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Body height and age at menarche of girls from eastern Poland in the period of political transformation

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Abstract: Biological state of a group of people or particular individuals in various phases of ontogenesis should be treated as a positive health measure. The aim of the study was to assess the directions of changes in body height and age at menarche of girls from eastern Poland in the years 1986-2016. The data regarding 30784 students aged 10-16 living in towns and villages of the eastern parts of such regions as Podkarpackie, Lubelskie, Podlaskie, Warminsko-mazurskie and, to a slight extent, Mazowieckie were used in the study. Body height was measured and information concerning the place of living and age at menarche (yes-no) was gathered during interviews. Acceleration of body height and age at menarche was observed in girls from the east of Poland in the period of political transformation and after European Union (EU) accession, while the level of secular trends was connected with the pace of changes in the environment. Biological effects of the EU preservation of Polish agriculture and particular care of the eastern provinces of Poland reduced developmental differences between these provinces and other regions of Poland. Moreover, in the analysed period of three decades (1986-2016), the disappearance of differences in body height and age at menarche between the inhabitants of rural and urban areas was noted, which indicates larger positive socio-economic changes in the countryside. In turn, greater body height was noted in non-menstruating girls compared to their menstruating counterparts. However, in subsequent observations, smaller differences between these groups were observed.

Key words: secular trend, pace of maturation, town, village

Introduction

Diagnosing the influence of various factors on the developmental processes of children and youth is significant in cognitive and practical terms. The biological state of a group of people or particular individuals in various phases of ontogenesis, their development and physical activity should be treated as positive measures of a widely understood health definition formulated by the World Health Organisation (Kemm and Close 1995). Numerous authors have attempted to determine the influence of various factors on the biological development of

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children and youth. It was concluded, inter alia, that genetic factors accounted for 50% of determinants of age at menarche (Morris et al. 2011; Dvornyk and Waqar-ul-Haq 2012). Other factors included body mass at birth (Wang et al. 2012), obesity (Wagner et al. 2012), body height (Flom et al. 2017), racial or ethnic origin (Ramnitz and Lodish 2013), socio-economic situation (Amigo et al. 2012; Deardorff et al. 2014), family environment and its structure (Ellis et al. 2011; Milne and Judge 2011, Toromanović et al. 2015), etc. Moreover, it was proven that genetic determination of body height was estimated at the level of 70% (Malina and Bouchard 1991), while its phenotypical level of realisation to a large extent reflected the influence of stimuli coming from the environment in which children and youth were growing up. This thesis has been confirmed, inter alia, by Castilho and Lahr (2001).

In the research on biological development of humans, auxologists grew interested in secular trends that resulted from environmental factors. Plentiful evidence indicates that somatic features and age at menarche may change together with the development of the society (Flash-Luzzatti et al. 2014; Kozieł et al. 2014; Lee et al. 2016) and may differ depending on race, country, region or the level of urbanisation of the place of living (Sławińska et. al 2012; Kozlov and Vershubsky 2015; Xin-Nan et al. 2015; Łaska-Mierzejewska et al. 2016). In the literature of the subject, the secular trend of somatic features and acceleration of maturation have been documented by the researchers from the developed and developing countries (Colle 2003; Malina et al. 2004; Mi Jung P et al. 2006; Danubio and Sanna 2008; Deardorff et al. 2014; etc.). The phenomena of increasing height in the society and accelerated maturation of the youth have been confirmed pointing to the fact that the pace of intergenerational changes depends on the socio-economic level and living conditions. Lower values of secular trends were noted in girls and boys from countries with a lower standard of living. Together with an improvement in the living conditions of the study participants and their families, an increase in secular trends was observed. In the countries with a high level of industrialisation, weaker trends of body height and age at menarche were noted together with an acceleration of body mass trends (Colle 2003; Komlos 2004; Gohlke and Woelfle 2009).

In Poland, the last thirty years saw rapid changes as well as socio-economic and political transformation, including the results of a deep crisis of the 1980s, socio-political changes and pre-accession period in the 1990s and EU accession. While analysing socio-economic changes, it was noted that they had a different pace in different regions of the country. Thus, it was interesting to analyse the direction of changes in body height and age at menarche in the years 1986-2016 in female inhabitants of eastern provinces of Poland, which, according to Eurostat (2014), are included in the group of the poorest regions of the European Union.

Material and Methods

The first studies on biological development of children and youth were conducted in 1985 and 1986 within the Priority Problem 10.7. The results of the observations carried out on 17245 girls were selected. Further measurements were made in 2005 and 2006 within the statutory research of the University of Physical Education in Warsaw (DS. 45) and the

results of 8966 students were selected. Observations were also repeated in 2015 and 2016 within the statutory research of the University of Physical Education in Warsaw (DS. 203). They provided the results of 4573 students. From each of the above-mentioned studies on children and youth aged 7-19, the results of girls aged 10-16 were taken into account. The calendar age groups were divided into menstruating and non-menstruating girls.

The research in 1985 and 1986 was carried out in the eastern voivodeships of that time (Suwalskie, Bialostockie, Bialskopodlaskie, Chełmskie, Zamojskie, Przemyskie and Krośnieńskie) which were located in the border area of eastern Poland. After the administrative reform in 1998, these voivodeships constitute an eastern part of such provinces as Podkarpackie, Lubelskie, Podlaskie, Warmińsko-mazurskie and, to some extent, Mazowieckie. Observations in the next decades were also made in the same regions of the country. Detailed information concerning the number of girls, their calendar age and the size of the place of living in subsequent observations is included in table 1.

The same research methods and techniques as well as procedures of data verification were applied in the three observations. The research was conducted in compliance with the guidelines of the declaration of Helsinki and was accepted by the Senate Ethics Commission of the University of Physical Education in Warsaw.

The measurements of body height and data from the questionnaires were selected from an extensive study on somatic features and motor abilities. Body height was measured with the use of an anthropometer with an accuracy of 1 mm. Personal data of the study participants and information regarding their living environment were collected with the use of a questionnaire developed by the authors and completed by parents of primary and secondary school students. From the general information collected in the questionnaire, data regarding date of birth, the occurrence of menarche (yes/no) and a place of living were used in the research.

On the basis of the information included in the Statistical Yearbook (2016) and other source materials, data concerning socio-economic situation of the eastern provinces of Poland were gathered.

Academics employed at the University College of Physical Education in Biała

Table 1. Number of girls participating in subsequent studies stratified by their place of living

Age (years)		10	11	12	13	14	15	16	Total
	Total	2434	2486	2538	2488	2521	2556	2222	17245
1986	Town	1188	1213	1239	1214	1231	1248	1085	8418
	Village	1246	1273	1299	1274	1290	1308	1137	8827
	Total	1245	1231	1102	1209	1093	1429	1657	8966
2006	Town	641	634	568	623	563	736	854	4619
	Village	604	597	534	586	530	693	803	4347
	Total	765	847	1054	533	472	461	441	4573
2016	Town	397	439	547	276	245	239	228	2371
	Village	368	408	507	257	227	222	213	2202

Podlaska as well as students trained for this purpose helped with the realisation of this research.

Following the verification and coding of the data, statistical analyses were commenced. Calendar age was calculated by subtracting the date of birth from the date of the study, where days and months were changed into a thousandths place in the decimal. After the calculations, the study participants were divided into age groups. The group of 10-year-olds included girls whose age was between 9.500 and 10.499 years. It was analogical in older age groups, both in calculations for the whole material and in the groups taking into account the place of living. Arithmetic means and spreads were calculated in the groups.

In all the observations, the percentage of menstruating girls was calculated, while the significance of differences between the number of participants in 1986, 2006 and 2016 was defined with the use of χ^2 test. On the basis of the data from the questionnaires regarding menarche, the ratio of menstruating girls to all the study participants was calculated with the "status quo" method and mean age at menarche was calculated with the probit method (according to Finney 1952) both for the whole material and for particular groups regarding the place of living. The significance of differences in body height and mean age at menarche between particular observations was determined with the use of ANOVA and Newmann-Keuls test. Environmental differences in all the described development indicators were calculated by subtracting the results of rural girls from the results of urban participants. Statistical significance of differences between the groups of girls from both environments in 1986, 2006 and 2016 was determined with the use of the student's t-test. Statistical significance of differences was set at the level of $p<0.05$.

Research results

In the period of political transformation and after the accession of Poland to the European Union, positive long-term tendencies of changes in body height were observed. In the girls from eastern Poland, a statistically significant trend of increasing body height was noted in all the calendar age groups (Table 2). In the first of the analysed periods, i.e. the years 1986-2006, this somatic feature increased by an average of 3.32 cm (1.66 cm per decade). The largest difference (4.41 cm) was noted in the group of the oldest examined inhabitants of eastern Poland, while the slightest difference (1.41 cm) was observed in 12-year-olds. In the next decade (2006-2016), the value of this somatic feature increased by 0.84 cm. The mean for all the results was 1.30 cm. After assessing the whole period of 30 years, it was concluded that from 1986 to 2016 the height of the girls increased by an average of 4.62 cm. The largest differences in the values of this somatic feature occurred in the oldest examined inhabitants of eastern Poland (5.76 cm), while the smallest differences were noted in 11-year-olds (3.09 cm).

While assessing environmental differences in body height of the girls in all the observations, a gradual decrease in differences regarding this somatic feature was noted (Table 3). In 1986 the inhabitants of the towns in eastern Poland were taller than their rural counterparts by an average of 1.58 cm. However, although all the differences were statistically significant, they were not identical in all the calendar age groups (0.93 cm in 16-year-olds to 2.69 cm in 11-year-olds). Twenty years

Table 2. Body height of girls from Eastern Poland in subsequent 1986, 2006 and 2016

Age (years)	1986	2006	2016	Acceleration		
	Mean±SD	Mean±SD	Mean±SD	1986-2006	2006-2016	1986-2016
10	137.35±6.59	141.46±7.59	143.00±7.91	4.11*	1.54*	5.65*
11	144.40±9.19	145.80±8.47	147.49±7.66	1.41*	1.68*	3.09*
12	149.20±7.74	152.57±8.01	153.41±7.45	3.37*	0.84*	4.21*
13	154.53±6.89	157.94±8.30	158.99±7.68	3.41*	1.05*	4.46*
14	157.76±6.11	161.34±7.28	162.42±6.30	3.58*	1.08*	4.66*
15	161.05±6.13	164.02±6.43	165.59±5.88	2.97*	1.57*	4.54*
16	160.99±7.68	165.40±5.99	166.75±6.11	4.41*	1.35*	5.76*
Mean differences				3.32	1.30	4.62

* Statistically significant differences at $p<0.05$

Table 3. Differences in body height of girls from towns and villages in 1986, 2006 and 2016

Age (years)		10	11	12	13	14	15	16	Mean
Body height (cm)	1986	1.09*	2.69*	2.29*	1.43*	1.43*	1.22*	0.93*	1.58
	2006	0.93*	2.23*	1.99*	0.94*	1.13*	0.84*	0.68*	1.25
	2016	0.63	0.83	0.87	0.93	0.27	0.85	-0.16	0.60

* Statistically significant differences at $p<0.05$

later, also urban participants were significantly taller than their rural counterparts, while a mean difference in all the groups was 1.25 cm. The largest difference was noted in the group of 11-year-olds (0.68 cm). In turn, such clear differences were not noted in 2016 as no statistically significant differences occurred in any of the age groups and the participants from towns were taller than their rural counterparts by an average of 0.60 cm.

Prior to the analysis of the age at menarche of the inhabitants of eastern provinces of Poland, it was also examined whether the ratio of menstruating girls to their non-menstruating counterparts in the same age groups changed. Table 4 presents the percentage of menstruating girls as well as differences between the groups and statistical significance calculated with the use of χ^2 for subsequent observations. On the basis of these data, it was concluded that the percentage of menstruating girls in each group between 10 and 16 years was significantly higher in 2006 than in 1986 (mean difference in an age group – by 8.55%, i.e. 4.27% per decade). However, differences were not equal among all the examined girls. The largest difference occurred in the group of 13-year-olds (22.38%), while the smallest difference was noted among 16-year-olds (1.53%). In the last decade under analysis, a similar trend in biological development was observed, where the largest differences occurred among younger study participants (11 years – 6.67%, 12 years – 6.64%), while the smallest ones among 16-year-olds (0.32%). A mean from all the groups

was 4.13%. Taking into account the above-mentioned research results as well as calculations regarding the whole period of 30 years, it may be concluded that compared to the girls observed in 1986, maturation processes started significantly earlier in the participants assessed in 2016, which points to the acceleration of biological development. After 3 decades, the number of 13-year-olds who started menstruating earlier increased by 25.52%, which is the largest difference calculated in any age group. In turn, the smallest difference, i.e. 1.85%, was noted among 16-year-olds, while the mean for all the groups was 12.68%.

The process of the above-mentioned intergenerational changes was reflected in the difference in mean age at menarche which decreased by 0.59 years between 1986 and 2006, i.e. 0.29 years per decade (Table 5). In the last decade, slower acceleration of maturation in the inhabitants of eastern Poland was noted (0.22 years). In turn, girls assessed in 2016 started menstruating earlier by 0.81 years than their counterparts observed in 1986. All the differences were statistically significant.

The size of the place of living constitutes one of the factors which significantly differentiate developmental processes. The larger the differences in the level of urbanisation, the larger the differences in the age at menarche. While assessing the changes which occurred in the study participants inhabiting places at various levels of urbanisation in three decades, it could be noted that the largest decrease in mean age at menarche occurred in rural girls (0.84 years), while in their urban counterparts it decreased by 0.60 years.

Table 4. Percentage of menstruating girls in 1986, 2006 and 2016

Age (years)	10	11	12	13	14	15	16
1986	0.95	3.65	12.04	37.09	70.70	91.47	97.63
2006	2.89	7.38	29.39	59.47	80.02	95.07	99.16
2016	6.71	14.05	36.03	62.61	85.02	98.36	99.48
Differences							
1986-2006	1.94*	3.73*	17.35*	22.38*	9.32*	3.60*	1.53*
2006-2016	3.82*	6.67*	6.64*	3.14	5.00*	3.29	0.32
1986-2016	5.76*	10.40*	23.99*	25.52*	14.32*	6.89*	1.85*

* Statistical significance calculated using of chi-square test; the level of significance at $p<0.05$.

Table 5. Age at menarche of girls from Eastern Poland in 1986, 2006 and 2016 stratified by place of living and year of study

Year of study	1986	2006	2016	Acceleration		
	Mean±SD	Mean±SD	Mean±SD	1986-2006	2006-2016	1986-2016
Total	13.44±1.21	12.85±1.92	12.63±1.21	0.59*	0.22*	0.81*
Village	13.58±1.21	12.94±1.27	12.74±1.21	0.64*	0.20*	0.84*
Town	13.17±1.23	12.79±1.23	12.57±1.22	0.38*	0.22*	0.60*
Town-Village	0.41*	0.15*	0.17*			

*Statistically significant differences at $p<0.05$

In 2006, the girls from villages in eastern Poland maturated earlier by 0.64 years than their counterparts observed in 1986, while after the next decade the girls maturated even earlier (by 0.20 years). In the described two decades, smaller differences were noted in urban girls (0.38 years), while in the last decade their age at menarche decreased by 0.22 years. After the first two decades, a decrease in differences in the age at menarche of girls from places at different levels of urbanisation was also noted. In 1986, the inhabitants of the smallest villages started menstruating 0.41 years later than their counterparts from towns, while in 2016 the difference was at the level of 0.15 years.

In order to draw more reliable conclusions from the results of bigger groups, the data of the oldest and the youngest girls were excluded from the description of the results while assessing secular trends in body height of girls with different paces of maturation. The results are presented in table 6. While assessing secular trends in both groups, it was concluded that between 1986 and 2016 body height increased from 4.07 cm to 7.90 cm together with an increase in age in the case of girls who matured later. A mean difference from all the examined age groups was 5.60 cm. Their counterparts who were more advanced in their biological development grew by an average of 2.50 cm in the same period. The smallest differences at the level of 0.52 cm were noted in 12-year-olds, while the largest differences at the level of 4.39 were observed in 14-year-olds. Taking into account the means from the first two decades, it should be emphasised that the smallest differences in both groups were noted in the last decade.

Table 6. Body height of menstruating and non-menstruating girls from Eastern Poland in 1986, 2006 and 2016

Age (years)	1986	2006	2016	Acceleration		
	Mean±SD	Mean±SD	Mean±SD	1986-2006	2006-2016	1986-2016
Non-menstruating girls						
11	142.56±7.97	145.43±8.60	146.65±7.06	2.85*	1.22*	4.07*
12	147.59±7.99	151.21±7.75	152.56±6.90	3.62*	1.35*	4.97*
13	152.36±7.49	155.96±7.71	157.51±6.87	3.60*	1.55*	5.15*
14	154.46±6.23	159.73±7.04	160.36±5.72	5.27*	0.63	5.90*
15	157.38±6.57	163.55±7.10	165.28±4.88	6.17*	1.73	7.90*
	Mean difference			4.30	1.30	5.60
11	151.30±6.66	153.33±8.30	153.41±7.86	1.99	0.08	2.07
12	155.75±4.11	155.83±7.52	156.27±8.08	0.08	0.44	0.52
13	157.90±5.69	159.56±8.60	159.62±6.82	1.66*	0.06	1.72*
14	158.36±5.36	161.82±7.23	162.75±6.12	3.46*	0.93*	4.39*
15	162.26±5.51	164.52±6.39	165.82±5.81	2.26*	1.30*	3.56*
	Mean difference			1.89	0.60	2.50

*Statistically significant differences at $p<0.05$

However, it is interesting to see whether differences between the groups of girls with various paces of maturation were changing. While analysing the values included in table 7, it was noted that in all the age groups in 1986, non-menstruating girls were shorter than their counterparts who had their first menstruation earlier by an average of 6.25 cm. In the next observations this difference gradually decreased, i.e. the means in 2006 and 2016 were 3.84 cm and 3.10 cm, respectively. In subsequent observations, the largest differences were noted among 11-year-olds (by 8.76 cm in 1986, 7.90 cm in 2006 and 6.76 cm in 2016), while the smallest ones among 14-year-olds (by 3.90 cm in 1986) and 15-year-olds (by 0.97 cm in 2006 and 0.54 cm in 2016).

Discussion

The best diagnostic indicators of biological development of females include body height and age at menarche. Between 1880 and 1980 in Europe and North America body height of youth in the maturation period increased by 2-3 cm per decade, while body height of young adults by 1 cm per decade (Danubio and Sanna 2008). However, this trend was different in various countries and a different pace of changes was noted depending on the period of observation. Therefore, it may be concluded that interactions which occurred between the environment in which children and youth were growing up and their development were dynamic and depended on the period and region which affected the pace of changes in the environment. A regular improvement in living conditions lowers age at menarche and increases the level of somatic features. The intensity of these processes depends on the region of Poland and on genetic factors. However, favourable living conditions help to make use of genetic development opportunities, which is manifested with earlier growth and maturation of girls and boys (Kaczmarek 1995). In the 1970s and 1980s, a slower pace of developing a tall stature was noted among the youth in the whole country (Kozieł et al. 2014; Kołodziej et al. 2015). Moreover, differences in secular trends were observed depending on the region of Poland or on the level of urbanisation of the place of living. Such results were presented by Hulanicka et al. (1994), who examined girls from Silesia and by Jopkiewicz (1997), who assessed the youth from Kielce. Similar conclusions were drawn from the observations conducted in towns and villages of various sizes, which was confirmed by the results of the youth from Wroclaw (Ignasiak and Sławińska 1993), children and youth from Zywiec (Kaczanowski et al. 2004) and rural girls from various regions of the country (Łaska-Mierzejewska and Olszewska 2003). In

Table 7. Differences in body height of menstruating and non-menstruating girls in subsequent studies and statistical significance of differences

Age (years)	11	12	13	14	15	Mean difference
1986	8.76*	8.16*	5.54*	3.90*	4.88*	6.25
2006	7.90*	4.62*	3.60*	2.09*	0.97	3.84
2016	6.76*	3.71*	2.11*	2.38*	0.54	3.10

* Statistically significant differences at $p<0.05$

the research carried out on a large population in Poland in the years 1979-1989-1999, lower values of body height trends were noted in the first decade and considerably higher values were observed in the second decade (Przewęda and Dobosz 2005). Observations of the Polish population in the first decade of the 21st century were continued by Dobosz (2012a). He observed a slower pace of growth increase in the years 1999-2009 compared to the previous decade, which was proven by the results of 18-year-olds. Simultaneously, he noted further acceleration of developmental processes such as growth and maturation among participants from younger age groups who were in the puberty period. The research by Wilczewski (2005; 2013) carried out in eastern Poland revealed that considerable developmental differences between the youth from these areas and average Polish population occurred in earlier years. They decreased considerably at the end of the 1980s, particularly in younger age groups (7-14 years). In our research, a tendency of body height to increase was also noted in the two decades between 1986 and 2006. However, the results of research carried out in eastern Poland by Saczuk (2011) made it possible to present the issue in a broader context. In the first decade, the author noted a lower tendency of body height to increase, while in the second decade, an increase was higher. The reasons for such secular trends regarding the described somatic feature in the first decade may stem from the negative effects of economic crisis and initial economic changes. Therefore, in the second decade, when parents provided children with better development conditions, bigger differences in these secular trends regarding body height also occurred and maturation may have accelerated. The observed differences in body height between particular stages of the research were larger in the girls from eastern Poland examined in the years 1986-2006 than in their counterparts from big cities (Charzewska et al. 2004; Perenc 2009). Such big intergenerational changes may result from "catch-up growth" modified by positive changes in the living environment of the study participants. The support from European Union funds for rural and small-town areas intended for eastern Poland, as one of the poorest region in the EU (Eurostat 2014), is also not without significance. Among these EU funds, the area payments directed for individual farms, which among other factors, contributed to the improvement of living standards, are of particular importance. During the study period, a decrease in the unemployment rate and the number of people living in poverty was recorded. Despite these positive trends, the unemployment rate in eastern Poland is still higher (Podlaskie Voivodeship 11.8%, Lubelskie 11.7%, Podkarpackie 13.25) than the national rate by 9.8%. In addition, the average monthly salary in Poland was raised from PLN 2,380.0 in 2006,to PLN 4,156.0 in 2016, however, in eastern Poland the average monthly salary is lower by 11-15% than the whole national rate.

It is common knowledge that an intergenerational increase in body height reflects a fuller realisation of genetic potential of an individual and results mainly from an improvement in the standards of living. Compared to the above results, a slower pace of body height increase among the girls from eastern regions of Poland was noted in the last decade. However, in that period, the secular trend of this somatic feature differed depending on the area in which the research

was conducted. Body height of children and youth aged 7.5-15.5 from Cracow increased slightly (by approximately 1.00 cm) in the years 2000-2010 (Kowal et. al 2011). Larger differences in growth were noted among female primary and lower-secondary school students from Lower Silesia, where body height of children and youth aged 7-15 increased by 1.75 cm to 2.45 cm between the years 2001-2002 and 2010-2011 (Ignasiak et al. 2016). The analysis of the literature and the results obtained in 2016 revealed that girls from eastern Poland are currently taller than the population from selected regions of Poland that were compared by Kaługa et al. (2011). However, the study by Wasiluk et al. (2016) on girls from eastern Poland aged 7-19 revealed that the youngest and oldest inhabitants of the eastern regions of Poland demonstrated body height values similar to the mean values of Polish norms (Dobosz 2012), while in the age groups analysed in our research they were shorter than their counterparts. It may prove that they matured later, which is confirmed by the results regarding age at menarche described below. Moreover, the observed differences confirmed the dissimilarity of the environment in which the participants of our study grow up. Eastern regions of the country are typically agricultural and have a low level of industrialisation, but they are not polluted owing to the lack of big industries. They are scarcely populated (83.2 inhabitants per 1 km^2, while in the whole country it is 123 inhabitants per 1 km^2). Moreover, an average gross salary of the inhabitants of this area is 12.7% lower than the national average, while the unemployment rate is 2.4% higher. The inhabitants of eastern Poland work in agriculture (20.9%), in small and medium-size enterprises (26.1%) and services (53.0%). It must be pointed out that in 1996, 30.9% of the inhabitants worked in agriculture, 23.8% in industry, while 45.3% in services (Statistical Yearbook 2016).

In the assessed three decades, decreasing differences in body height between the inhabitants of towns and villages were also noted. Thus, it proves that secular trends were higher among the inhabitants of the smallest towns, which was also confirmed by Saczuk (2011). Moreover, it confirms the changes in the environment which occurred in the villages of eastern Poland. The inhabitants of this area mainly worked in agriculture which in the last twenty years was supported with considerable pre-accession and post-accession grants from the European Union. They were, to a certain extent, a driving force behind socio-economic changes in the rural areas, which affected the level of biological measures of life.

Age at menarche is one of the symptoms of maturation in girls. It is more sensitive to the influence of environmental factors than body height (Laska-Mierzejewska and Olszewska 2003). It was proven that together with an improvement in living conditions, earlier occurrence of the first menstruation was observed. The first scientific studies regarding the assessment of age at menarche in women were carried out 150 years ago. They revealed that in the middle of the 19th century, girls started menstruating at the age of 16-17 (Ong et al. 2006; Gohlke and Woelfle 2009). Compared to the current results, it means a decrease by 3-4 months per decade (Ong et al. 2006). Despite suggestions that a decrease slowed down or even stopped in certain countries (Talma et al. 2013; Cabrera et al. 2014), there are regions in which the decreasing trend regarding

age at menarche is still noticeable (Cho et al. 2010; Prentice et al. 2010). It must be remembered that worse life conditions caused by wars or long-term economic crises hinder the development pace or even cause deceleration. When negative factors disappear, these delays are quickly overcompensated. Such observations were presented by Vecˇek et al. (2012), who described the effects of the Balkan war on girls from Zagreb. The girls' age at menarche increased by 0.10 years in 1997 compared to 1990, while it decreased by 0.61 years after 13 years. The retardation of maturation in the 1980s followed by a considerable decrease in the age at menarche was also noted by Gomuła and Kozieł (2017), who analysed age at menarche of girls from selected regions of Poland, by Łaska-Mierzejewska et al. (2016), who assessed the inhabitants of Polish villages from non-agricultural families and by Wilczewski (2005), who studied the process of maturation of girls from the towns of southern Podlasie. At the same time, lower values of secular trends in the maturation pace followed by their increase were observed, inter alia, among the inhabitants of Cracow (Kowal et al. 2011) or the inhabitants of the Polish countryside working in agriculture (Łaska-Mierzejewska et al. 2016). The authors, who analysed the results of deceleration and retardation of secular trends in age at menarche, claimed that they stemmed from an economic crisis which took place in Poland in the 1970s and 1980s. The crisis was less visible in agricultural areas where small farms producing food were the dominant ones (Wilczewski 2005). The first findings presented in our study were collected in 1986, so they reflect the effects of the above-mentioned economic crisis. At that time, the inhabitants of eastern provinces of Poland matured 0.17 years later than girls from other regions of the country (Gomuła and Kozieł 2017). Moreover, a higher age at menarche was noted compared to the population of Poland in groups divided according to the size of the place of living (Łaska-Mierzejewska et al. 2016). The difference among rural girls was 0.25 years, while among urban girls it was 0.20 years.

In the present study, there are no data regarding menarche of the inhabitants of eastern Poland after the first decade, which would show the pace of maturation of children and youth in particular decades. On the basis of the available results it was concluded that from 1986 to 2006 age at menarche decreased considerably (by 0.59 years) and was close to the average age at menarche in Poland (12.80 years, after Przewęda and Dobosz 2005). Moreover, bigger positive changes were noted in the inhabitants of rural areas who started menstruating earlier (0.64 years), while in their urban counterparts these changes were smaller (0.38 years). It caused a significant decrease in differences between the analysed environments. Thus, according to Cole (2000), a physiological lower limit of mean age at menarche which should not exceed 13 years of age was crossed. According to the cited author, menarche only after the 13th year of life points to bad social conditions in which the girls were growing up. Therefore, it may be concluded that living conditions in eastern Poland improved considerably.

In the years of 2006-2016, a further decrease in age at menarche of the inhabitants of eastern Poland was noted; however, it was smaller than a 10-year mean calculated on the basis of two previous decades. At that time the study participants maturated earlier by 0.27 years

than their counterparts from other regions of Poland described by Gomuła and Kozieł (2017). However, they maturated later by 0.25 years than the inhabitants of Germany and Scandinavian countries (Gohlke and Woelfle 2009) and girls from South Korea (Mee-Hwa end 2016).

While comparing the results of the girls from towns, it was noted that the inhabitants of eastern provinces of Poland still maturated later by 0.18 years than the national average (Łaska-Mierzejewska et al. 2016), by 0.28 years than the study participants from Zagreb (Vecˇek et al. 2012) and by 0.22 years than the inhabitants of Chinese cities (Xin-Nan et al. 2015). In turn, the girls observed in our study started menstruating earlier by 0.11 years than their counterparts from Cracow agglomeration (Kowal et al. 2011) and by 0.53 years earlier than the inhabitants of Izmir in Turkey (Tekgül et al. 2014). Also, age at menarche was higher by 0.26 years in the case of the girls inhabiting villages from eastern Poland compared to the general Polish sample (Łaska-Mierzejewska et al. 2016) and by 0.15 years when compared to the inhabitants of eastern China (Xin-Nan et al. 2015). However, a slight difference (0.05 years) was noted compared to the inhabitants of villages from the southwest of Poland (Sławińska et al. 2012)

Age at menarche is closely related to the division into menstruating and non-menstruating girls. In all the calendar age groups of the inhabitants of eastern provinces of Poland examined in 2016, the percentage of girls in which the processes of maturation already began was higher than among the study participants in 1986 and 2006, which proves that biological development accelerated. This was a regular process in the whole period under observation and the largest differences were noted in 13-year-olds. It should be emphasised that this is a mean age at menarche of the examined girls. The acceleration of the development is also confirmed by the fact that in 2016, 20.76% of the girls started menstruating before the age of 12, while 17.14% of the study participants had their first menstruation when they were 14 and older. Thirty years earlier these percentages were at the level of 4.90% and 40.20%, respectively.

The authors' observations revealed that in the last thirty years, body height increased considerably in non-menstruating girls, while the pace of changes was higher than in their menstruating counterparts. It should also be pointed out that differences in body height between the analysed groups were decreasing in subsequent observations. Thus, it may be assumed that the observed increase in body height occurred mainly at the beginning of the maturation period, before the girls started menstruating and is closely related to the pubertal spurt of this feature. Pubertal spurt is the period in which the most positive changes in body height occur, since in further periods, when body mass increases, growth is slight (Malinowski et al. 2013). Menarche usually (85% of the study participants) occurs in the third stage of secondary sexual characteristics (Wilczewski 2005), i.e. in the middle of the puberty period. Therefore, considerably smaller positive changes in this somatic feature occurred in non-menstruating girls than in their counterparts who were at an earlier stage of biological development. Thus, it may be concluded that a decrease in age at menarche is closely related to a faster pace of growing. These conclusions are confirmed by the findings of Floma et al. (2017). They noted that age at men-

arche in fast-growing girls is lower by 4.6 months than in their counterparts who were growing at an average pace.

Conclusions

In final conclusions it might be said that

Acceleration of body height and maturation was observed in girls from the east of Poland in the period of political transformation and after European Union accession, while the level of secular trends is associated with the pace of changes in the environment.

Biological effects of the European Union preservation of Polish agriculture and particular care of the eastern provinces of Poland reduced developmental differences between these provinces and other regions of Poland.

In the analysed period of three decades (1986-2016), the disappearance of differences in body height and age at menarche between the inhabitants of rural and urban areas was noted, which points to larger positive socio-economic changes in the countryside.

Greater trends in body height are still noted in non-menstruating girls compared to their menstruating counterparts. However, in subsequent observations, smaller differences between these groups were observed.

Authors' contributions

JS, AWa and AWi design the study, oversaw the statistical analysis/interpretation and were the authors of the written content.

Conflict of interest

The authors declare that there is no conflict of interests regarding publication of this paper.

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