

THE SECULAR TREND IN BIOLOGICAL AND SOCIAL CONTEXT OF LIFE STYLE AND SOCIAL WELL-BEING

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Abstract: *The name “secular” in various acceptations, it means “which succeeds or repeats itself each century, which is existing during one century or that exists since different centuries”, finds its origin, initially, as Latin adjective in, seccularis, which has later been transformed to a name, saeculum, indicating one generation, one century and in definitive a large period of time (Tobias, 1985). A secular change is indicating “something” which is taking place slowly, but in a constant way during time, in contrast with a periodic or a short time change, for instance. In Physical Anthropology, the term secular trend has been applied to a clear tendency, observed during the last 100 - 200 years, of earlier occurring both physical development and maturation. This tendency is essentially observed in two main ways: a) in stature and weight, children of the same age are gradually higher and heavier than in the past; b) the puberty, especially the pubertal growth spurt and the menarche, occurs progressively at earlier ages. It also means that many populations have experimented increases of the average adult stature and of other body dimensions.*

Keywords: *secular trend, biological and social context of secular trend, life style, industrial revolution, social well-being*

1 Introduction

The term secular trend has acquired larger connotations and it is applied to systematic changes (not at random), which occur in a large variety of characters, in the successive generations of a population living in the same territory (Wolanski, 1966, 1967). This definition implies the fact “of living in the same territory” which excludes as examples of secular evolution those changes associated with the migration of the individuals, including changes which could be related to the urbanisation of some previously rural communities. Some authors prefer to difference between the secular changes with this type of territorial restrictions and the secular changes due, to migration and urbanisation (Tobias, 1985).

Although systematic observations of secular changes during growth, more often stature and weight, were performed since mid-19th century in many populations of developed

countries, it does not mean that these changes occurred only since 150 years. The paleoanthropological and historical data show variations of stature, observed on a cyclical way (Eveleth, 1994, Bogin and Keep, 1999). Since the Neolithic Age till the end of the 19th century, a process of debrachycephalisation occurred. But, the process of secular trend is applied basically to changes produced in modern societies, as a response of the organisms to the “industrial revolution”. Wolanski (1985) suggested that, in the contemporary man, it is possible to speak about a “syndrome of industrial civilization”. This process, understood in its positive sense (acceleration of growth rhythm, higher stature, earlier ages of maturation, etc.), does not appear to be universal. Many human groups have not experiment it yet. In a negative sense, negative or reverse secular trend can be found (Tobias, 1985).

The secular trend is interesting from a biological and social point of view and because it has been studied by anthropologists but also by historians of economy, for instance. This process can be considered as a marker of the public health of the populations as it changes over time (Tanner, 1992), it provides insights into the link between growth and environment (Cole, 2000), and it illustrates some aspects of the physiology of the intergenerational relationships in growth and size (Cole, 2003). The anthropological literature offers much information about secular trend (also called secular change and secular evolution), its possible causes (genetical and mesological factors), its direction (positive, negative, absence), the type of traits involved (stature, weight, body and cephalofacial proportions, the peak height velocity, the age at menarche, etc.), and its possible applications (for a review see Vercauteren, 2003).

Secular Trend as Endogenous and/or Exogenous Factors

The secular trend is a multifactorial and complex observation, from which the causes are not unanimously accepted: there are factors of endogenous type (genetical) as well as of exogenous (environmental) type (Malina, 1979, Bernis and Sandín, 1983, Terrenato and Ulizzi, 1983, Wolanski, 1985, Greiner and Gordon, 1992, Eveleth, 1994, Cole, 2003, Vercauteren, 2003). Among the endogenous factors there are genetic processes that accompany outbreeding, such as an increase in the heterozygosity of the offspring resulting from larger marriage distances (Duvrova et al., 1995). Possible causes of secular changes could be the increase of exogamy, of migration and of mobility between social classes. The migrants are not necessarily representative of their population of origin and can be a selected group different of the parental population. If they are arriving to countries with better

environmental circumstances, it could be logical that stature increase, but it is not the direct effect of the opening of isolates but of the environmental factors.

The results of many studies show that inbreeding and outbreeding have not many effects on stature, even if we are speaking of negative effects on stature in endogamous groups, it is more the effect of the poor environmental conditions. Also the effects of natural selection have been considered, but the effect in our case is not clear and has only a slow effect. Natural selection could be more a factor during neonatal and prenatal periods: in well-nourished populations, mortality is always higher in children of lower dimensions and this could be a factor of directional selection, although the birth height is not highly correlated with adult height, but with the natural height (Malina, 1979).

For many authors, the factor important to consider in secular changes in industrialised countries is the improvement of life conditions through nutrition, hygiene, medical care and social politics (Bielicki, 1999). In the same way, the absence of the secular trend or the negative one is associated with a poor quality of the social, economical and political environment related with human growth (Bogin and Keep, 1999). The secular changes observed during human development are objective indices of social stress and of economical problems, and thus they can be used as a measure of poverty (or of wellbeing) in sociological and economical researches. The existence of cycles of changes in stature since the industrial revolution, in Europe as well as in North America, is one of the main discoveries of the anthropometrical studies in the last decades. Many studies have revealed the existence of fluctuations of stature in short or long periods that could be due to economic cycles observed in the previous steps and during the first phases of the economic development. We can summarise some arguments in favour of the environmental factors (see Bielicki, 1999):

a) There is a parallelism between the secular changes of growth and the changes of indices of social wellbeing of the populations. By this way, indices of socio-economical type such as the level of survival till adult life, the daily ingestion of animal proteins and the *per capita* income, show a narrow association with the increase of height. The decrease of the age at menarche shows a significant correlation with the increase of the national product in different countries. For example, in Japan, a relationship between the decrease of age at maximum peak height velocity (PHV) and the increase of consumption of some foods (milk, sugar) has been observed.

b) In periods of economic crisis, the secular trend shows interruptions and could go in a reverse way: during the World War II some decreases of height or increases of age at menarche were observed in Germany, France, Norway and Japan, for instance.

c) Secular trends were not registered in economically deprived countries such as the Sub-Saharan Africa, some groups of Mexico (Mayas, Zapotec), some Guatemalan Indians, the Xingu from Brazil, and in India, where a decrease of the average height was observed. The Laplander population has kept invariable its mean age at menarche (15 years, 1870–1930) while they have maintained intact their lifestyle.

In some societies the differences of growth largely established between high and low level classes tend to disappear or have already disappeared. In countries where social differences have disappeared, it was not the result of the gradual convergence of tendencies of high and low classes, but a process of “recuperation” of the low class. This does not mean that social classes have disappeared. If we take the case of the most developed European countries, some marked social differences are still present, and defined in the level of an economical control, the political influence, salaries, education or prestige. It is more exact to consider the absence of significant differences in the level of growth as the result of the fact that the society, as a whole, reached an adequate level of wellbeing in such a way that the limiting environmental factors are equally improbable in low and high socio-economical levels.

2 Traits Experimenting Secular Trend

2.1 Growth and Adult Height

The secular trend has been well documented for stature, weight, the age of menarche, even if these variables do not cover the large spectrum of morph physiological characters affected in one or other way by secular changes. In fact, the most visible expression of the secular trend is the increase of the adult height observed in many parts of the world, with grown-up children being taller on average than their same sex parents (Cole, 2003). Stature of children will increase at each age but the curve is also in advance regarding maturity, especially during puberty. The secular changes of stature are already present during infancy (Hauspie et al., 1996) and the increase in height from one generation to the next occurs mainly during the first two years of life (Cole, 2003). On average, the secular increase of stature in Europe and North America was about 1.5 cm/decade during infancy in the period of 1880–1980, 2.5 cm/decade during adolescence and 1 cm/decade during adulthood (Malina, 1990). As we have already mentioned, positive secular changes of physical growth are a combination of two trends: a) height, weight, maturity stages and the end of the bone growth

are attained at an earlier age, b) the increase of the adult height. Often, it is not an increase of the mean height but that maximum height is reached before.

Adult height represents the final product of a continuous and often non-additive interaction between genetic and mesological factors, such as social class, family income, parental education, hygiene and disease (Tanner, 1992). Height reflects, more than any other anthropometrical trait the nutritional, status of the subject, that is, the food experience cumulated all along the subject's life (and probably also of the parents'), so it could be considered as a good socio-economic indicator, and its analysis confirms the socio-economical character of the secular tendencies (Gómez Mendoza and Pérez Moreda, 1985). The historians of the economy have utilised last years data of increase of adult stature of different populations during the 20th century to analyse the economic development of these populations and to make previsions about mortality and morbidity. Adult stature has reached a limit (plateau) during the mid of the years 1980 in some developed countries (essentially of the North of Europe), what would suggest that those populations reached their genetic potentialities for this trait or that the social conditions ceased to improve better (Bodszar and Susanne, 1998). Nowadays, studies of variations between countries or between groups in the same country continue to be done on growth and/or stature along the time, and thus it can help to identify the variations of the conditions of life during infancy.

2.2 Weight and Associated Variables (BMI, Adiposity)

Secular changes were observed on weight of children and adults all over the world (Malina and Zavaleta, 1980, Gutiérrez Muñoz et al., 1993, Yi-Ching and Malina, 1995, Vercauteren et al., 1998, Bodszar and Susanne, 1998, Danker-Hopfe and Roczen, 2000). This secular trend comes from two different sources: the increase of body dimensions and the changes of the body shape, corresponding to changes of the mean adiposity as weight for height, or of body composition indices, as well as of subcutaneous skinfolds or circumferences (Thompson, et al., 2002). The best documented measure of weight changes are the studies about the secular evolution of the BMI (Blanksby, 1995, Tremblay and Willms 2000), an index which is now used almost universally in adults and increasingly in children. Without any doubt, we have to take into account that although BMI has its utility as an approximation of overweight or of obesity in a population, it cannot measure the individual levels of fat and it fails to distinguish between fat mass and muscle mass.

2.3 Other Anthropometric Variables

Secular trend has been also observed for other anthropometric traits than height and weight, as the biacromial and bicristal diameters (Mesa et al., 1993), the leg length compared to stature, some thoracic measurements (Jaeger and Kromeyer 1999), and so on. Sometimes, the results of these anthropometrical variables could look contradictory (partly due to the different origin of the dimensions: bony vs. soft tissues) and they are introducing a kind of “confusion” factors both on the interpretation of the causes and on the direction of the secular changes. The secular increase of stature is essentially due to the increase of the legs length, where the sitting height did not change strongly. Moreover, the analysis of the weight/height relation indicates, in some countries till the years 1980, a tendency to more longline morph types after puberty (Vercauteren, 2003), although the rapid increase of overweight and obesity observed after 1980 in many industrialised countries, such as Sweden and Norway, resulted in a re-verse tendency (Cernerud, 1993, Liestol and Rosenberg, 1995).

About the cephalofacial dimensions, although the data are less numerous, it seems clear that the process of debrachycephalisation was observed since the end of the 19th century and during the whole 20th century in countries such as France and Switzerland, but also in Germany, the Czech Republic (Susanne et al., 1988) and Croatia (Buretic-Tomljanovic, 2004). The observations are based on the cephalic index, the head length being almost constant, the head breadth is reducing. Moreover, a general grasilisation of the head is observed (higher, larger and narrower) as well as of the face (longer and narrower). This process cannot be considered as independent of the secular evolution of stature, different dimensions being correlated (Susanne et al., 1988).

2.4 Puberty and Age of Menarche

Concerning to the “tempo” of growth or of maturation of the children, measured for instance as the pubertal stage or the bone age, the simplest is to observe the mean age at menarche, which decrease is well documented during the 20th century: data collected from the middle of the 19th century till the years 1960 show a decrease from 17–16.5 years to 13.5–13 years in United States and Europe (see revisions of Danker-Hopfe, 1986, Eveleth and Tanner, 1990, Bodzsar and Susanne, 1998, Vercauteren, 2003). The studies after 1960 show a stabilisation around 13 years of age in many countries, sometimes accompanied by a decrease of the variability (Vercauteren and Susanne, 1985, Rebato et al., 1993); on the contrary, an increase is observed in periods of economic crisis. Regarding boys, as judged by testicular volume, a stop of the decrease in the age of maturation has been observed since 1980 (Cole,

2003). The age at menarche is a very sensible indicator of the environmental variations, and it is highly correlated with the age at the peak height velocity. Nowadays, adult height is attained earlier than a few decades ago; this results in earlier steps of growth and development (as it is the feminine sexual maturation for instance) such as it has been demonstrated through mathematical modelisation of growth data (Hauspie et al., 1996).

About the possible existence of a secular trend during the prenatal period, the studies are not frequent and do not give concordant results. In the recent version of Cole (2003) on secular trend, he mentioned that the length at birth did not show a secular trend, it is the case also for birth weight which did not seem to increase. The interpretation is difficult because an increase at birth can be compensated by an increase of low weight of premature birth that would not have survived earlier. On the other hand, mothers are now fatter than they were before and this acts directly on the birth weight of their babies. Data show that secular evolution is taking place after birth, from about two years of age.

3 Discussion

The studies on secular trend representative of the “whole population” are relatively scarce and, generally, they are based on recruits’ data (Schmidt et al., 1995). However, in spite of the advantage of these kind of data regarding the large amount of data available as well as the uniform method employed during the collection of the data, which permits comparability, some conditions (minimal height), exclusions for several reasons (unfitness, diseases, and so on), and other factors, are introducing remarkable biases, and excluding a group of individuals which contributes to the population variability (Rebato, 1998). For this reason, the average stature of soldiers should not be identified with mean adult height in the male population. In addition, females are not represented.

The studies in population samples are more numerous and provide data on the secular evolution in the general population, and in different ontogenetic periods (in- fancy, childhood, puberty, adulthood) of both sexes and of different socio-economic groups and ecological situations (for instance rural versus urban). In the revision of Bodszar and Susanne (1998), several European countries are represented, but there are also more and more data on Asiatic populations such as Japan and China, populations of the Pacific and Australia where the existence of the secular trend was demonstrated (Blanksby, 1995, Cheng-Ye, et al., 1995, Yi-Ching and Malina, 1995, Micklewright and Ismail, 2001). The results on secular changes in different Western countries show some common characteristics, among which we can mention the following ones:

- a) The start of the secular increase of height in the 20th century corresponds with better socio-economic conditions at the beginning of the industrialisation.
- b) The secular changes correspond to an earlier maturation and an increase of the adult height.
- c) The increase of weight is approximately proportional to the heights.
- d) The periods of war and famine are related with a stop or a decrease of the secular trend.
- e) Since World War II, in various countries the trend was more intensive.
- f) The trend could vary in function of the sub-regions, being higher for regions of low standards in the past. Nowadays, it results in a lower geographical variability.

As far as the direction of the secular changes is concerned, the term has always been applied to changes focused in one direction. The studies done in Europe, North America, Canada, China, Japan and Australia indicated the positive tendency of these changes. However, as we already mentioned, the tendency of positive changes is not universal (in fact, it can be reversible): in some populations, tendencies of negative changes while in other populations an absence of changes have been observed (several populations in Africa, Latin America, India, Turkey, Syria, Iran, etc.) In the case of negative secular changes, it could be demonstrated that the population suffered of environmental changes during a large period of time in a negative sense. The absence of secular trend implies that no change is observed in the rate of growth or the adult height in a population during a long time. The interpretation of the different tendencies (positive, negative, absence) related to the environmental changes is complex. In his excellent paper, Tobias (1985) considered at least four possibilities:

- a) Some populations have showed a positive secular trend till recently, but actually an absence of this trend could be observed (a kind of plateau). This fact is interpreted as “a phenotypical limit” which has been reached and that is related to the genetical potentiality. This is the case of the highest classes of the industrialised communities (the Netherlands for example).
- b) On the other hand, in other populations an absence of secular evolution has been observed, for instance, during the 19th century, followed by a positive trend during the 20th century. These groups are “moving” from the median part to the higher part of their growth rate and of their body dimensions genetically determined: the lowest socio-economic classes of the industrialised societies (essentially in the countries of South- and East Europe).
- c) In some populations, since the beginning of the 20th century, an absence or a negative secular evolution has been observed. These populations are changing to lower body

dimensions and later maturation rates, for example, some non-industrialised communities, with a subsistence based on agriculture and grazing (Birmanian, India, for instance).

d) Moreover, other populations are showing a positive secular evolution from the end of the 19th century. These groups are coming from the lower part of their genetic potentialities to an average part, like many of the hunting-gathering communities surviving today (Papua from New Guinea, Bushmen from Kalahari, Aborigines from North Australia).

Some “Negative” Aspects of the “Positive” Secular Trend

We have already mentioned that the secular tendencies to an increase of body size and to an earlier sexual maturation have a positive connotation and are considered as a measure of the wellbeing of a population. However, some researches already emphasize certain negative aspects of the secular trend phenomena, such as a growing prevalence of obesity, hypertension and stress. In fact, Price et al. (1993) have suggested a worldwide epidemic of obesity, which they put to cultural changes, the increase in property and the sedentary lifestyle. At the same time, there has been an increase in the prevalence of the associate diseases (i.e. diabetes type II, atherosclerosis). We may also wonder about optimum human size and whether early puberty is indeed biologically preferable or it involves social and/or maladjustments. Some evidence suggests that the acceleration in the development process is accompanied by an earlier beginning of the involute processes; in addition, a higher cancer and cancer mortality incidence related to stature has been observed (Micozzi, 1987). The younger reproductive feminine period also results in the possibility of an increase of pregnant adolescent mothers and in the possibility of an increase of the health problems and of the mortality of these mothers and babies.

4 Conclusions

Some authors think that the positive secular evolution could go on during a long time yet, while some others are beginning to see a limit. Effectively, the process shows a lower velocity in the recent researches. Some works are pointing out a stop in the height increase in the high class groups. The stabilisation of the mean age at menarche in many countries is another proof of a stop in the secular evolution. An end of height increase (and the development acceleration) in those groups where environment is favourable enough to allow the total expression of the genetic potential of the development could be expected. In this case, even if the environmental factors improve, they will not anymore influence a process of secular evolution. It could also be observed that positive secular trend stops, because there are

no more improvements in the factors responsible of this process. But, how could we demonstrate that a population has reached its genetic limit? On the other hand, is it reasonable to think that the environment would continue to become more and more favourable? It seems more logical to think in the existence of the economic crisis or/and that the pollution could become worse and to affect the development of the children (Schell, 1999). It must be taken in mind that the secular trend is reversible so, if the environment gets worse, we could envisage, probably the positive secular evolution which has characterised populations of 20th century, is giving way to a negative secular trend in the 21st century (Vercauteren, 2003).

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