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# LATE MEDIEVAL LITHUANIAN CHILDREN GROWTH (ACCORDING TO PALAEOOSTEOLOGICAL MATERIAL OF 14th–17th CC. ALYTUS BURIAL GROUND)

*ABSTRACT: The aim of this paper was to analyze late medieval Lithuanian children growth patterns and its factors and compare them with corresponding data of contemporary Estonian, modern Lithuanian and African children. In total 239 children skeletons were measured and stature reconstructed according to Telkkä* et al. *(1962) regression equations. The data revealed little stature differences between newborns and 0–2 year infants in all four populations, as stature in this age depends more on fetal conditions in uterus and genetic potential, rather than on external factors. Children growth in medieval Lithuania and Estonia was characterized by decreased growth rates at the age from 2 to 5 years and delayed pubertal growth spurt. Modern Lithuanians were significantly taller in all other age groups. Our data demonstrated small difference in stature between African seminomadic pastoralist children and medieval Lithuanian children due to greater influence of growth conditions than genetic factors. The most important cause of poor children growth in late medieval Lithuania was environmental factors, especially chronic undernutrition.*

*KEY WORDS: Palaeoauxology – Children growth curves – Late medieval populations – Lithuania*

## INTRODUCTION

Contemporary biology and medicine interprets human developmental process holistically by evaluating its physiological, cultural and statistic aspects. Human growth is determined by endogenic (genetic) and biocultural (environment, that predicts final phenotypic realization of genetic potential) factors (Bogin 1999). The most rapidly growing long bones are the most greatly affected by nutritional and disease stress (Sciulli 1994). This evidence shows that growth velocity depends on nutritional adequacy and, to a lesser extent, disease history. As environment improves, growth increases. Individuals with adequate nutrition tend to reach upper limits of their genetic growth potential; those with poor nutrition do not (Larsen 1997). Thus, children growth reflects population health and nutritional status better than any other index, a notion well documented via analysis of historical data (Hoppa 2000).

Till now, a plethora of observations on growing children are known. Experimental modelling is needed to test the hypotheses that were created. Therefore to understand growth and development processes and their biocultural factors, deeper studies of past populations may be very useful – history had made unique experiments. Osteoarchaeological studies enable us to reveal the influence of environmental factors on children growth from diachronic point of view.

Many researchers used historical data to analyze the growing of past children (Steegman 1985, Komlos 1986). These studies revealed that 6–8 year-old children growth in 18th century East and Central Europe depended on nutritional conditions at time of birth. Stature also varied with local environmental conditions, annual temperature and also depended on migration and urban/rural residence. Unfortunately such studies have some drawbacks: they are available only if recorded data are present (in Europe – only from the 18th c.); also, these data as a rule are from specific socio-economic groups (boys from military and other privileged schools, orphanage children), thus they do not represent total population.

Analysis of osteoarchaeological material is another possibility for palaeoauxology (Johnston 1962, Merchant, Ubelaker 1977, Jantz, Owsley 1984, Lovejoy *et al.* 1990, Miles, Bullman 1994, Hoppa, Gruspier 1996, Le Mort 2000, Rewekant 2001). Paradoxically, there are not many large immature skeleton collections in the world although infant mortality, according to demographical data, was immense: in Imperial Rome 27–34% children died during the first year, in 17th century London 25–27% (Storey 1986).

Like anthropometrical studies of living populations, studies of skeletal growth from archaeological collections enable to make interpretations regarding the overall health and well-being of a population. Since the long bone growth is differentially affected by the nutritional and health status of the individual, osteologists have utilized cross-sectional analyses of long bone growth as a non-specific indicator of nutritional status, and discuss differences between entire populations, either geographically or chronologically. It must be noted though, that growth-related studies remain non-specific indicators of health, and are sensitive to many factors (Hoppa 2000).

Bioarchaeological research of immature skeletons faces some specific problems: age and sex estimation, stature reconstruction, and finally – representativeness of the data.

Subadult age at death estimation generally is considered more accurate than age estimation of adults because of high children growth rates and greater age impact on skeleton. Majority of scholars are determining age at death according to Massler *et al.* (1941) and Ubelaker (1987). These methods are based on deciduous and permanent teeth (crown and root) development chronology. Diaphyseal length is often used as an estimate of skeletal age when teeth are missing (Florkowski, Kozlowski 1994). There are also specific bone size standards for estimating fetal and perinatal age (Olivier, Pineau 1960, Fazekas, Kósa 1978).

Another, almost unsolvable problem is limited possibility to determine sex. There should be sufficient sexual dimorphism in fetal and early infant skeletons because of the presence of higher levels of testosterone in boys. Dimorphism should increase again at adolescence as pubertal changes begin to occur (Saunders 1992). Unfortunately by now there is no reliable method to estimate skeletal sex from the age of 1 year to the beginning of puberty. The most exact sex estimation method – DNA analysis (Faerman *et al.* 1995, Stone *et al.* 1996) – is rather expensive; besides, possibility of specimen contamination remains (Saunders, Yang 1999).

Reconstruction of the stature enables to make direct comparisons between living and past people, thus tracing secular trends during the long periods of time. By this time Telkkä, Palkama and Virtama (1962) regression equations are used to reconstruct children stature from long bone length over the world. Newborn stature is calculated using Balthazard (1921), Olivier and Pineau (1960), Gindhart (1973), Fazekas and Kósa (1978), Garmus (1981) regression equations. The most exact results are obtained when stature is calculated from all long bones using different methods.

Specific problem of palaeoauxology is the question how archaeological material represents living population of the past. There are opinions that this material is not from healthy, normal children but from those who suffered an early death (Johnston 1962). On the other hand, many researchers agree that majority of infant deaths were not the result of chronic afflictions with long developmental histories, but rather acute gastrointestinal or respiratory infection, which should not drastically alter dental or osteological maturation (Lovejoy *et al.* 1990, Iregren 1992, Allmäe 1997). Therefore comparison of growth curves from skeletal samples and from living children is justifiable.

The purpose of this paper is to analyze late medieval Lithuanian children growth patterns and compare them with corresponding data of contemporary and modern children.

## MATERIALS AND METHODS

The skeletal series taken for investigation consisted of 239 subadult individuals from Alytus 14th–17th cc. AD burial ground, excavated in 1984–1986 by archaeologist E. Svetikas. This largest completely excavated cemetery in Lithuania (in total, 1,345 individuals, 475 of them subadults up to 15 years) was left by Alytus town population of that time. Alytus was a typical Lithuanian late medieval town. Town-dwellers lived on mixed subsistence: they cultivated agriculture, but urban occupation (trade and crafts) was more important. The number of population in the town varied from 450 to 1,200 because of years of famine, epidemics, wars and fires (Kiaupa 1989). Demographic situation in Alytus was better than in Vilnius, but worse than in contemporary countryside (Jankauskas 1995).

The age at death was estimated on the basis of decidual and permanent dental formation (Massler *et al.* 1941), stature was calculated according to Telkkä *et al.* (1962) regression equations using lengths of humerus, radius, ulna, femur, tibia and fibula. Stature average and standard deviation for age groups as well as annual stature increase were calculated.

In order to evaluate growth patterns, we have compared our data with another 3 populations: their contemporary Estonian (Allmäe 1997), modern Lithuanian (Tutkuvienė 1996) and modern African seminomadic pastoralist (Sellen 1999). For modern populations, the average of boys and girls stature was taken.

TABLE 1. Reconstructed stature of children from Alytus burial ground (in cm).

| Age (years) | Number of individuals | Average | Standard deviation | Stature increase per year |
|---|---|---|---|---|
| newborns | 27 | 52.18 | 2.95 | |
| 0–2 months | 5 | 57.40 | 3.35 | |
| 2–6 months | 13 | 60.35 | 3.43 | |
| 0.5–1 | 6 | 66.06 | 1.55 | 16.96 |
| 1–1.5 | 13 | 72.87 | 2.59 | |
| 1.5–2 | 7 | 74.85 | 1.82 | 7.23 |
| 2–3 | 22 | 82.14 | 4.11 | 4.50 |
| 3–4 | 21 | 83.79 | 4.37 | 5.27 |
| 4–5 | 13 | 91.66 | 5.75 | 5.71 |
| 5–6 | 10 | 93.89 | 4.70 | 5.68 |
| 6–7 | 20 | 100.32 | 5.22 | 7.41 |
| 7–8 | 10 | 108.64 | 5.25 | 7.00 |
| 8–9 | 13 | 111.85 | 6.41 | 4.16 |
| 9–10 | 10 | 119.09 | 6.92 | 5.80 |
| 10–11 | 12 | 126.27 | 8.00 | 3.48 |
| 11–12 | 9 | 125.04 | 5.65 | 1.40 |
| 12–13 | 6 | 132.88 | 8.10 | |
| 13–14 | 5 | 132.90 | 3.61 | |
| 14–15 | 10 | 138.55 | 7.43 | 5.98 (years 12–15) |

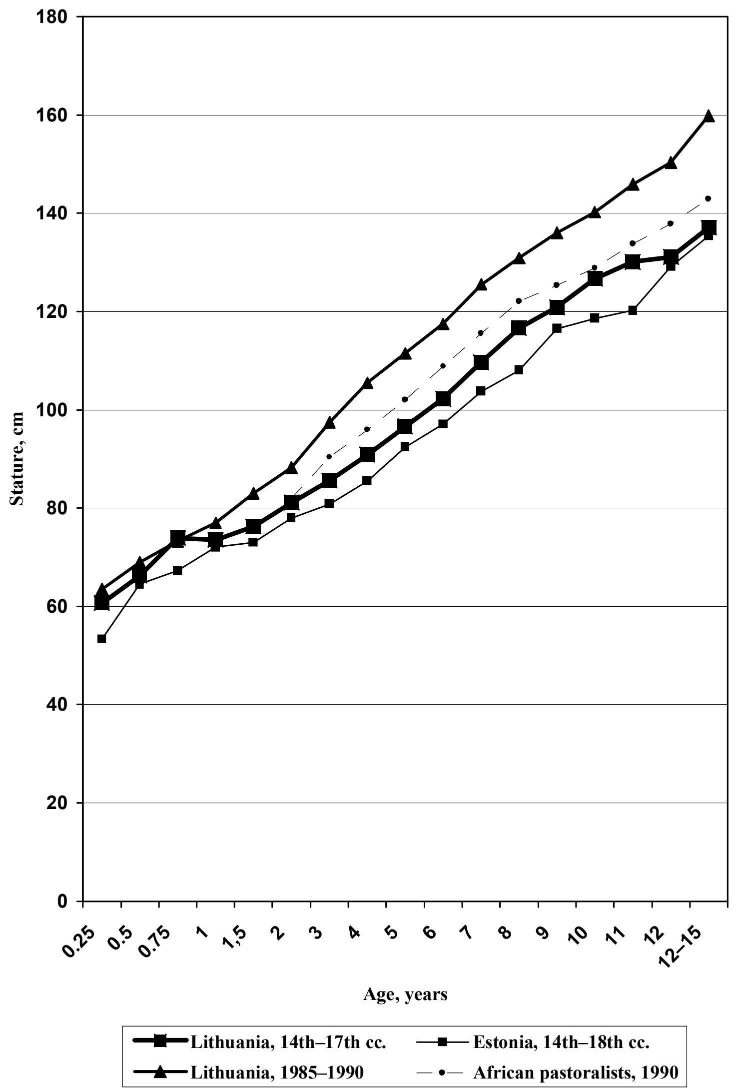


FIGURE 1. Children growth curves of compared populations.

## RESULTS

Reconstructed late medieval Lithuanian children stature is presented in *Table 1*. Newborn body length does not differ significantly in past and modern Lithuanians. But in all other age groups modern Lithuanians were significantly taller, difference reaching 10–15 cm in the 2nd decade of life (*Figure 1*). Growth curves of other populations after the age of 2 years do not cross and distribute by as follows: tallest – contemporary African children, then – late medieval Lithuanian and the shortest – late medieval Estonian. However, all three populations are significantly shorter than contemporary Lithuanians.

Comparing growth velocity (stature increase per year) in these populations (*Figure 2*), common growth patterns can be seen: the greatest height gain was at the first and second years of life, later growth velocity diminished. Modern Lithuanian children grow rapidly up to 4–5 years, and archaeological populations and modern Africans grow slower. We also can notice slight growth increase at the age 5–7 years in all 4 compared populations. The variations in growth velocity between past populations are statistically insignificant ($p > 0.05$), although slight diminishing in Estonian children growth in all age groups was observed. The pubertal growth spurt in modern Lithuanians begins at 11–12 years, but in archaeological populations and modern African children it begins 2–3 years later. It must be noted that growth patterns of African children are more similar with modern Lithuanian than medieval children (although African children stature at 12–15 years is more similar to archaeological populations than modern).

## DISCUSSION

Revealed differences in stature and growth velocity may occur due to both genetic and biocultural reasons. Our data demonstrated little difference in stature between African seminomadic pastoralist and medieval children. It seems that medieval Lithuanian and Estonian children growth conditions were more similar to modern African than modern Lithuanian. It is difficult to explain such Estonian children growth delay. We suggest it may be due to different age determination methods. The growth of past children had two main features: diminished growth velocity from 2 to 5 years and by 2–3 years delayed pubertal growth spurt. Stature differences between newborns and 0–2 years infants in all four populations were small, as stature in this age depends more on fetal conditions in uterus and genetic potential, rather than on external factors.

What were the growth conditions in late medieval Alytus? As in all Europe, concentration in towns and increasing population density was followed by social differentiation. Majority of people continually lived on the verge of starvation (Roehl 1972, Kamen 1984, Livi-Bacci 1991). Besides, different regions of Europe were periodically affected by famine (Boyden 1987). In the Great Duchy of Lithuania, at least 54 famine yearswere recorded in 14th – 17th cc. (Grickievič 1973). Both acute and chronic nutritional deficiency affected mostly the lowest social status groups.

Chronic undernutrition (especially protein deficiency) manifests by delaying children growth and decreasing their definite height, but their weight-to-height ratio is similar to that of individuals who grow in affluent circumstances (Stinson 2000). It has been suggested that small body size is a successful adaptation to nutritional stress because small individuals are able to survive on fewer nutrient (Frisancho, Garn 1970, Magennis 1986). This idea is controversial because such adjustment has also many disadvantages (Martorell, Ho 1984). Body size influences the ability to perform energy-demanding activities, thus these individuals would be expected to be less productive. Although small body size does reduce nutrient needs, it can hardly be considered a no-cost response to undernutrition (Stinson 2000). Besides, nutritional deficiency reduces immune function. Survey of studies in Colombia, India, Nepal and Bangladesh has revealed that starving children have consistently lower cellular immunity levels than normally fed ones (Martorell, Ho 1984). It may not affect resistance to all infectious diseases, because the minimal immune response is enough to cope with some kinds of infection. If the patient had already been ill, undernutrition doubtlessly influences the course of the disease – it will be more severe. Nutritional deficiencies, if they can depress the human body's defenses, can also in certain cases interfere with the metabolic and reproductive process of the attacking microorganism. In some cases malnutrition has an antagonistic, rather than synergic, effect, thus limiting the damage done by infection. While the action of bacterial infections is almost always synergic, that of viral diseases is often as antagonistic as synergic. Parasitical infections would appear to be in the halfway between the bacterial and the viral (Beisel 1989). For many forms of infections, which played a decisive role in determining historical levels of mortality, the connection with nutrition seems minimal or non-existent (Rotberg, Rabb 1985). *Table 2* provides some examples. Some researchers, especially biologists, even state that mild undernutrition may be an individual's greatest physical asset, producing longer life, fewer malignances, reduced mortality from inherited susceptibility to auto-immune disease and perhaps fewer infections (Chandra, Newberne 1977). Even without entirely rejecting this opinion, it is reasonable to consider that below certain specific levels of malnutrition, individual organic defenses are not weakened.

Summarizing we can say that the most important cause of poor children growth in the past was environmental factors, especially chronic undernutrition, that to certain extent can be considered also as accommodation to infectious agents.

TABLE 2. Influence of nutritional level on infective processes (after Rotberg and Rabb 1985).

| Definite influence | Influence uncertain, variable | Influence minimal, non-existent |
|---|---|---|
| Cholera | Diphtheria | Encephalitis |
| Diarrhea | Helminthiasis/worms | Yellow fever |
| Herpes | Staphylococcus infection | Malaria |
| Leprosy | Streptococcus infection | Plague |
| Respiratory diseases | Influenza | Tetanus |
| Measles | Syphilis | Typhoid |
| Intestinal parasites | Typhus | Smallpox |
| Whooping cough | | |
| Tuberculosis | | |

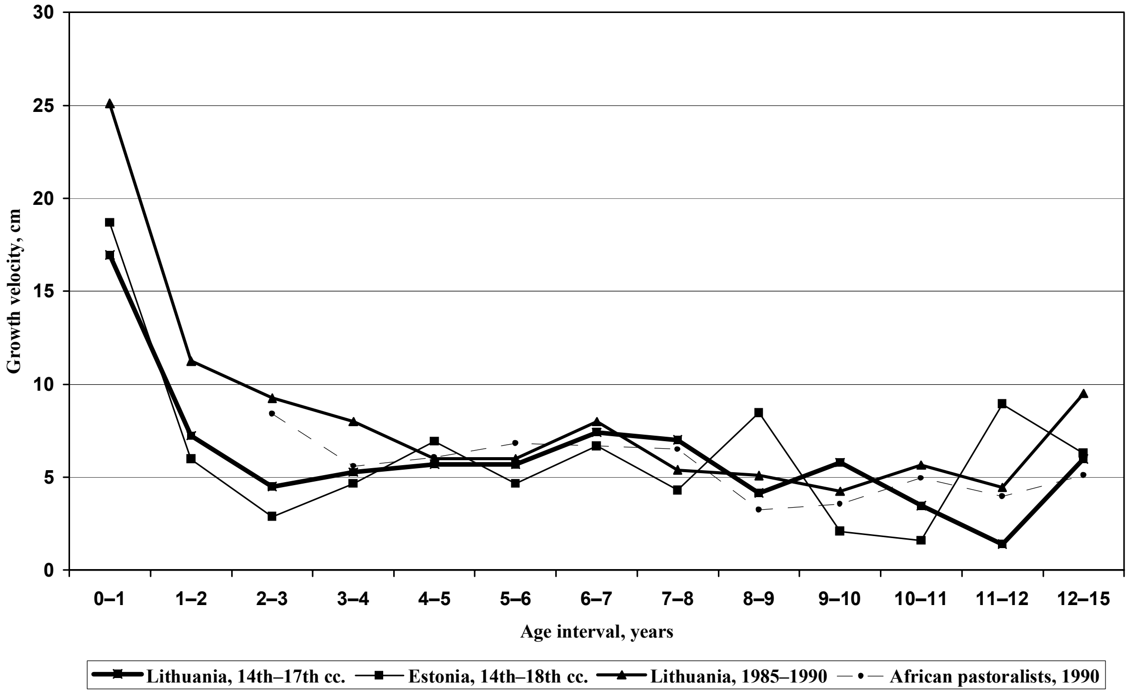


FIGURE 2. Growth velocity curves of compared populations.

## CONCLUSIONS

1. Stature differences between newborns and 0–2 years infants in all four populations were insignificant, as stature in this age depends more on fetal conditions in uterus and genetic potential, rather than on external factors.
2. Modern Lithuanians were significantly taller (difference reaching 10–15 cm in the 2nd decade of life) than all other age groups.
3. Children growth in medieval Lithuania and Estonia was characterized by decreased growth rates from the age 2 to 5 years and delayed pubertal growth spurt.
4. Small difference in stature between recent African seminomadic pastoralist children and medieval Lithuanian children indicates greater influence of growth conditions, especially nutrition and morbidity, than genetic factors.
5. The most important cause of poor children growth in late medieval Lithuania was environmental factors, especially chronic undernutrition.

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