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FOCUS ON PHYSICAL AND SEXUAL MATURATION: THE CASE OF BELGIUM

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Introduction

One of the earliest observations illustrating a secular trend was that pertaining to the increase in stature. However, since the 19th century, other modifications have been observed in almost all industrialized countries, such as an increase in weight and earlier physical and sexual maturation (VAN WIERINGEN, 1978; WOLANSKI, 1978; EVELETH and TANNER, 1990). The published data are very consistent: menarche is now taking place between 2 and 3.5 years earlier than a century ago. Thus, secular changes in body dimensions have occurred simultaneously with secular changes in tempo of growth, as shown during the last 100 years by ever earlier ages at menarche and at peak height velocity (about 3-4 months earlier per decade in most European countries; EVELETH and TANNER, 1990).

The trends observed for height and weight, especially at the time of puberty, agree with this observation of earlier maturation (TANNER, 1968). The higher tempo of growth has resulted in adult height being reached at an earlier age.

As individual growth is a barometer of a child's health, it is important to consider secular changes in growth and tempo of growth as indicators of a population's changing nutritional, hygienic and health status (SUSANNE, 1985; VAN WIERINGEN, 1986; TANNER, 1992); for example, in industrialized countries, the trend may slow down or be reversed during periods of hunger and war (BRUNDTLAND et al, 1980; LIESTOL and ROSENBERG, 1995), and in some developing countries no or only a very slight secular trend has been observed.

Many factors (familial, genetic or socio-economic) may influence growth and menarche (MARESH, 1972; EVELETH and TANNER, 1990). Improvements in environment and nutrition probably exert simultaneous influences (BAKWIN, 1964a; SHORTER, 1981).

Like most other European countries, Belgium has been characterized both by a movement towards earlier maturation and menarche, and by an increase in height at each age (DEFRISE, 1967; JEURISSEN, 1969; VERCAUTEREN, 1984; VERCAUTEREN and SUSANNE, 1986).

Material and methods

In 1980-82, 4177 Belgian subjects (2093 males and 2084 females) aged 3-26 years were measured once during medical examinations by the Brussels Central Health Service. These children, attending various educational establishments in Brussels, had very varied socio-economic backgrounds, representative of the diversity of social origins of the Belgian population living in Brussels (city and suburbs) (VERCAUTEREN, 1984).

From this sample, 1048 girls aged 9-17 years (with their birth years falling between 1963 and 1971) were asked about their menarcheal status. Data were collected with the status quo method, which is more accurate than the recall method (BRUNDTLAND and WALLOE, 1973). The girls were grouped in age classes of 6 months. Probits were used and the median age and standard error of the median were estimated.

To allow comparison of our results with those of JEURISSEN (1969), a method of centiles was also used.

Results

A. Secular trend in tempo of statural growth

During puberty, an acceleration of growth in terms of stature (or weight) has been observed universally (LJUNG et al., 1974; EVELETH and TANNER, 1990); it is detected through the well-known peak height (or weight) velocity.

A secular trend in the tempo of growth is observed through the advance of the adolescent spurt and explains why, temporarily during adolescence, the secular trend in size is greater than during childhood and adulthood. For instance, the average secular increase in height in Europe and North America between 1880 and 1980 was about 1.5 cm/decade during childhood, 2.5 cm/decade during adolescence and about 1 cm/decade in adulthood (EVELETH and TANNER, 1990).

Studies on secular trends in age at peak height velocity of a population are scarce, due to difficulties in estimating this biological parameter: age at peak height velocity determinations, derived from the increments in the cross-sectional mean heights, are in general inefficient. Indeed, if the cross-sectional data are grouped into the usual 1-year age classes, the maximum increment can be estimated only to the nearest year (HAUSPIE et al., 1996). Nevertheless, this procedure may sometimes underline a trend. In her comparison of the Belgian data from 1948 and 1960, DEFRISE (1967) found an earlier maximum growth rate (or peak) in the 1960 sample for girls and boys. However, when an identical methodology (graph of annual increases in stature) is used, no differences in the ages at this peak seems to exist between the 1960 and 1980 children.

Calculation of the fit of a growth model to the means has been used to obtain a better estimate of age at the maximum increment of height (TANNER et al., 1982; VERCAUTEREN, 1984, 1993).

Figure 1 shows the secular trend in age and peak height velocity in Belgian girls, the PREECE-BAINES model (1978) being applied to data from 1830 (QUETELET, 1831), 1930 (GALET, 1931), 1960 (TWIESSELMANN, 1969) and 1980-82 (VERCAUTEREN, 1984). After a very slow advance during last century - in fact, surveys on the stature of conscripts revealed that the process of secular trend began around 1920 in Belgium (CHAMLA, 1964) - the adolescent spurt advanced very quickly between 1930 and 1960. Subsequently, there has been a further slight trend towards earlier maturation in height, but of only 0.1 year between 1960 and 1980. This suggests a decrease in rate in the secular trend relating to the age of puberty.

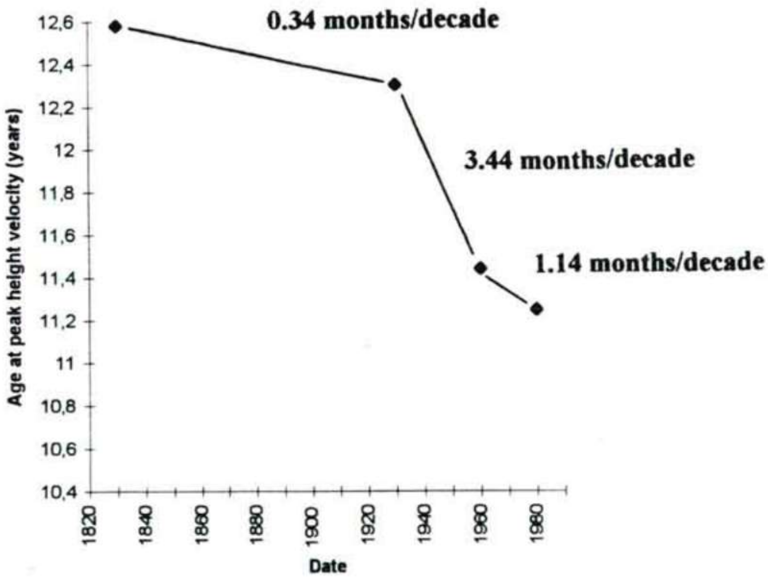

Fig. 1. Secular trend in age and peak height velocity in Belgian girls. Age and peak height velocity is estimated by applying the PREECE-BAINES model to data from 1830 (QUETELET, 1831), 1930 (GALET, 1931), 1960 (TWIESSELMANN, 1969) and 1980-82 (VERCAUTEREN, 1984).

B. Secular trend in menarcheal age

Secular changes in tempo of growth are best documented by data concerning the age at menarche.

The median age at menarche and its standard error, calculated by probit analysis on the Belgian 1980-82 survey is 13.06 ± 0.06 years, with a standard deviation of 1.47 year.

We may compare our results with the data from 1915 to 1959 collected by JEURISSEN (1969) in different welfare centres in Brabant (Belgium). Figure 2 represents the age at which 10%, 50% and 90% of the girls reached menarche; it clearly shows the tendency towards earlier sexual maturation (C50) between the 1920 and 1960s. During this period, the mean age at menarche in Belgian girls advanced by 4.5 months/decade. The obvious shift of age at peak height velocity observed during the same period should be borne in mind.

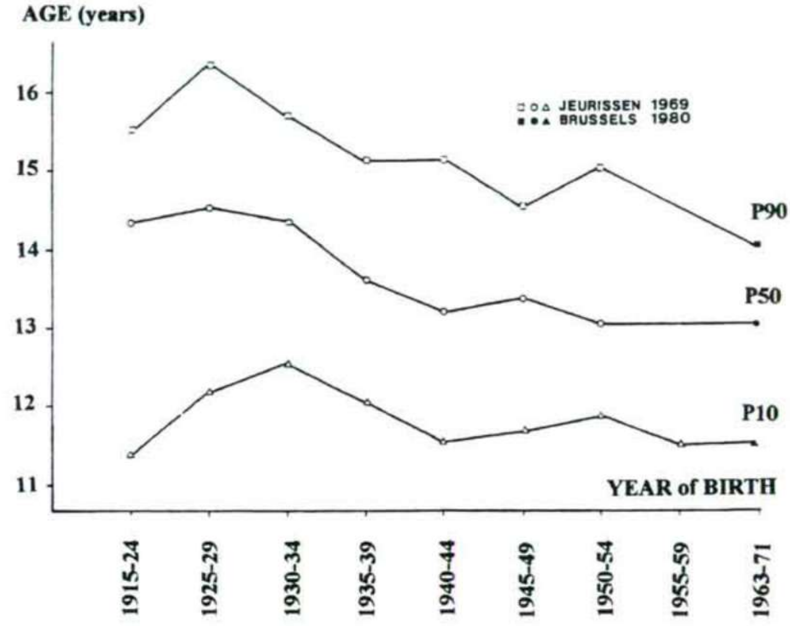

Fig. 2. Secular trend, according to year of birth, in menarcheal age and its distribution (C10, C50, C90) in Belgium.

If the 10th centile for age at menarche has remained almost unchanged at around 11.8 years, the 90th centile has decreased by about 4.8 months/decade.

The centile method applied to the recent sample gives a median age of 13.0 years, which is unchanged in comparison with the girls born between 1950 and 1954. Hence, for the first time in Belgium, it seems that the median age has stabilized. However, C90 is attained at a lower age: 14.0 instead of 15 years. Hence, the secular trend in age at menarche in the most recent period was merely a result of a decreased number of girls who mature late. This continues to cause a considerable reduction in the variability of the process of reaching menarche, as seen in Fig. 3, where we have applied probit curves to our sample and to two of those of JEURISSEN: the "sitting upright" is very clear through the surveys. These results suggest that medical progress and better socio-economic conditions during recent decades have eliminated most of the factors causing late menarche (VERCAUTEREN and SUSANNE, 1985).

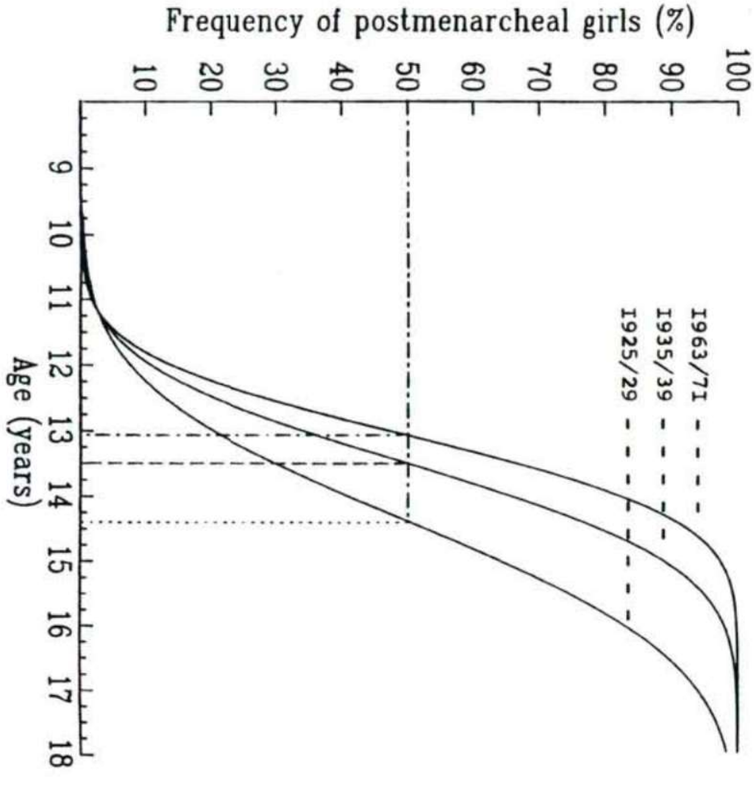

Fig. 3. Secular trend in menarcheal age in Belgium. Probit curves are calculated from surveys of JEURISSEN (1969) and VERCAUTEREN (1986).

C. Menarcheal age and some socio-familial factors

To explain the variation in the age at menarche, the socio-economic level is often taken into account, girls of lower social origin on the average exhibiting a delay in first menstruation as compared with girls from well-off families (BIELICKI et al., 1982; EVELETH et al., 1990). Therefore, we studied this social influence in our sample, where we discriminated two sub-groups on the basis of the level of education of the parents:

- high level: university or high school studies;
- low level: primary or low secondary schools (this means schooling up to 12 to 15 years of age).

The mean ages and the results of the t-tests in Table 1 indicate no significant differences due to social background in our sample from Brussels, at least for the data relating to the age at menarche.

The size of the family is also considered to have an impact on the menarcheal status: young girls from small families reach menarche more precociously (MARESH, 1972). Again we distinguished two groups:

- Small families: families with only one daughter or with 2 children at most;
- Large families: 3 children or more.

Table 2 clearly shows that for daughters in large families there is a small (but significant) delay of maturation (Fig. 4).

Table 1. Comparison of menarcheal age (mean and standard error) and social status (educational level) of the parents; data on girls from Brussels.

	years	N	t-test	significance
Educational level of father				
low level	13.04 ± 0.13	344		
high level	13.11 ± 0.11	285	0.58	N.S.
Educational level of mother				
low level	13.03 ± 0.11	399		
high level	13.19 ± 0.14	213	1.33	N.S.

Table 2. Comparison of menarcheal age (mean and standard error) and family size; data on girls from Brussels.

	years	N	t-test	significance
Family size				
Small families	13.00 ± 0.08	711		
Large families	13.26 ± 0.11	382	32.5	$p < 0.001$

We also examined the level of education of the girls from the Brussels schools, distinguishing two groups:

- girls with normal school progress (or one year in advance of their age);
- girls displaying a delay of at least one year in their schooling.

A slight (but significant) delay of first menstruation is observed among backward pupils (Table 3 and Fig. 5).

Table 3. Comparison of menarcheal age (mean and standard error) and schooling level of girls.

	years	N	t-test	significance
Schooling level of child				
Normal	12.98 ± 0.08	791		
Delayed	13.42 ± 0.13	293	4.89	$p < 0.001$

Discussion

The two factors most often cited to explain the secular trend are the better living standards (hygiene, medical care, etc.) and better nutrition. It would be difficult to dissociate these two factors, however, as changes in one usually have repercussions on the other. Therefore, environmental changes and nutrition very probably act simultaneously (TANNER, 1968).

In the same way, an abnormal situation has been observed in the case of Belgian girls born between 1930 and 1934, who were influenced by the poor environmental (and alimentary) conditions of the Second World War: amongst these girls, there were few cases of early menarche and many late menarches (JEURISSEN, 1969, and Fig. 2). At the same time, during (or just after) the war, a diminution in stature was noted in some populations, including that in Belgium (ELLIS, 1945; CHAMLA, 1964). Similar observations led some authors to hypotheze that a positive secular trend would result from the disappearance of factors delaying growth and development (VAN WIERINGEN, 1978).

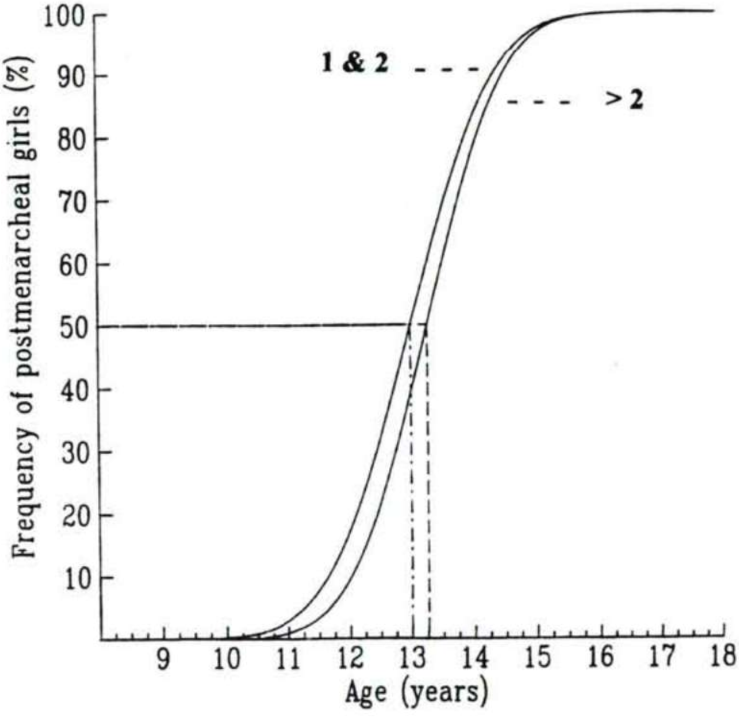

Fig. 4. Menarcheal age according to the size of the family. Probit curves. Brussels, 1980-1982.

More recent publications concerning the age at menarche in the Belgian population are not frequent. A large sample has recently been studied in Belgium (BECKERS and PLEYSIER, 1982): the status quo method gives 12 years 10 months as the median for the girls from the French-speaking part of the country; however this population includes 17% of foreign children and a direct comparison with our sample is therefore difficult. The median age for the Flemish-speaking part of the country (which includes only 2% of foreign children) is 13 years 1 month.

Our results seem to indicate that, as far as Belgium is concerned, the secular trend of the age at menarche has come to a halt at 13.0 years. This is perhaps the first time that the end of this secular trend has been observed in Belgium, but it is not the first time in Europe (HAUSPIE et al., 1996). If the trend is still continuing in The

Netherlands, Sweden, Spain, Germany (Bremerhaven) and Eastern Europe (The Czech Republic and Hungary (Szeged), FARKAS, 1983), a very small decrease in the age at menarche has also been observed in London (TANNER, 1973). The end of the secular trend at around 13.2 years has been observed in Norway (BRUNDTLAND and WALLOE, 1973; LIESTOL and ROSENBERG, 1995). In Massachusetts (DAMON, 1974), a stabilization of the age at menarche at 13.1 years has likewise been observed. The similarity between the ages in Belgium, Norway and Massachusetts should be noted.

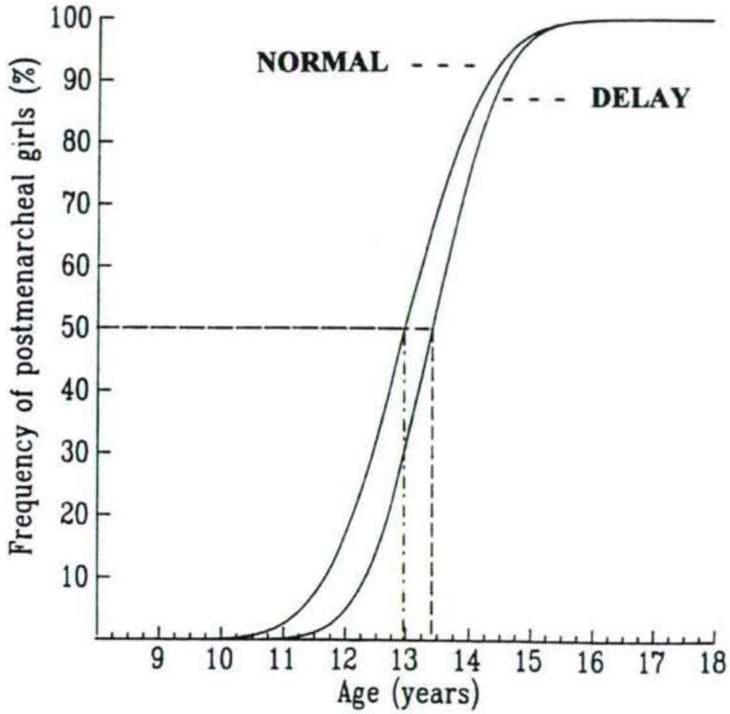

Fig. 5. Menarcheal age according to the schooling level of girls. Probit curves. Brussels, 1980-1982.

Thus, it appears that, although the age at menarche was still advancing in many countries in the 1970s and 1980s, it has stopped or even reversed in others (Sweden (Stockholm), Hungary (Körmend), Croatia (Zagreb) (HAUSPIE et al., 1996).

It may be interesting to make a parallel with statural changes during the recent period for Belgium. Between 1960 and 1980-82, if there was still a significant increase in stature at almost all ages for boys and girls, secular changes during adolescence were of almost the same magnitude as those during childhood or adulthood. This strongly suggests that the secular increase in height that occurred between 1960 and 1980-82 was due solely to an upward shift in stature at all ages and not to a secular change in tempo of growth (HAUSPIE et al., 1996). Of course, this is supported by the facts that the age at peak height velocity has undergone almost no change, and that the age at menarche in Belgian girls has stabilized at the age of 13 years during this period.

With the disappearance of the C50 secular trend, it was possible to postulate the disappearance of socio-economic differences in Belgium as far as menarche is concerned, as has already been observed in Sweden (LINDGREN, 1976). This seems to be the case, as shown here.

However, a relationship between the age at menarche and the dimensions of the family and/or level of education still exists. Here too, we can compare it with similar trends in stature: many studies have indeed shown the influence of the familial dimensions on stature, children of small families being on the average taller (RONA, 1981; EVELETH and TANNER, 1990).

We observed this too in our Brussels population (SUSANNE and VERCAUTEREN, 1996, for the dimensions of the family; and FREESE et al., 1986, for the educational level).

If no secular trend has been observed in the median age at menarche, we have seen that the variability in the process of maturation is still regularly diminishing in the Belgian population: the 90th centile for the age at menarche has decreased by about 2 years during recent decades, while the 10th centile has remained virtually unchanged over the same period.

Again a comparison with stature is of interest. The mean stature continues to increase in most of the industrialized countries, but the difference between the socio-economic groups is decreasing (LINDGREN, 1983). A cessation of the secular trend of stature has been observed only for children in higher social groups (BAKWIN, 1964b; DAMON, 1968; KIMURA, 1977).

A similar trend has been detected in Belgium: from a comparison of the mean heights of Belgian university students and conscripts, SUSANNE and HEYNE (1972) suggested a kind of catch-up phenomenon. Later, other results clearly showed that the different social classes did not follow the same secular trend: girls from the more favoured group revealed no secular trend during 20 years, while in the less favoured group a significant positive rate of 1.8 cm/decade was noted. This results in a clear decrease in the deviations, and hence in the variability (SUSANNE and VERCAUTEREN, 1996). The relationship between stature and number of children per family revealed the same reduction in growth difference between the samples of 1960 and 1980-82.

In conclusion, if observations in some countries do seem to reveal a clear decrease or even an end of the global positive secular trend, there is still a trend towards a reduction in the variability of growth and maturation measurements in these populations.

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