Bantu villages and paths. Moreover, a health program was initiated, encouraging them to substitute their traditional remedies with western drugs and striving to improve their sanitation conditions.²⁵ Although the Pygmies are reluctant to accept these changes, in the last

decade a slow (about 2 cm) small increment in adult height was observed in female subjects. These data might indicate that a secular trend is starting now, parallel to the small upgrading in living conditions. In contrast, the Bantu increase in adult height during the last fifty years most likely reflects improvements in hygienic conditions and better nutrition. Another recent study demonstrated a significant increase from 1962 to 2001 in the skeletal maturity and stature of black South African children, indicative of removal of growth constraints due to better social conditions.²⁶

Another possibility that may account for the difference between West Pygmies and Bantu subjects is that Pygmies have attained their genetic growth potential and, therefore, their final height will not increase despite improvements in their socio-economic and health conditions. The exact mechanisms and factors involved in the short stature of Pygmies are not yet fully elucidated and are highly likely not to be dependent on their lifestyle. Alternatively, as suggested by Diamond,²⁷ it is quite possible that their short stature is epigenetically determined to facilitate adaptation to life in the dense tropical forest and endurance against starvation. Furthermore, their small body size could favour their life in the hot, humid climate of a tropical forest by minimizing the body's heat production during exercise. With regard to possible pathophysiological mechanisms, it must be mentioned that Merimee et al⁸ reported normal GH secretion but low IGF-I levels. We also recently reported that reduced IGF-I and GHBP levels in Pygmies are associated with a marked decrease of the *GHR* gene expression which is not associated with variants in the sequence of the *GHR* gene. This supports the hypothesis of a genetically determined short stature in Pygmies.¹²

Finally, one should also consider that the sample size may not be adequate to unambiguously reveal a secular trend in Pygmies. This is primarily due to the many difficulties involved in reaching and enrolling these subjects.

In conclusion, over the last century the Bantu population from Cameroon exhibited a positive trend for height, while West Pygmies have not increased their linear growth, suggesting either that their short stature is mainly genetically determined, that epigenetic factors are involved and/or that in the regulation of their growth their living conditions have not

substantially been altered. The results of the present study could be important in that they augment our knowledge concerning Pygmy somatic growth.

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