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Changes in the somatic and fitness variables in girls over two decades

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Summary

Study aim: To assess the generation changes in somatic and motor variables in menstruating and non-menstruating girls from Eastern Poland.
Material and methods: Two cohorts of girls aged 10 – 15 years from Eastern regions of Poland were studied in 1986 (n = 2554) and in 2006 (n = 5563). The age at menarche was determined in girls by probit method employing the *status quo* technique. The girls were subjected to the International Physical Fitness Test battery and the results were classified into two categories: those of girls who already menstruated (M) or who have not yet (N).
Results: Mean menarcheal age significantly ($p<0.001$) decreased in 2006 compared with 1986 (12.77 and 13.41, respectively). This was accompanied by marked, significant increases in body height, significant changes in body mass and significant increases in the slimness. Physical fitness generally decreased, especially in girls aged over 12 years, but in the handgrip and in sit-ups significant improvements were noted in both groups of girls.
Conclusions: The results seem to support the view that the secular advancement of somatic traits was associated with decreasing physical fitness.

Key words: Girls – Physical fitness – Generation changes – Biological maturity

Introduction

Youths of the same calendar age are known to differ in the maturation rate, those advanced in adolescence exhibiting higher values of somatic and motor variables than their slower maturing mates, e.g. as expressed by the age at menarche [8,13,16]. Progressing values of somatic traits (so-called secular trend), reported for many countries [1,6,9,15,19], are accompanied by decreasing age at menarche as reported for Brazil [10], Poland [14], Portugal [18], USA [21], Israel [4], Korea [17] and many other ones. Only in few countries, mainly the Scandinavian ones, no such secular changes were reported [2,3,12,24]. On the other hand, for most motor variables no progress or even decreases were observed [19,20].

It would seem logical to monitor the secular changes in somatic and motor traits n relation to the biological maturation rate; however, such reports are scarce. The aim of this study was thus to evaluate such changes over two decades (generation changes) in menstruating and non-menstruating girls.

Material and Methods

Subjects: In 1986, a cohort of 2554 girls from schools randomly selected in the Eastern regions of Poland were studied. In 2006, another cohort of 5563 girls from the same schools were studied. The girls aged 10 – 15 years on both occasions. The study was approved by the local Committee of Ethics.

Methodology: Body height was measured with a stadiometer (accuracy 0.1 cm), body mass with medical scales (accuracy 0.1 kg). From these, ponderal index was computed. The age at menarche was determined in girls by the probit method by employing the *status quo* technique [7]. The International Physical Fitness Test battery [11] was applied which included the following tests: 50-m dash, shuttle run 4×10 m (SHR), long run (LOR) at a distance of 600 m (up to 12 years of age) or 800 m (over 12 years of age), standing broad jump (SBJ), bent-arm hang (BAH), sit-ups (SUP), handgrip (HGR) and stand-and-reach test (SAR) measuring trunk flexibility. The results were classified into two categories: those of girls who already menstruated (M) or who have not yet (N).

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Data analysis: The data of 2006 were standardised against the respective means and standard deviations of 1996 for yearly age categories, separately for menstruating and non-menstruating girls. The categories 10 and 16 years were omitted from graphical presentations due to small numbers of menstruating or non-menstruating girls, respectively. The differences between means for menstruating and non-menstruating girls or between the years 2006 and 1986, in given age categories, were assessed by Student's *t*-test for independent data. The chi-square function in the logarithmic form [22] was used to assess the differences between those two years in the frequencies of menstruating girls in given age categories. The level of $p \leq 0.05$ was considered significant.

Results

The numbers of menstruating and non-menstruating girls studied in years 1986 and 2006, classified by age, are presented in Table 1 and the corresponding percentages of menstruating girls in Fig. 1. In 2006, the percentages of menstruating girls were significantly ($p<0.05$ – 0.001) higher than in 1986 in age categories 10 – 14 years. Those higher percentages resulted in a significantly ($p<0.001$) lower age at menarche – 12.86 years (2006) vs. 13.44 years (1986). On the other hand, those percentages were significantly lower in girls aged 15 and 16 years ($p<0.001$ and 0.05, respectively).

As shown in Fig. 2, both menstruating (M) and non-menstruating (N) girls from 2006 significantly gained in body height compared with those 20 years earlier. The N girls significantly gained up to about 0.5 SD in body mass while M girls were significantly lighter, especially at the menarcheal age. These changes resulted in significant increases in the ponderal index in both groups of girls.

Regarding physical fitness variables (Fig. 3), a general trend towards worsening was noted, especially in speed (50-m dash and SHR), explosive strength (SBJ) and sustained strength (BAH). A marked worsening was noted in trunk flexibility (SAR). On the other hand, older girls showed significant improvement in long runs (LOR), handgrip (HGR) and sit-ups (SUP).

Table 1. Numbers of menstruating and non-menstruating girls in years 1986 and 2006

Non-menstruating		Age	Menstruating	
1986	2006		1986	2006
313	605	**10**	3	18
317	678	**11**	12	54
285	454	**12**	39	189
212	257	**13**	125	410
75	185	**14**	181	741
12	71	**15**	595	761
2	27	**16**	383	1113

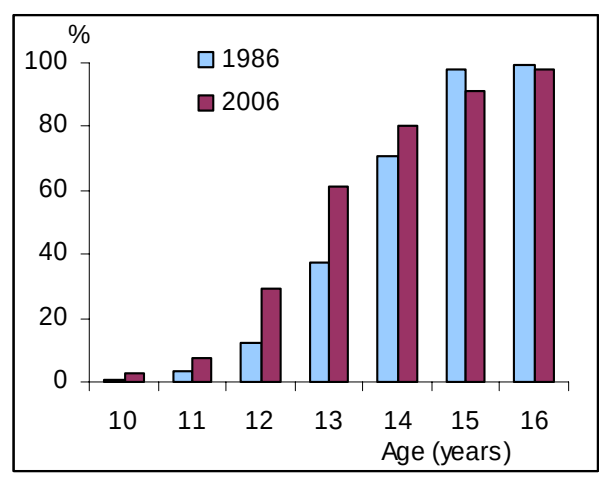


Fig. 1. Percentages of menstruating girls in various age categories studied in 1986 (n=2554) and in 2006 (n=5563)
The differences within every age category are significant ($p<0.05$ – 0.001)

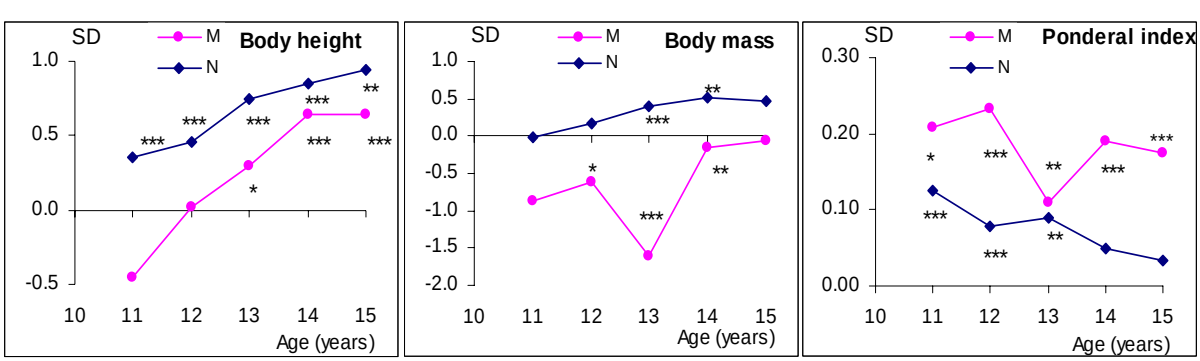


Fig. 2. Two-decade distances in somatic traits in menstruating (M) and non-menstruating (N) girls: Year 2006 (n = 2554) vs. 1986 (n = 5563; horizontal axis)
Significant differences vs. girls studied in 1986: * $p<0.05$; ** $p<0.01$; *** $p<0.001$

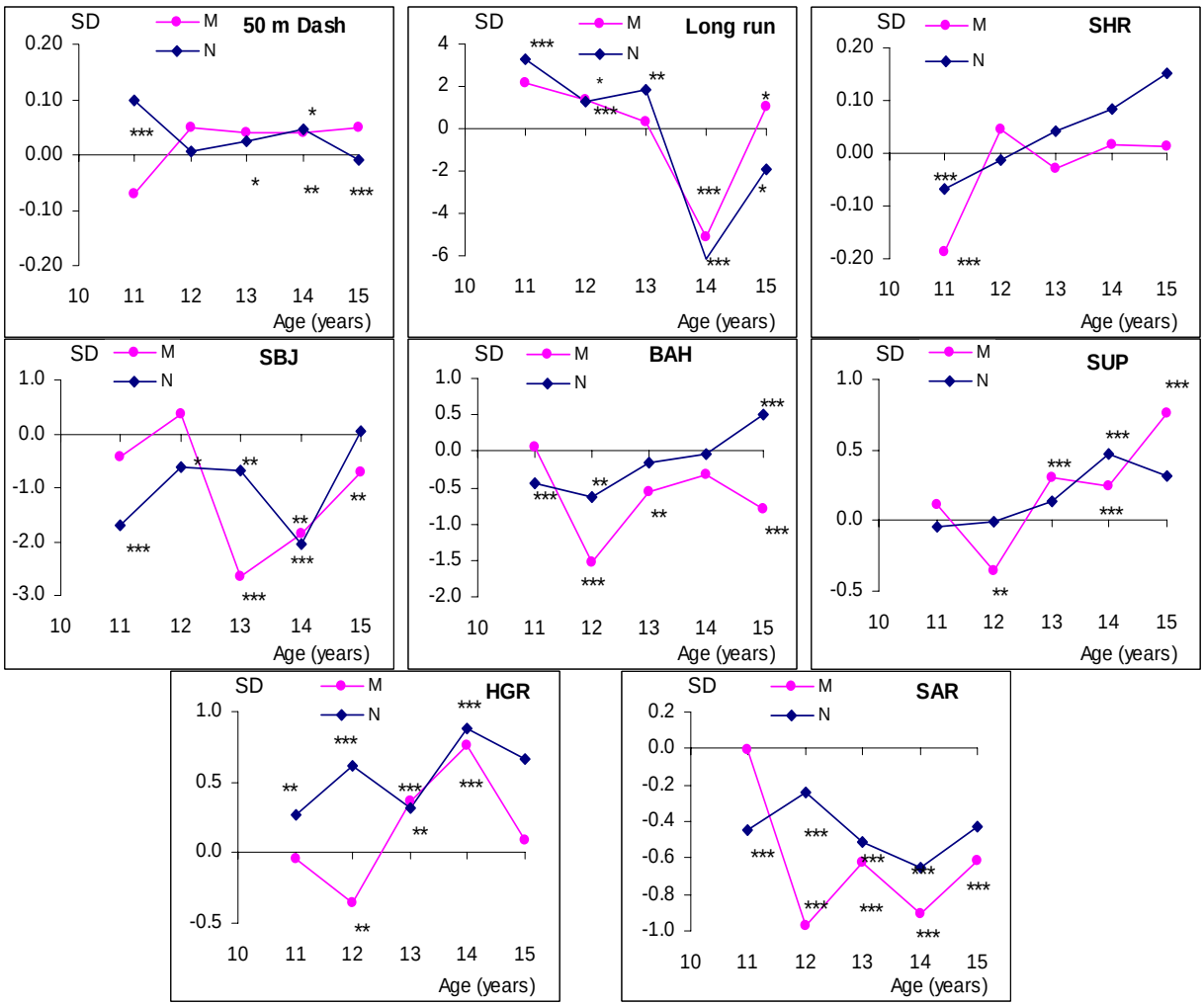


Fig 3. Two-decade distances in fitness variables in menstruating (M) and non-menstruating (N) girls: Year 2006 (n = 2554) vs. 1986 (n = 5563; horizontal axis)
Legend: Long run – 600 or 800 m run (up to or above 12 years of age, respectively); SHR – Shuttle run 4×10 m; SBJ – Standing broad jump; BAH – Bent-arm-hang; SUP – Sit-ups; HGR – Handgrip; SAR – Sit-and-reach; Significant differences vs. girls studied in 1986: * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Discussion

Biological advancement of adolescents of the same calendar age but differing in sexual maturation is greatly diversified. It was shown in this study that girls aged 10 – 13 years, studied in 2006, entered the maturation process markedly earlier than their peers 20 years earlier. This was much less pronounced in 14 years olds and in older ones the pattern was even reversed. At any rate, non-menstruating girls could be classified as homogenously late maturing. On the other hand, the percentage of such girls among the menstruating ones increases with age, thus making that category non-homogenous. This was reflected in the observed generation trends which were more pronounced in younger than in older girls. Mean age at menarche in 2006 amounted to 12.77 years, i.e. decreased over the 20-year period by 0.64 years and was practically identical with that reported for Poland in 2005 (12.80 years) [19]. The menarcheal age in 1986 (13.41 years) was well beyond the physiological limit suggested by Cole [5] and was indicative of unfavourable socio-economic conditions at that time.

The observed changes in body height and mass of girls and in their ponderal (slimness) index suggest that the increase in body height was closely associated with the growth spurt, mainly at the beginning of the adolescence period, since later the stature increases slower than body robustness [23]. Menarche usually appears after the girls have attained Tanner's Stage 3 of puberty [25], i.e. in the mid-pubertal period, and this was the reason for a less pronounced somatic development of menstruating girls compared with their non-menstruating mates.

The observed changes in slimness, especially pronounced in menstruating girls, could be attributed to an increased awareness of girls and their parents regarding their education, lifestyle, nutrition, etc., as well as to fashion trends. This view is supported by the obesity rate among girls from the Eastern region in 1986, much higher than the average for Poland or large towns [26]. Those positive trends in awareness could not be, however, detected in the motor development of girls that was in menstruating and non-menstruating girls alike. Thus, despite the effects of earlier pubescence on motor fitness, the generation changes in that latter were slight if not negative.

Summing up, the age at menarche of girls from Eastern Poland decreased between the years 1986 and 2006 by 0.64 years and is now practically identical with the man value for Poland. Among other generation changes were significant increases in body height and decreases in body mass in menstruating girls, and even greater increases in body height and increases in body mass in the non-menstruating ones. Physical fitness, generally, was not improved over those two decades – significantly worse results were noted in most tests, especially in leg strength, some improvement being noted in hand strength and trunk strength. Those observations call for undertaking preventive steps against the decreasing motor fitness of adolescent girls.

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