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Klotz Communications 2017: From the shortest to the tallest

Have we finally solve the enigma of the small size of Pygmies?

L'énigme de la petite taille des pygmées est-elle enfin résolue ?

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Abstract

Pygmies are considered to be among the smallest humans. Their small size is an enigma that has puzzled numerous scientists. Many data have been collected concerning their clinical and biological phenotypes, genetics, lifestyle, culture and environment, but the reasons for their small size remain a matter of debate. Is it an adaptation to life in the tropical forest, an impact of the environment, an usual genetic feature or a mixture of these factors? Studies of the somatotrophic axis have revealed that serum IGF-1 concentrations are low in this population, probably due to an impairment of the GH receptor. However, many uncertainties remain, and further hormonal, genetic and epigenetic studies will be required in the framework of multidisciplinary studies.

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Résumé

Les pygmées sont décrits comme étant parmi les humains les plus petits. Cette petite taille est une énigme qui anime depuis longtemps bon nombre de scientifiques. De nombreuses données concernant le phénotype clinique, biologique et génétique sont connues ainsi que leur mode de vie, leur culture, leur environnement mais l'étiologie de leur petite taille fait toujours débat. S'agit-il notamment d'une adaptation à la forêt tropicale, de l'impact de l'environnement, d'une particularité génétique ou d'un mixte de ces différents paramètres? Concernant l'étude de l'axe somatotrope, un déficit sérique en IGF-1 a été observé pour lequel un défaut d'efficacité du récepteur de la GH semble être impliqué. Il reste cependant beaucoup d'incertitudes et d'autres analyses hormonales, génétiques et épigénétiques sont nécessaires et doivent être intégrées dans un cadre d'études multidisciplinaires.

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1. Introduction

The name “Pygmy” originates from the small body size of this population. The term “pygmaios” was used by Homer (The Iliad, Song III, 1-6). Etymologically, it designates an ancient unit of length, the cubit (about 45 cm, the distance from the elbow to the wrist). In his book “African Pygmies”, Cavalli-Sforza raised the problem of how to define Pygmies. His chosen definition is as follows: “It therefore seems reasonable to call Pygmies groups of Africans who live (or lived until a short while ago) as hunter-gatherers in the tropical forest, and have a stature smaller than that of the farming tribes with which they are in contact and

have a relation of servitude”. This reference to servitude has largely disappeared from current definitions of pygmies, which are based, more than the use of a stature threshold, on a specialist forest lifestyle (hunting, gathering, medicinal practice), with its own social organization and complex socioeconomic relationships with non-Pygmy neighbors [1–7]. Pygmies are among the smallest humans known, with the exception individuals with growth-related diseases [4], with statures even smaller than those of *Homo erectus* or *Homo neanderthal* [8,9].

About 20 Pygmy populations speaking different languages (e.g. Aka, Baka, Bongo, Kola, Koya, Tumandwa, Batwa, Babenzi, Binga, Twa, and Efe. . .) are found throughout the equatorial forests extending from east to west over Central Africa. The ancestral non-Pygmy and Pygmy populations seem to have diverged 50 to 70 thousand years ago. Two major groups of

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Pygmies, those of East and West Africa, diverged about 20,000 years ago, and the Western Pygmies have diverged into a number of smaller groups over the last 3000 years. Genetic analyses of the various Pygmy groups have raised questions about whether they have a common origin or whether they acquired their current stature through a convergence effect. In the case of convergence, small size, a useful adaptation to life in the tropical forest, would have emerged independently in the two regions, West and East Africa [6,10–12].

The key question that divides opinion and has driven many studies and discussions is that of the cause of the small size of Pygmies. Several evolutionary hypotheses have been proposed: is small size an adaptation to the tropical forest and the impact of its environment (heat/humidity, infection/parasite infestations, the effects on mobility of the density of the forest, and access resources), does it reflect a lifestyle choice involving the choice of particular mates, or is it a genetic feature? [3–6,11–13].

2. Growth and puberty

Few data for adult size in Pygmies have been published. The Pygmies from the western region, such as the Baka group (Cameroon) have a mean height of 155.6 cm for men (range: 144–167 cm) and 146.5 cm for women (range: 136.7–146.5 cm). These heights are lower than those of the Nzime population (non-Pygmies from Cameroon): mean height of 168.5 cm for men (range: 155.5–181.5 cm) and 155.8 cm for women (range: 142.2–169.4 cm). The Pygmies from East Africa are shorter than those of West Africa, with the shortest statures recorded for the Efe and MButi populations (ITURI forest in the Democratic Republic of Congo): mean height of 144 cm for men and 137 cm for women. These populations are shorter than the neighboring Lese population (mean height of 162 cm for men and 152 cm for women). However, no longitudinal studies of individual size have been performed and no growth curves for these populations are available. One of the principal problems encountered in these studies is uncertainty about date of birth [14–18].

Data for birth parameters are sparse and insufficient for any inferences to be made about the mechanisms affecting postnatal growth. Only two publications have provided height and weight data, at birth, for Efe Pygmies (compared to the non-Pygmy Lese population) and for Ngayu Pygmies from Ituri Forest (compared to the neighboring non-Pygmies Bantou) [14,17]. Mean birth lengths were 44.6 ± 2.1 cm for the Efe Pygmies and 46.4 ± 1.4 cm for the Lese. Mean birth weights were 2.69 ± 0.46 kg for the Efe Pygmies and 3.07 ± 0.43 kg for the Lese. However, it should be noted that the sample size was very small for these studies ($n=10$ to 15) and no information was provided about gestational age at birth. Similar results were described for Ngayu Pygmies. The growth of the Efe Pygmies was followed between the ages of six months and five years. A marked decrease in growth rate was observed in Efe Pygmies (height measurements of -2.7 SD (6 months) to -4.1 SD (5 years)) that was much greater than that in the Lese (-1.76 SD and -2.11 SD, respectively). Head circumference, determined at birth, was found to be similar in Ngayu Pygmies (Ituri forest) and the non-Pygmy Bantu population (mean: 33.4 cm (range:

32–36 cm) for Ngayu Pygmies and 34.1 (range 30–37 cm) for the Bantu) [14].

No data for birth parameters was available for the Pygmies of Western Africa. Central African Pygmy populations displaying genetic admixture with neighboring non-Pygmy populations are taller, consistent with a genetic impact on the stature of the Pygmy population [5].

There is controversy about the growth velocity of Pygmies during puberty. According to the group of Pygmies have similar growth rates to other populations during childhood, but the Pygmies of the Ituri Forest are small because the pubertal growth peak is entirely absent in boys and very blunt in girls [16]. However, this study was performed on a very small sample (9 male subjects, and 10 female subjects with a mixed tanner stage from 2 to 4, six of whom were already menstruating).

Importantly, Bailey et al. have focused on frequent uncertainties about the age of Pygmies; moreover, Pygmy populations are nomadic, and the rate at which they mature may be different from that of European and American populations [15,17]. Bailey also noted a height under the 3rd percentile for Pygmies from the Ituri forest during the first year of life, with an increasing growth deficit until the age of five years, after which, growth velocity was maintained until after puberty, with an adult height of about -4 to -5 SD. He therefore concluded that a lower growth rate during childhood, rather than puberty, was the principal cause of small adult size in this population.

We recently described the growth pattern, from birth to adulthood (25 years), of Baka African pygmies for whom birth dates were known with certainty [19]. Body weight at birth within the Baka group is within the normal range (3 kg at birth, 4 kg at 1 month and 7.89 kg at 12 months), but growth rate (both weight and height) significantly slows during the first two years of life, subsequently remaining steady. This results in final height values below the third percentile on the French standard growth curve [20], with a normal growth spurt at adolescence (30 cm) providing evidence that short stature in this population is not due to as the absence of a growth spurt during adolescence, as previously suggested. Median age at menarche was slightly late (14.5 years), with the first period occurring 2.5 years after the growth spurt, probably because of low levels of body fat. The youngest age at first pregnancy for Baka women was 16 years, and men seemed to begin reproducing later, as the youngest father were 20 years old. The Pygmy phenotype in the Baka may therefore result from a growth deficit in early infancy.

3. Biology of the somatotrophic axis

In 1981, Mérieux et al. described biological and hormonal explorations in adult Aka Pygmies from the Central African Republic [21]. The secretion of GH following stimulation, in the arginine test, was strictly identical to that of control subjects. However, the insulin response in the arginine or glucose perfusion tests was much weaker than that in controls and in subjects with GH deficiency. Baseline serum IGF I concentration was lower than that in controls, but higher than that in subjects with GH deficiency. By contrast, IGF II levels were within the normal range. Particularly marked hypoglycemia was

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