THE AGE AT MENARCHE AND THE SOCIAL STATUS OF THE FAMILY[1]

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Abstract: The authors sketch the biological process of girls' maturation of which the menarche is an adequate indicator. They enumerate the human biological conditions of the onset of puberty: the biological/physiological symptoms (e.g. developmental status of the growing female organism; critical body mass, etc.) and/or the environmental, ecological and economical conditions (e.g. climate, nutrition, social status of the family, urban and rural mode of life, etc.).

They give a brief overview of the changes of age at menarche over centuries, as a part of the phenomenon of a secular trend.

They touch on some questions thought of as factors influencing the age at menarche. (1) *Climate*: we think today that the climate's influence plays a lesser role in this, because it is covered by the more significant effects of socio-economic status. – (2) *Nutrition*: human ecology states that under factors influencing the growth process of children, one of the most important factors, if not the most important one, is nutrition. – (3) *Secular trend* is a world-wide phenomenon of long-term, systematic changes in a wide variety of anthropological traits in successive generations of a population living in the same territory (Eiben 1988). Data from different parts of the world demonstrate the earlier onset of the menarche. The age at menarche today is about 12.6–12.8 years. – (4) *Constitutional correlations*: There are certain relationships between body build and biological maturation, and "critical body mass" also influences the onset of puberty. – (5) *Heredity*: Genotype and environmental variation, the correlation between these two, and the interaction of the two, influence biological maturation. Inheritance of age at menarche is 88.2% > H > 72.2%. – (6) *Race/Ethnic groups*. General migration in the last third of the 20th century all over the world

[1] This paper is based on the key-lecture of the authors, presented at the conference "Models of Domestic Service" in Munich 11 September 2003.

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KSH NKI Történeti Demográfiai Évkönyve 2003. 5–31.

was so intensive that this form of question of differences in age at menarche under ethnic groups has decreased in its importance. – (7) *Social-economic status*: The influence of social inequality on the growth and maturation of children was studied scientifically about 180 years ago. Many authors detected effects of social gradients to growth and maturation. It is scientifically proved that better environmental status, better family background (both financial and cultural) help the manifestation of the growth pattern. The authors demonstrate differences in onset of puberty in girls according to social classes: girls of lower-stratum families mature later than those living in the upper strata. The unfavourable family background of poor girls retard their maturation, i.e. their age at menarche appears at a later age of life, – as can be seen based on much data collected in different parts of the world. An important lesson of growth/maturation studies is: body measurements and maturation characteristics, i.e. the age at menarche, these very objective measures react to irreproducible social events and/or changes exactly and with a very quick and sensitive response.

Introduction

One of the most intensively and most frequently studied aspects of human biology is the growth and maturation of children. One reason for this is the scientifically proved and generally accepted statement that *the growth and biological maturation status of children is the best index of the health and nutritional status of a community* (WHO 1978, Tanner 1986). In the last decades of the 20th century, a new name for growth studies came into general use: *auxology* (αύξάνω [= auxáno] an Ancient Greek word, which means increase, add to, in our sense: science of growth). A modern field of interest in growth studies is *epidemiological auxology*, when the growth survey concerns the whole population (i.e. based on a large sample) and its results are generally well-founded.

The age at *menarche* provides a convenient measure for the tempo of growth of a population at a given time (Tanner 1981).

The sanguineous history of the 20th century called attention to several problems concerning youth, e.g. the ratio of youth in the population determines many of its possibilities. Add to this that the most dramatic changes happen over the first two decades of human life, i.e. puberty is a very important period concerning development. In females, the most remarkable event of girlhood is the *onset of the menarche*. The appearance of the first menstruation in the continuous, complex process of the maturation of females represents a sharply defined point in time. According to Fekete (1955) the age at menarche depends on when the central nervous–hypophysis system reaches the required level of function and when the ovaries are adequately ready to respond to impulses

coming from the higher centres. To the continuously flowing endogenous and exogenous impulses, the organism responds with a quantitative reaction with the onset of the first menstruation associated in normal conditions with the maturation and detachment of ova. Thus, the menarche is a highly suitable *indicator* in studies of the biological process of maturation, although its onset does not actually mean, of course, that the organism may be considered to be sexually mature.

"*Menarche*" is an artificial medical expression used for naming the onset of the first menstruation. This expression is recognisable in the Ancient Greek μην (mén) = lunar month and also in the Ancient Greek αρχη (arché) = beginning words. As far as we know today, the phrase *menarche* was introduced to the medical and/or human biological literature by the German doctor C. H. Stratz in 1908.

Age at menarche varies enormously (between 8 and 24 years) in different populations of the world, and is influenced by many factors. Looking for the causes of the phenomenon (i.e. the age at the menarche in time), there are many factors which influence it. Two large groups of factors are (1) genetic endowments and (2) environmental (ecological, economical) ones. The authors intend to detail all these in this paper.

Before doing that, however, it is worth mentioning that there are some methodological questions of data-collection on the age at menarche. To reconstruct the menstrual history was at one time not easy, because of several problems. The first data originated from gynaecological records, as the female patients were asked about their first menstruation. These samples were "selected" groups of women, since only patients who had some gynaecological illness came to the clinic, or women came to give birth to a child, i.e. these samples were "selected", i.e. non-characteristic of the whole population.

This so-called "recall" method of data-collection (as adult women were asked about their first menstruation) hides other possible mistakes. (1) The woman may truly not remember the exact date of her first menses; (2) She may have had pseudo-menstrual bleeding; (3) She may have personal reasons for falsifying her report. On the other hand, if we ask post-pubertal girls (e.g. high school students) – as it is to be hoped that they remember accurately the date of their menarche – we shall be given answers only from those who have already their menstruation, i.e. we again have a "selected sample".

Nowadays, we use the "status quo" method of data-collection: we ask the young (9–15 year-old girls) whether they have already had their first menstruation. The answer can be only "yes" or "no". We divide the sample into half-year age-groups and separate the sub-groups of "yes" and "no" expressed in percentages. Then, we elaborate the material with probit- analysis. We calculate the *median* age at which exactly half of the questioned girls answer yes.

In the world literature of human biology, one can find hundreds and hundreds of papers analysing the problems of puberty, with particular consideration given to the age at menarche. Here we give a brief overview about knowledge of age at menarche in the past, as well as concerning factors which influence it.

Historical overview

In the Classical Greek era, data on puberty was available only for boys. In Antiquity, in China, in connection with the description of the stages of human life, Ch'i Po explained to the Yellow Emperor, that when a girl reached her fourteenth year, she began to menstruate (and he thought that she was able to become pregnant). Confucius (B. C. 551–497) wrote about the numerology of the social hierarchy extended to the concepts of the stages of man's development and then gave descriptions of physical growth and development: e.g., he measured his own moral maturation by units of 15 and 10 years (Boyd 1980).

The rabbis of the Babylonian Talmud were greatly concerned that, with the onset of the menarche, the adolescent girl observed the rules of the uncleanness of the menstruant. Although their legal definition of puberty of girls was 12 years and 1 day, they recognised that the onset of menstruation as well as the development of the breasts and the pubic hair was somewhat variable in timing and extent (Boyd 1980).

Aristotle (B. C. 382–322) in his "*Historia animalium*" (Book VII) gives a factual account of age changes in form and function of the human organism. 'When twice seven years old…in the female the breasts swell and the so-called catamenia (= menstruation) commence to flow' (Boyd 1980).

In Ancient Rome, Cicero (B. C. 106–42) and Horace (B. C. 65–8) have dealt with life cycles, among other things, but also with puberty, but rather for boys. Varro (B. C. 116–27) divided human life into stages: Females under 12 years, under tutelage, cannot make a testament. About puberty: females 12 years, not released from tutelage, on account both of their infirmity of sex and ignorance of forensic medicine, until they have born three children (Boyd 1980).

In the Roman Empire (A. D. 200–800), the New Testament added nothing to the Old Testament's brief references to the postnatal developmental stages of man. The early Christian Fathers and other writers of this period adapted the ancient numerology to their own way of thinking. Ambrose (340–397), Bishop of Milan, summarised the seven ages of Hyppocrates, and then, the individual belonging to each period. Since his terms were incorporated untranslated into the languages of modern Europe, especially in medico-legal treatises we give the Latin and English terms (only in the first three decades of human life), as follows:

1st under 7 years	Infantia	*Infancy*	Infans	*Infant*
2nd 7 to 14 years	Pueritia	*Childhood*	Puer	*Child*
3rd 14 to 21 years	Adolescentia	*Adolescence*	Adolescens	*Adolescent*
4th 21–28 years	Juventus	*Youth*	Juvenis	*Youth* etc.

Two late Greek medical compendiums, one by Aetius of Amida (6th century) who wrote in his Tetrabiblon (Book XVI, Chapter IV): About the fourteenth year, the menses begin to appear. And about the same time, these girls arrive at the age of puberty and the breasts enlarge. But the period does not appear in all instances, in the same time, in the same account, nor does it last the same number of days…etc. – Paul of Aegina (625–690) wrote that with most women the menstrual discharge began about the fourteenth year of their age (Boyd 1980).

The prominent writers of the Middle Ages and the Renaissance wrote little about the physiology of human growth and nothing about body measurements. They used to report only one characteristic, the age at menarche. Isidore (c. 560–636), Bishop of Seville wrote about puberty in a very general way, including the ages of man in his book Etymologiae (Book XI). Vincent of Beauvais (Vincentus Bellovancensis), who was active in the first half of the 13th century, wrote about the age at menarche: that it was proper, i.e. normal, that the flow of menses should be discerned after twelve years have been completed and [it occurs] in the majority if this period is extended to fourteen years. Bartholomew, the Englishman, cited Aristotle, saying 14 is the usual age for the menses. It seems to be that by the end of the Middle Ages, menses was naturally absent below twelve and above fifty years (Post 1971, cit. Tanner 1981).

One can summarise that the age of the first menstruation of girls in ancient times was thought to be between 12 and 14 years, which was – by the way – more or less similar or a little later than modern data. Researchers agreed that the age at the menarche in classical and medieval times took place at an average age that was broadly comparable to the average at which it occurs nowadays (Tanner 1981). But recent data give a *median* age of 12.7 years, so in medieval times the average age at menarche was later than now. On the other hand, some scientists think that girls in medieval times reached their menarche earlier than poorly-off working girls in the 19th century (of whom the age at menarche was 15.5–16.0 years, Tanner 1981).

In the 16th century, also in Shakespeare (1564–1616), there appeared questions of the periods of life. He mentioned in "*As you like it*" (Act II, Scene VII) his charming, still much-admired version of the seven stages of man's life. "His acts being seven ages. At first, the *infants*,… then the whining *schoolboy*, …and then the *lover*…" (Boyd 1980). In "Romeo and Juliet", Shakespeare thought that Juliet did not complete her 14th year. Marinello (1574) was not

able to define the time in childhood when the menarche appears, because some girls have not completed their twelfth, and others, the majority, were in their thirteenth year (Tanner 1981). As Paolo Zacchias of Rome (1584–1659), an expert at the highest papal court, also mentioned, the various historical concepts of the physiological and psychological determinants of man's legal responsibility in each of the seven ages: *Infantia, Pueritia, Pubertas* or *Adolescentia, Iuventus, Virilitas, Senectus,* and *Senium* or *Decrepitas* (Boyd 1980).

In 17th century Europe, some new drafting of the life cycle appeared. Venette (1696) mentions that menstruation appeared very seldom at 9 or 10 years (Tanner 1981). At the end of 18th century, Blumenbach (1795) was the first who described several physiological properties of man: *his slow growth, long infancy and late maturity* (Boyd 1980).

Laslett (1971) cited some mid-nineteenth century data (which originated from gynaecological records, i.e. data collected with the recall method). Raciborski (1844) reported the age at menarche at 14.9 (15.4?) years in French women. According to Whitehead (1847), English women in 1830s – 1840s had an age at menarche of 15.33 years. The Englishman Ridgen (1869) in the 1860s reported 14.96 years. Bowdich (1844) reported 14.7 years as the age at menarche in American women.

In the 19th century: Fleury (ca 1815–1872) returning to this problem presented ten periods of human life. He defined Puberty as in 15–20 years of age: complete development of the genital organs, and the establishment of menstruation in the female. E. Beaugard (1865) dealt with periods of human life, and wrote about "rapid transformation" in girls 12 or 13 to 21 years (in boys 13 to 21 years) (Boyd 1980).

Brierre de Boismont (1797–1881) was the first, who in 1841 gave the exact data of the age at menarche in different social groups. Girls of poor families (N=171): 14 years 10 months, in well-to-do girls (N=135): 14 years 5 months, and in rich, noble girls (N=59) 13 years 8 months (Boyd 1980).

In the 20th century, especially in the second half, many investigations have presented data of the age at menarche, and the papers sprang up like mushrooms. Several of these papers aimed at analysing the factors influencing variation in the age at menarche. The first remarkable impetus was the paper by Wilson and Sutherland (1950), when they introduced the method of probit analysis or status-quo method into this kind of research. By their time, data-collection had been unified and results were comparable. The second impetus to study the age at menarche sprang from a concern about over-population (understanding causes of sterility, c.f. Malthus 1798), and the third impetus had to do with clinical practice (Tanner 1981).

Factors influencing the age at menarche

Climate

There was a deep conviction that climate determined the age of the onset of puberty, a belief which seems to have originated in an irresponsible remark by Montesqieu (1757) in *L'Esprit des Lois*. "It was in order to provide a refutation of this belief that John Robertson, surgeon to the Manchester Lying-In Hospital, undertook his researches, starting in the 1820s and publishing them finally in his *Essays and Notes on the Physiology and Diseases in Women* (London, 1851)" – wrote Laslett (1971).

The problem of the climate's influence dates back several centuries. It was a widely believed that the menarche occurs at an earlier age in women living in warm climates. In the 17th century, Guarinoni (1610) wrote that peasant girls living in the mountain (i.e. colder) country, in general, menstruated much later (seldom before their 17th, 18th or even 20th year of age), than the daughters of the town-people. In the 18th century, Berdot le Fils (1774) mentioned climate in connection with the age at menarche: in hot climates it was precocious, in cold countries much more delayed. Boismont (1841) wrote that the 14th year was "a kind of menstrual equation from which 'temperature' could deviate the age of the onset of menstruation". He mentioned only hot, light and magnetic temperatures, not degrees.

Laslett, (1971) a historical demographer, carried out a survey of eighteenth century's Belgrade population. The title of his paper contains the word "menarche", although the main item of his paper is, however, the age at marriage. He investigated data of the Serbian Orthodox parish register in 1733/34 and gives an estimation for the age at menarche as 16.7 years. He pointed out that "the age at menarche and maturation generally could vary over time, as well as from social class and place to place". He also connects all these with wide variations of nutrition.

Millot (1952) has found in China that the age at menarche in South China was 11–13 years, in Middle China 12–14 years, and in North China 14–16 years. Škerlj (1932) published the results of his detailed analysis of European data. According to him, menarche is influenced by annual temperature, the annual amplitude of temperature variations, the amount and seasonal distribution of rainfall, the humidity of the air, and by the altitude above sea level. The menarche comes earlier in the oceanic and later in the continental climate – he wrote. Eveleth and Tanner (1990) expressed, however, their opinion that the old idea that climate exerted a major influence and that girls matured earlier in tropical climates and later in circumpolar ones, was erroneous. Eveleth (1966) found that American girls growing up in the hot, humid environment of Rio de

Janeiro had a median age at menarche 12.6 years, equal to that of girls of comparable socio-economic status in the temperate United States (Eveleth – Tanner 1990). [We add to this in a low voice that there are some opposite findings; Homo Sapiens is very variable!]

It would be interesting to see in the future, whether the recent dramatic changes of climate, global warming and the greenhouse effect in our time (together with other effects!) will (and if yes, how) influence the onset of girls' puberty in different regions of the world.

Nutrition

It was also Škerlj (1947) who called attention to the protein contents of the diet as important factors influencing onset of menarche. His compatriot, Kralj-Čerček (1956) investigated the age at menarche in Slovenia, and found that in girls living in fishing-villages, having a high protein diet, the age at menarche was 12.56 years, while in those having a mixed diet it was 13.42 year, and in those living far from the sea and having a preponderantly high carbohydrate diet, the age at menarche was 14.10 years. These differences were statistically significant.

Komlos (1989) published data on Viennese women from 1907, and discusses the relationship between nutrition and fertility. He mentioned: "a long hiatus generally separated the onset of menses from the onset of reproductive life". Menarche occurred at between 11 and 20 years of age in these Viennese women in the first decade of the 20th century (but no concrete year of the age at menarche).

Menarche is delayed by chronic under-nutrition. Based on their longitudinal study, Dreizen et al. (1967) found that poor rural area girls (South USA) had a mean menarcheal age of 14.4 years compared to 12.4 years in their well-nourished counterparts (Eveleth – Tanner 1990).

A generally accepted statement of human ecology that under the factors influencing growth process and causing secular trend, one of the most important factors, if not *the most important one is nutrition*.

Secular trend

Anthropology (together with botany and zoology) was a classical branch of biology, dealing with the evolution and variation of Hominids (chiefly Homo Sapiens) in time and space. In the 20th century, there was an elaboration of methods, (e.g. somatometry was an elementary task), and *biological anthropology* became wider with sociological and demographic approaches, especially in

growth studies. That resulted in increasingly improved intensive studies carried out on living populations. The growth surveys drew attention to one of the most important human biological phenomena in the twentieth century, which was called "secular" changes.

The secular trend is a phenomenon of long-term, systematic changes in a wide variety of anthropological traits in successive generations of populations living in the same territory (Eiben 1988). ["Secular": came from Latin secularis, and means generation, age of man, life time, in other word a long time-period.] This phenomenon, that the acceleration of growth and maturation took part in the developed countries more than a century ago is well known (but, secular trend is more than a simple acceleration of the growing process). Several part-phenomena of the secular changes can also be observed in new-born babies, in childhood and in the young adult stage, as well as at population level. Changes in the age at the menarche can be ranked amongst these phenomena.

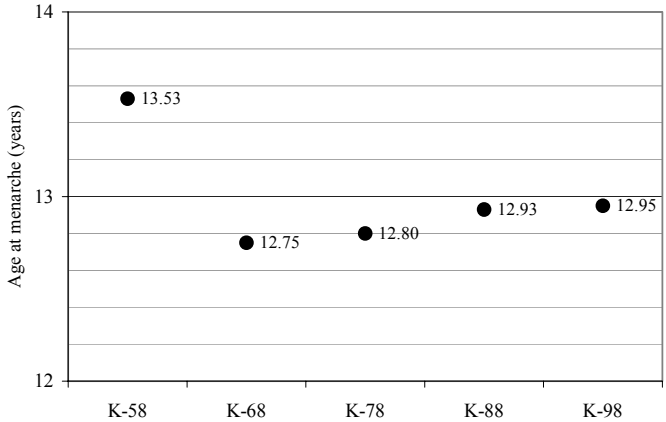
Changes in the age at menarche were already being reported in the 18th and 19th centuries. The above previously mentioned Venette (1696), reported an average age at menarche as 14–15, years based on his own experiences. C. F. Jampert (d 1758) a German doctor found that the age at menarche was the same as that which H. Guarinoni (1571–1654) had reported one century earlier.

Newer data demonstrates secular changes in the age at menarche. That of clinical patients changed half a year from 16.5 to 16.0 years between 1875 and 1900 in Helsinki, and by one year, from 15.7 to 14.7 years between 1890 and 1915 in Stockholm (Tanner 1981; he cited data of Malmio 1919, and Lenner 1944).

One of the oldest series of data on the age at menarche, containing changes from 1860, came from Norway. Brudevoll, Liestøl and Walløe (1979) reported data of pregnant women attending the Women's Clinic in Oslo back to 1837. In the middle of the 19th century, the age at menarche of their patients was 16.0 years, at the turn of the 19th/20th century about 14.6 years, and in the 1960s about 13.4 years (Tanner 1981).

In the middle of the 20th century, in Europe, the menarche used to appear at an increasingly earlier age, but this tendency changed towards the end of the 1960s. Roberts and Dann (1967, 1975, Dann and Roberts 1984) examined the age at menarche over twelve years in a Swansea (Wales) sample, and eleven years in a Warwick sample of female students. The trend towards an earlier age at menarche stopped and reversed, i.e. the age at menarche came at a later age. Looking for causes for changes, these scientists mentioned that environmental factors did not change during the time period of their studies. In 1985 Roberts summarised the results of the British research into the age at menarche: he thought that impairment of life standards could not be the reason for these changes (a negative secular trend?) but at the same time height increased.

A similar phenomenon was reported by Eiben (1988, 2003) based on his "Körmend Growth Study", carried out over half-a-century in a small Western Hungarian town. The age at menarche in 1958 (K-58) was 13.53 years, which was the latest age, not only in Hungary but also in Eastern Middle Europe. After ten years, in 1968 (K-68) the median was m=12.75 years (which was one of the earlier ages in the mentioned region). In the next decade (K-78) the median was 12.80 years, while in 1988 (K-88) the median was later at 12.93 years, and in 1998 (K-98) it remained essentially the same at 12.95 years. So, in Körmend, we witnessed a positive secular trend, then the absence of a secular trend, and in the last decades a negative secular trend (Fig. 1). Looking for causes for this phenomenon, we can state that body measurements increased over these decades, and the environmental factors of the town also changed a great deal. The conditions of a manifestation of the growth pattern in Körmend children improved, and a (positive/negative) secular trend seems to be manifested in the Körmend children. The primary lesson of the Körmend Growth Study was that *body measurements and measures of maturation, these very objective measures react to irreproducible social events and/or changes exactly and with a very quick and sensitive response*. The reasons for changes of the age at menarche in Körmend girls need further analysis.



1958	K-58	m = 13.53 y.
1968	K-68	m = 12.75 y.
1978	K-78	m = 12.80 y.
1988	K-88	m = 12.93 y.
1998	K-98	m = 12.95 y.

I. Changes of age at menarche in Körmend (Western Hungary) over the second half of the 20th century

Constitutional correlations

According to Škerlj (1927), in the same population, the more darkly pigmented girls usually have their menarche earlier then their lighter pigmented counterparts. Kralj-Čerček (1956) classified Slovenian girls based on their body build, and found differences in the menarcheal age. In girls with baroque physique, broad body build, feminine, the age at menarche was m=12.93 years, in girls with a renaissance physique, medium body build m=13.5 years, and girls with "gothic", physique, linear or boyish type m=14.61 years. The differences were significant. Bodzsár (1980) studied physique and sexual maturation in Hungarian girls. She found that the relationship between the age at menarche and the somatotype (Heath and Carter's anthropometric somatotype method) was significant. Girls who reached their menarche sooner were predominantly endomorphic, and those reaching their menarche later were predominantly ectomorphic.

An interesting problem, the question of "critical body mass" occurred to American human biologists and this involved a long and wide discussion in the human biological literature. Frisch and Revelle (1969) published their hypothesis: the attainment of a specific body mass, associated to the pubertal growth spurt can be critical for the arrival of the menarche. The mechanism for such an interrelationship could be that as body mass reached a critical range it leads to some changes of ratio in metabolism. In turn, the sensitivity of the hypothalamus for oestrogen decreases, and makes a change in the hypothalamus–ovarium feedback. This hypothesis was discussed vehemently by more than one (mainly American) scientist. Newer studies warranted, however, that the hypothesis of critical body mass may well be correct: the onset of the menarche postulates a body weight of about 46 kg, of course, with remarkable individual variations (Eiben 1988, 2003).

Heredity

Twin and familial studies proved that genetic factors have an intensive influence on the age at menarche. According to Lerner (1958), the phenotypic variation of a character is composed of four components: the genotypic and peristaltic (environmental) variation, the correlation between these two, and the interaction of the two. Neglecting here a complicated mathematical-statistical demonstration, the following limiting values are obtained for the *heritability of age at menarche*: $88.2\% > H > 72.2\%$ (Thoma 1960).

Race/Ethnic groups

As we speak about races, it is necessary to mention in advance that *Homo Sapiens is a unified species with many variants*, called "races". These races are systematically sub-species, and they differ from each other only with non-crucial characteristics (e.g. stature, skin-colour, head-form, etc.). Homo Sapiens corresponds to the inevitable condition unambiguously, that its individuals can produce fertile offspring in any of the combinations of the sub-groups. So, today the human biology and/or biological anthropology do not write about races but instead they write of *ethnic groups*.

Differences in the age at menarche between "races" or ethnic groups are very difficult to investigate methodologically, because differences between groups may be caused by a great many factors. Michelson (1944) found only insignificant differences in the age at menarche between American negroids and whites. A counter-example, in which peristaltic factors are relatively homogenised: in the Lapps the mean age at menarche was 18 years, in Angmassalik Eskimos it was 14 years and 9 months (Millot 1952, *cit*. Thoma 1960).

The oldest data on the age at menarche in European and American samples originated from the late 18th century and continued until the 1940s (Germany, Great Britain, France, Russia, Denmark, Norway, Italy, Hungary, Sweden, The Netherlands, Yugoslavia (Serbia, Slovenia), Canada, and the USA). The age at menarche varied over these 150 years between 12.5 and 17.5 years (in Hungary, Budapest, 1982: Doktor 15.36 years). The earliest age reported was 7.5 years, the latest one the unbelievable (!) 38.5 years (Boyd 1980). One of the latest ages at menarche that was reported in the 20th century was 18.0 year in the Bundi people in New Guinea (Malcolm 1971).

The mean age at menarche at the Hebrew Orphan Asylum for girls born between 1905 and 1908 was 14.8 years and for girls born in 1918/19, 13.1 years. Boas (1932) commented that the tempo of growth and maturation seemed to be little affected by racial descent, but depended rather upon environment.

Further sporadic data are from different parts of the world: Madeira around 15.4 years, in Jamaica and Antigua about 14.5 years (with no difference between Blacks and Whites living there), in Tahiti around 10–11 years. The Hindus have an earlier age at menarche in Calcutta 12.3 years, and in Bombay 12.6 years. Based on well-off-Berliner patients' answers, Schaeffer (1908) reported an average 14.4 years, amongst them, women with Jewish origin and culture averaged 14.0 years, the others 14.6 years (Tanner 1981).

Tanner (1981) summarised that the Mediterranean mean age of menarche was about six months lower than the English ones of the same period and a year less than the values in north-west Europe. European values, also in the last quarter of the 20th century, show a difference: the mean for London was 13.0,

for Paris 12.8, and for Italian cities, even in the north, about 12.6 years (in Hungary m=12.79 years).

Two further pieces of data about ethnic heterogeneity: Shiloh (1960), and Belmaker (1982) published menarche, breast development and pubic hair data of Jewish girls in Jerusalem: Middle class girls reached all these earlier that those from both the upper and lower classes.

Changes happened in the age at menarche in some Western countries between 1860 and 1980 (Marshall and Tanner 1986), and the secular trend is well marked. Eveleth and Tanner (1990) have published the largest overview about the age at menarche in various populations (p. 162–165). In the last third of the 20th century, world migration has increased dramatically and the form of the question of differences according to the "races" has lost in its importance today.

The factors influencing growth and biological maturation of children, discussed here, correlate with the socio-economic status of the families.

Socio-economic Status

In the last few decades, one of the most important points of view in growth studies is to analyse the *socio-economic status* (SES). As we investigate SES, this very complex and thorny question, we cannot elude the question of poverty, inequality and health (Eiben 1998).

The European Council's definition of poverty (also adopted by several other countries) does not only encompass the lack of material resources but also social and cultural exclusion. A person or a family or a group of people with resources (material, cultural and social) too low to ensure only a minimum of reasonable living in a certain national environment, are also poor (Martin-Guzman 1993, cit. Artnik 2002). "Cultural and social exclusion are both responsible for and caused by material shortage. Poverty is connected to a lack of education, unemployment, low income, poor housing conditions, poor health and low cultural level, in short: *inequality*. All of these shortages are enclosed in a circle of dependency upon the basic sources and living conditions, such as a stable eco-system, food, education, income, and first of all peace and social justice and equity. The poor are excluded from a special life and prevented from making full use of their cultural and social possibilities. The poor are thereby exposed to violations of their basic human rights, while their human dignity is undermined. Efforts to reduce poverty and promote human development, including to create chance-equity, are therefore efforts to safeguard human, economic, social, and cultural right (Hanžek and Gregorčič 2001, *cit.* Artnik 2002, Eiben 1998).

It is worth mentioning some outstanding scientists who have called attention to SES connected with growth surveys. It was Villermé (1828) who very early

on described the effects of social factors on the rate of growth of children, and on final adult stature. Chadwick (1833) wanted to promote social reforms with the use of growth data. Galton (1873/74) found that boys and girls (aged 8–12 years) working in factories were shorter (3 cm) than their counterparts who did not work in factories, although originating from worker families. Similarly, based on the data of Charles Roberts, Bowditch (1877) found that across all ages, the sons of the labouring class were shorter than those of the non-labouring class. Pagliani (1879) published similar data: boys and girls of the well-to-do classes ('classe agiata') were on the average taller and heavier than those of the poverty-stricken ('poveri'). In general, children living under better socio-economic conditions have consistently exceeded in growth and maturation their counterparts living under worse condition (the phenomenon of '*hysteroplasia*', Rietz (1906). Ten years later, in 1916 Pfaundler (1872–1947) described the phenomenon of '*proteroplasia*', i.e. the observation that urban children were taller, grew faster and matured earlier than their rural peers (Eiben 1998).

Tanner (1981) cited the Russian Grüsdeff's (1894) report on the menarche about 1875: rural women, i.e. peasants 15.7 years, townsfolk 14.8 years, and the well-to-do 14.4 years. Boismont (1841) mentioned the menarcheal age for the poor, hospital-attending women in Paris, 14.8 years, and for the well-off private client women, 13.7 years. Differences in age at menarche according to social strata existed one and a half centuries ago.

Manniche (1983) reanalysed Ravn's (1850) data based on a small Danish sample plus Copenhagen gynaecological protocols. He reported results of 3385 Danish women from the 1840s, with age at menarche 16 years and 3 months. Ravn found differences between social status: In upper class urban women the age at menarche was 14 years and 3 months, in middle class ones 15 years and 5 months, and in lower class ones 16 years and 5 months. In rural women, and daughters of non-farmers it was 14 years (and 0 months), in farmers' daughters 16 years and 3 months, and in small holders' daughters 16 years and 8 months. Ravn (1850) explained these urban-rural differences with "the more refined style of life that you find among the educated classes, the more stimulating nutrition, and so on…" Manniche (1983) concludes that the lowering of the age at menarche appeared in Denmark over the last one and a half centuries on average a little over 2 months per decade.

Nowadays, instead of "social differences", it is more usual to mention *social gradients*. Height for age tends to increase with increasing parental cultural level or with income of the family. Added to this is the effect of intergenerational changes in growth and maturation i.e. the secular trend (Bielicki et al. 1986).

Differences existing in girls' puberty were observed, as has been shown, as early as the mid-19th century. The modern questions are: How do the effects of

a specific social factors change in time? Did the body measurements and time of maturity change over the decades in a certain population? If yes, in which direction they did? Under what kinds of effects and for which factors did they change? Are differences in parental cultural level (e.g. educational level) losing or gaining in importance as a "stratifying agent" in a society?

Environmental (and genetic) factors influencing the age at menarche were studied in Western Hungary in the late 1960s (N=15,229, age 11.5–16.0 years, status quo/probit analysis; Eiben 1972). Very marked differences in the age at menarche were found in relation to birth order (first born girls have their menarche at 12.9 years, 8th and later born girls at 13.4–13.5 years), family size (girls living in a two or three member family, the menarche was m=12.9 years, in the case of 11-or more family members, the menarche was m=13.6 years), and the number of people sharing the bedroom (girls sharing a bedroom with one other family member the age at menarche was m=12.9 year, for those sharing with four other family members m=13.4 years). The age at menarche also varied according to the profession of the fathers and mothers. Girls of intellectual fathers and/or mothers have the menarche between 12.7–12.8 years, while those of manual workers, 13.2 and 13.3 years. There was a trend for a later age at menarche from girls of intellectual parents through clerks, other employees, light manual workers, and heavy manual workers to peasant parents (Eiben 1972).

Bielicki et al. (1986) reported social-strata gradients in the menarcheal age in Upper-Silesia (Poland), from the towns Katowice, Bytom and Sosnewiec, based on a large sample (N=19,000), studied in 1981 in relation to parental education and father's occupation. The age at menarche tended to increase with decreasing parental education, although the gradient was not steep. Mean age at menarche varied between 12.8 and 13.3 years. Mean menarcheal age for an occupational group was strongly dependent upon the group's socio-economic status, the later being defined by parental education, family income, family size and dwelling condition. – A similar study was repeated in the same region, ten years later (in 1991) by Hulanicka et al. (1993). It is remarkable that – contrary to other expectations – there was no change in the mean age at menarche in Katowice between the decades investigated. Both studies cited here reported a mean age at menarche of 13.1 years. Hulanicka realised that the maturation of children was heavily influenced by very significant inequalities in social and economic conditions in that region. She pointed out that, since the Polish population was ethnically homogeneous and their sample size was very large, the influence of social differences on maturation was very obvious. As a comparison, mean age at menarche in Hungarian girls in the 1980s (based on the Hungarian National Growth Study, Eiben 1988) was 12.79 years. Hulanicka (1990) have published other growth data on 6-18 year-old Polish boys and girls, based on their study carried out in 1987–88. The earliest matured were girls from the

big cities (m=12.96 years), followed by those from towns (m=13.4 years) and villages (m=13.53 years). Rural girls from a certain region reported the menarche occurring on average 1.02 years later than the Warsaw girls (Eiben 1998).

Mode of life used to be also studied in growth and maturation surveys. Tanner (1981) cited Roberton (1851), who said that the slave traders used the supposed earliness of maturing of Africans as an argument to support their activities.

Let's look at some *Hungarian data*!

Planned in the early 1980s, the *First Hungarian National Growth and Physical Fitness Study (HNGS)* was designed to meet two important needs: (1) To provide normative standards to assess and monitor individual growth, biological maturation, and physical fitness, and (2) to establish a baseline for successive sampling so as to study changes in the Hungarian population (see Eiben et al. 1991). The sample was based on the 1980 national census (Népszámlálás, 1980), and it was regionally stratified (i.e. the industrial and/or agricultural character of the counties was taken into consideration).

Age was calculated according to the formula: completed year ±6 months, expressed as a decimal (e.g. 10 year old a child between 9.51 and 10.50 years of age). Only healthy children were involved in the final sample. The sampling investigated (i.e. elaborated) 39,035 boys and girls, with a cohort size ranging from 830 to 1730 over the age range from 3–18 years.

Program of investigation: The methods used were (1) *human biological*: The anthropometric program was detailed, contained 18 body measurements, and produced information about (a) children's growth status and age differences, (b) proportional changes, (c) changes in body composition, (d) changes in physique (somatotype components), and (e) maturation status, age at both oigarche and menarche, and in part, skeletal age. The instruments used for these investigations were internationally standardized tools (2) *physical educational* methods, investigated physical fitness of the boys and girls. (3) *sociological data collection*, obtained data on the socio-economic back-ground of the children's family: birth order, number of siblings and other members in the household, age, educational level and profession of the parents (both father and mother), type of the schools the children had attended, and some estimate of the opportunities and availability of facilities for physical activity.

Based on the HNGS, the first (!) *Hungarian national growth standards*, reference values were elaborated: all the body measurements and physical fitness data have been published in tables and percentile curves (Eiben and Pantó 1986, Eiben et al. 1991). Interrelationships between body measurements, biological maturation and social-economic status of children were analysed according to the occupation and educational level of the parents, both fathers and mothers, as well as other data of the family background, and the size of the population in the settlement.

It is worth citing here some important findings of the HNGS. The *profession of the parents* characteristically influences the growth and maturation of the children. The trend of height goes from agricultural manual workers through industrial and other manual workers to non-manual workers. The profession of parents as an organising principle, however, at least in Hungary, is less suitable to describe the family's standard of living, or to characterise the child-centeredness of the family home. The most important environmental factor seems to be the educational level. We are convinced that the *cultural level* is the most important social factor influencing growth and maturation of youth. Consequently, it seems important to point out the determinative role of mothers in creating a better cultural background in the family. The mothers call into life a family nest-effect (Eiben 1989).

Educational level of the parents. Sons of fathers with uncompleted basic education (i.e. general school, in this case less than 8 classes) are the shortest, sons of fathers with completed general school level were taller, sons of fathers with vocational training school level were taller again, sons of fathers with secondary school level were still taller, and sons of fathers with high school or university level were the tallest. According to educational level of the mothers, boys showed a similar picture, and indeed, in sons of mothers with low educational level, backwardness in growth and maturation were more evident. This phenomenon was further expressed in girls. Daughters of fathers and mothers with low educational level were the shortest, and daughters of fathers and mothers with university degree were the tallest, especially, after puberty. These differences between the two extreme social groups can be 6–7 cm, and it was significant in both sexes. The mothers' educational level seemed to be more of a determinative factor in this respect than the fathers' (Eiben 1989).

For Hungarian youth, the *educational level of the parents is a determinant. The higher the educational level of the parents, both fathers and mothers, the taller are their sons and daughters*. These differences in height can usually be already observed in early childhood, and during pre-puberty and puberty they usually become more marked.

Urban/rural comparison: It is clear that towns and villages offer different possibilities to people. There are advantages and disadvantages in both types of settlements (e.g. in nutrition, in stresses, in population density, etc.). Differences in growth and maturation for the benefit of the urban youth are well-known (see above *proteroplasia*, Pfaundler 1916). In cities and towns, the ratio of well-off families used to be higher than in villages. Urban boys and girls in Hungary also used to be taller and heavier, more robust and stronger than their rural counterparts, and it was true also for Hungarian youth. Pubertal growth spurt in urban boys and girls appeared about one-and-a half years earlier than in rural children. In width and girth measurements, urban boys and girls usually have higher mean sizes than the rural children. Based on the skinfold-data,

however, urban boys and rural girls usually have more subcutaneous fat. These differences are the most pronounced during and at the end of puberty (Eiben et al. 1996).

In *physical fitness tests*, boys usually performed better than girls. As far as muscular endurance was concerned, the performances of the boys and girls were nearly the same, especially in early childhood. Thereafter, the performance of boys increased gradually with age. In girls, however, it increased more slowly and at a decreasing tempo and became stable at a low level (Barabás 1989, Eiben et al. 1991) at age 13, a relatively early age, coinciding with the age at menarche (Eiben – Pantó 1985).

In the last decades there has been a certain difference in the mode of life in towns and villages in Hungary as elsewhere. In the 1950s, there was a political movement to eliminate the disadvantageous difference prevailing in rural areas. Forced urbanisation proved to be unfounded and the political ambition became entangled. Even today, there are differences in urban and rural modes of life which also affects childhood. Parents with a higher education level tend to live in towns. Although the majority of these people in Hungary live on a modest salary, they better exploit the possibilities given. This is true for nutrition, medical care and treatment, physical education and sports or even extra activities, e.g. music or languages, etc. offered to the children. The highly educated parents motivate their children to participate at these regular activities (Eiben et al. 1996). (One can add to these, that people belonging to the upper strata have always been taller than the average of the population, and have always shown greater readiness for modification of their life, e.g. migration, or for social mobility, cf. Boas's report on the offspring of the immigrants in America, Boas 1910).

The *onset of puberty* showed a similar tendency: the age at menarche (also at oigarche). The age at menarche in the whole HNGS sample (girls interrogated between ages 9 and 18.5 years, N=12.719) was m=12.79±0.15 years. [The age at oigarche in the whole sample (boys interrogated between 10 and 18.5 years of age) was m=14.37±0.09 years.] The age at menarche in the lower categories was later by 4-8 months (in boys by 5–7 months) than in upper categories (*Table 1*). Most factors causing differences in socio-economic groups more or less correlate to each other, e.g. the educational level and profession, since the earlier ones partly determines the latter ones. This is one reason why it is so difficult to separate the effect of certain ecological factors. Higher educational level usually combines with better nutrition and better care of infants and children. Additionally, these parents usually use social services better than others (Eiben 1989).

The better life-conditions in towns were positive, easily perceptible factors influencing the growth and maturation of children. They promptly worked an effect and the children's organism was highly susceptible to them. In the 1980s,

it was repeatedly proved in Hungary that the advantageous environmental factors promoted manifestation of the growth pattern while the disadvantageous ones stopped or retarded it (Eiben 1988). It is obvious that childhood (including pre-puberty and puberty) is the most sensitive life-period for environmental effects like socio-economic factors presented by the urban and/or rural mode of life. A remarkable experience is (documented e.g. in Eiben's "Körmend Growth Study", 1988, 2003) that many *human biological effects of irreproducible social events and/or changes can be observed exactly and have a very quick and sensitive response.*

Table 1
Onset of puberty in Hungarian boys and girls according to educational level of the parents
(N=39,035, status quo/probit analysis, medians in years, HNGS, Eiben 1987)

Educational level of the parents	Age at oigarche	Age at menarche
Fathers		
Uncompleted basic school	14.73	13.07
Completed general school	14.70	13.09
Vocational training school	14.66	12.99
Secondary school	14.58	12.61
High school/University	14.27	12.44
Mothers		
Uncompleted basic school	14.66	12.93
Completed general school	14.57	12.99
Vocational training school	14.52	12.83
Secondary school	14.60	12.86
High school/University	14.08	12.67
The whole Hungarian sample	*14.37*	*12.79*

Evolution of Human Populations

In the last three or four decades, major changes have occurred which have had an impact on growth and maturation. First of all, *demographic changes* have happened: (1) population growth, (2) fertility control, (3) increase in child survival due to changes in mortality, especially the decline in infectious diseases, (4) changes in age structure due to changes in fertility and mortality, (5) increased speed, distance and quantity of population movement, (6) increased rural to urban migration, (7) increased size of urban agglomerations, (8) increased size and heterogeneity of breeding populations. One can add to these a

tendency, at least in Hungary: rate of unskilled manual workers changing to skilled manual workers, and rate of manual workers in general changing to non-manual workers. – These changes happened parallel with *economic changes*, as (1) increased total wealth, (2) increased poor–rich gap, (3) decreased self-sufficiency of rural populations (i.e. increased dependency on market). – The third group of changes were *environmental ones*: (1) loss of natural habitat and species diversity, (2) increased use of prevalence of toxic substances like motor vehicle emissions, smog, lead, and pesticides, (3) antibiotics (both human and veterinarian), (4) industrial pollutions of all kinds, (5) genetically altered species. It does not need too much explanation to show that all these changes influence the growth and maturation process of children and youth.

The last question is, how would it be possible to create equal chances in growth and maturation for all groups of youth (rural and urban, well-off and poor, etc.). It is rather an economic and social-political question than a human biological problem. The auxologists have had an ambition to call the politicians' attention to this problem, to elaborate a better and more equitable distribution, a better and well-considered health and welfare politics as well as equitable youth-politics for a long time (Eiben et al. 1996). Gabriella Mistral wrote in 1948: *We are guilty of many errors and many faults, but our worst crime is abandoning the children, neglecting the foundation of life. Many of the things we need, can wait. The child cannot. Right now is the time their bones are being formed, their blood is being made and their senses are being developed. To them we cannot answer 'tomorrow'. Their name is 'Today'*. Do we dare to think about this? What happened over half-a-century? In this sense we still have a lot to do, quickly and definitely, sparing no time or money. It would be something that we can manage if we could realise the principle that *a healthy child is a happy child*. The responsibility of the adults as well as of the authorities, including governments, is tremendous. We must remember that *children grow up only once* (Eiben 1998).

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A MENARCHE ÉLETKORA ÉS A CSALÁD TÁRSADALMI HELYZETE

Összefoglalás

A szerzők felvázolják a leányok biológiai érésének folyamatát, amelynek a menarche megfelelő indikátora. Sorra veszik a pubertás kezdetének humánbiológiai feltételeit: a biológiai/fiziológiaiakat (pl.: a növekvő női szervezet fejlődési állapotát, a kritikus testtömeget stb.) és/vagy a környezetieket, ökológiaiakat és gazdaságiakat (pl.: a klímát, a táplálkozást, a család társadalmi helyzetét, a városi és vidéki életmódot stb.).

Rövid áttekintést adnak a menarche életkorának évszázados változásairól, amely a szekuláris trend részjelenségének tekinthető.

Érintenek néhány olyan kérdést, amelyet általában a menarche életkorát befolyásoló faktornak tartanak. (1) *Klíma:* ma úgy gondoljuk, hogy a klíma hatásának kisebb szerepe van, mivel azt a gazdasági-társadalmi helyzet több jelentős hatása fölülmúlja. (2) *Táplálkozás:* a humánökológia állítása szerint a gyermekek növekedését befolyásoló tényezők közül az egyik, ha nem a legfontosabb a táplálkozás. (3) *Szekuláris trend:* az ugyanazon a területen élő népesség egymást követő nemzedékeiben a nagyon különböző antropológiai vonásokban megfigyelhető hosszú távú, szisztematikus változások világjelensége (Eiben, 1988). A világ különböző részeiből származó adatok a menarche egyre koraibb kezdetét mutatják. Ma a menarche életkora körülbelül 12,6–12,8 év. (4) *Felépítésbeli összefüggések:* Van bizonyos kapcsolat a testfelépítés és a biológiai érés között, és a „kritikus testtömeg" szintén befolyásolja a pubertás kezdetét. (5) *Öröklés:* a genetikai típus, a környezeti körülmények, a kettő összefüggése és interakciója befolyásolják a biológiai érést. A menarche életkorának örökölhetősége 88,2%>H>72,2%. (6) *Rasszok, etnikai csoportok:* Az általános migráció a 20. század utolsó harmadában világszerte olyan intenzív volt, hogy a menarche életkorának etnikai csoportok szerinti különbségeit tekintve ez a fajta kérdésfeltevés elvesztette jelentőségét. (7) *Társadalmi-gazdasági helyzet:* A társadalmi egyenlőtlenségeknek a gyermekek növekedésére és érésére gyakorolt hatását körülbelül 180 évvel ezelőtt vizsgálták tudományosan. Számos szerző fedte fel a társadalmi tényezők növekedésre és érésre gyakorolt hatását. Tudományosan bizonyított tény, hogy a jobb környezeti állapot, a jobb családi háttér (anyagi és kulturális értelemben egyaránt) segíti a növekedés látható megnyilvánulását. A szerzők kimutatnak társadalmi osztályok szerinti különbségeket a leányok pubertásának kezdetében: az alsóbb társadalmi rétegekből származó leányok később érnek, mint a felsőbb társadalmi csoportokból szár-

mazók. A szegény lányok kedvezőtlen családi háttere késlelteti érésüket, t. i. menarchéjük későbbi életkorban jelentkezik, amint a világ különböző részein gyűjtött nagymennyiségű adat ezt alátámasztja. A növekedési/érési tanulmányok fontos tanulsága, hogy a testméretek és az érési jellemzők, t. i. a menarche életkora nagyon objektív mérőszámok, amelyek a megismételhetetlen társadalmi eseményekre és/vagy változásokra pontos és nagyon gyors és érzékeny választ adnak.

Tábla:

1. *Magyar fiúk és lányok pubertásának kezdete szüleik iskolázottsági szintje szerint*
   (N=39 035, status quo/probit analízis, medián értékek években, Magyar Nemzeti Növekedésvizsgálat, Eiben, 1987)
   Táblafej: Szülők iskolázottsági szintje; Oigarche életkora; Menarche életkora
   Oldalszöveg: Apák: Befejezetlen elemi iskola, Befejezett általános iskola, Szakiskola, Középiskola, Főiskola/egyetem
   Anyák: Befejezetlen elemi iskola, Befejezett általános iskola, Szakiskola, Középiskola, Főiskola/egyetem
   Az egész magyarországi minta

Ábra:

I. A menarche életkorának változásai Körmenden a 20. század második felében
(medián értékek években)
x tengely: a vizsgálatok időpontja
y tengely: a menarche életkora években