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The menarcheal age of school-aged female athletes in the light of their social and environmental background

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Wiek menarche młodych sportsmenek w świetle zmiennych społeczno-środowiskowych

Streszczenie

Celem pracy było przedstawienie wieku menarche dziewcząt pochodzących z różnych rodzin, środowisk i warstw społecznych oraz w odniesieniu do wielkości wskaźnika BMI. Badaniami objęto 119 dziewcząt (w wieku 16–19 lat) uczących się w szkołach sportowych. Za pomocą kwestionariusza ankiety zebrano dane dotyczące wieku menarche, wielkości środowiska zamieszkania, wykształcenia i charakteru pracy rodziców, pochodzenia społecznego i inne. Zmierzono wysokość i masę ciała dziewcząt i na ich podstawie obliczono BMI. Istotność różnic oceniono za pomocą jednoczynnikowej analizy wariancji ANOVA, testu Najmniejszych Istotnych Różnic Fishera oraz te-

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stu t-Studenta. Obliczono współczynnik korelacji rang Spearmana i przeprowadzono analizę korespondencji pomiędzy wiekiem menarche a pozostałymi analizowanymi zmiennymi. Na podstawie przeprowadzonych analiz i otrzymanych wyników można stwierdzić, że średni wiek menarche badanych dziewcząt nie różnił się istotnie od wieku menarche populacji ogólnej zamieszkującej zachodnią Polskę. Dziewczęta z miast, w których mieszka 100 tys. i więcej ludzi, a także te, których rodzice mają wyższe lub średnie wykształcenie, dojrzewają wcześniej, natomiast dziewczęta z mniejszych miejscowości, jak i te, których rodzice mają tylko wykształcenie podstawowe, dojrzewają później. Dziewczęta z nadwagą lub otyłością dojrzewają wcześniej niż dziewczęta o prawidłowej masie ciała i niedowadze.

Słowa kluczowe: dojrzewanie, zawodniczki, środowisko życia, BMI.

Abstract

This study aimed to present the menarcheal ages of girls from different families, backgrounds, and social strata with respect to their BMI. This study included 119 girls (aged 16–19 years) from Polish sports schools. Using a diagnostic questionnaire, data on the girls' age at menarche, their living environment, parents' education and occupation, social origin, and others were collected. The body height and mass of the girls were measured, and the Body Mass Index was calculated. The significance of the differences was assessed using ANOVA, Fisher's least significant difference test, and t-test. Spearman's rank correlation coefficient was calculated and the analysis of correspondence was made between the age of menarche and the ranked variables. In conclusion, the average age of menarche among the studied samples did not significantly differ from that in the population living in western Poland. Girls from locations with 100,000 or more inhabitants and whose parents have higher or secondary comprehensive education are early maturing, whereas those from smaller towns and villages and whose parents only have primary education are late maturing. Girls with overweight or obesity mature earlier than normal and underweight girls.

Keywords: puberty, maturation, sportswomen, living environment, BMI.

Introduction

In industrialized societies and developed countries, social and economic stratification are reflected in the biological growth rates of children and youth. Numerous studies show that girls from higher social classes mature earlier than their counterparts from lower ones [9, 53, 59]. The question arises whether the difference in growth rate reflects only girls' backgrounds. Many factors, including parents' education, the number of children in the family, and standard of living, indirectly affect the age of menarche. Thus, it can be concluded that biological differences are related to the living conditions. Among factors directly affecting girls' maturation rate the most often quoted are: nutrition, psychological factors, social background and physical work load [23, 39, 41].

Body height and age of menarche are most often used by anthropologists as indicators of the material and cultural position of families, professionals, and social classes. Age at menarche is especially sensitive to changes in quality of

life. This is corroborated, for example, by Charzewska et al. [7] and Charzewski et al. [8], who examined the growth and maturation of children and adolescents during the crisis of the 1970s and the 1980s in Poland and found out that girls from upper social classes matured earlier than girls from the poorest families, while parents' education, number of siblings, living in town or in the country, number of older siblings, parents' occupations, etc., indirectly affected girls' maturation.

Age at menarche is a highly variable and sensitive feature. Although biological maturation processes are strongly determined genetically, the age at first menstruation is highly affected by environmental and social factors. According to Łaska-Mierzejewska and Olszewska [30], it is a very sensitive 'barometer' of living conditions. The effect of living conditions on age at menarche has been described by several researchers [4, 7, 46, 59].Various Polish and foreign authors estimate that the age of menarche has decreased by three years over the past century [18, 22, 35, 56]. At present, young people enter puberty earlier than they did 20 years ago, which is known as the acceleration of growth [29].

Numerous studies on menarche are most often based on studies in girls who are not physically active above average, and there are very few studies on groups of young girls practising sports [9, 31, 43, 54]. Girls who engage in sports consume much more energy because of their high training load, which, in addition to environmental and social factors, may affect their age at menarche.

Given the current status of research, this study aimed to examine the age at menarche in girls practising sports with regard to selected social-background factors and body mass index. Therefore, we need to answer the following questions: (1) Does the average menarcheal age of girls attending sports schools who are regularly loaded with exercise differ from that of girls who do not play sports or those who exercise occasionally?; (2) Among girls who regularly practise sports, do social variables such as the size of living environment, parental education and occupation, parents' social background, family status and number of siblings, and financial status of family differentiate the age of menarche?; (3) Is the menarcheal age of the girls studied associated with physique as determined by BMI categories?

Material and methods

In 2017–2019, a cross-sectional survey was conducted on the age at menarche among students attending seven sports schools in Poland, Lubusz Province. The girls were asked whether they menstruated, and if so, they were asked about the date (year and month) of their first period [24]. This study included 119 girls (aged 16–19 years) who participated in regular training in various

sports. The sports which they practised were: acrobatic dance, bullseye shooting, bodybuilding, swimming, volleyball, handball, modern pentathlon, track and field, basketball, horse-riding, long-distance running, badminton, and acrobatics. This study was approved by the Bioethics Committee of the Regional Medical Council in Zielona Góra, Poland (Registry Number 3/63/2016).

Using a diagnostic poll and questionnaire, information was obtained about the girls' age at menarche, rural/urban background, parents' education and occupation, social origin, number of siblings, number of older siblings, type of feeding during the first six months of life, family material means, and family status.

Inaccuracy is a common problem in most retrospective studies [11, 14, 27]. Some studies have shown a tendency for women to under-report their menarcheal age [10], and some to over-report it – as they get older [6]. In some studies, the results appeared to be consistent or only slightly different [15]. In our study, we decided to apply a retrospective method because the study included girls between the ages of 16 and 19, meaning that only an average of five years had passed between menarche and the study.

Somatic measurements (body height and mass) were performed using the technique described by Martin and Saller [33]. Body Mass Index (Body Mass Index) was calculated using body height and mass data. The assignment to subsequent categories of the body mass index was as follows: (1) underweight (<M-1SD), (2) normal weight (M±1SD), and (3) overweight or obesity (>M+1SD) for subjects within each year of calendar age separately, in accordance with the reference values for assessing the nutritional status of children and adolescents in Poland according to OLAF [43].

Data analysis

The mean age at menarche, along with the standard deviation and the variability coefficient, were calculated for particular social background factors that could affect the maturation rate (Table 1). The significance of the differences in the mean age at menarche for different social classes was assessed using the analysis of variance (ANOVA) and post-hoc Fisher's Least Significant Difference (LSD) test or Student's t-test (for independent samples). A p-value less than 0.05 implied statistical significance. Spearman's correlation coefficient was calculated between the age of menarche and social-background factors and between menarcheal age and BMI categories. In order to assess the structure of relations among the respective factors, the analysis of correspondence was used for the categorized age of menarche and factors that were correlated with the age of menarche. This method allows for graphical representation on the plane in the system of XY axes of the different categories of the dependent and independent variables, taking into account the distances between them. To carry out the correspondence analysis, the age of menar-

che was categorized based on the following centiles: 1 – <C25 (lower quartile = 11.5), 2 – (C25:C75), 3 – >C75 (upper quartile = 13.17), where 1 denoted an early maturing girl (in this cohort), 2 denoted normal maturation, and 3 denoted late-maturing girls. The purpose of the analysis was to show which categories of variables were close to each other and which categories were distant.

Results

Below, the findings on the age at menarche with regard to selected social-background factors and BMI are shown (Table 1).

Table 1. The mean age at menarche with regard to socio-background factors and body mass index

Factors		N	M	SD	V	SS	df	MS	/8F	p-value	Post-hoc Fisher's LSD Test
Total		119	12.72	1.18	9.30						
Living environment						14.49	2	7.246	5.583	0.005	
Big town – over 100,000 inhabitants	(1)	43	12.27	1.09	8.88						1–2 (0.013)
Town of no more than 100,000 inhabitants	(2)	45	12.88	1.18	9.16						1–3 (0.002)
Village	(3)	31	13.10	1.15	8.78						
Father's education						26.41	3	8.802	7.301	0.000	
Primary	(1)	6	13.29	1.33	10.01						1–4 (0.031)
Secondary vocational	(2)	36	13.35	1.04	7.79						2–3 (0.001)
Secondary comprehensive	(3)	42	12.50	1.03	8.24						2–4 (0.000)
Higher	(4)	35	12.23	1.19	9.73						
Mother's education						18.58	3	6.193	4.863	0.003	
Primary	(1)	11	13.40	0.91	6.79						1–3 (0.039)
Secondary vocational	(2)	32	13.16	1.14	8.66						1–4 (0.006)
Secondary comprehensive	(3)	33	12.58	1.15	9.14						2–3 (0.042)
Higher	(4)	43	12.32	1.15	9.33						2–4 (0.002)

Table 1. The mean age at menarche… (cont.)

Factors		N	M	SD	V	SS	df	MS	/8F	p-value	Post-hoc Fisher's LSD Test
Father's occupation						5.445	2	2.722	1.979	0.143	
Manual job	(1)	69	12.54	1.15	9.17						
Intellectual work	(2)	36	12.95	1.01	7.80						
Other (odd jobs, disability benefit, old age pension)	(3)	14	13.02	1.60	12.29						
Mother's occupation						0.200	2	0.100	0.070	0.932	
Manual job	(1)	53	12.68	1.08	8.52						
Intellectual work	(2)	49	12.77	1.19	9.32						
Other (odd jobs, disability benefit, old age pension)	(3)	17	12.70	1.50	11.81						
Father's social background						2.854	3	0.951	0.674	0.569	
Working class	(1)	40	12.62	1.24	9.83						
Farmer family	(2)	15	12.42	1.42	11.43						
Intellectual family	(3)	41	12.87	1.14	8.86						
Other	(4)	23	12.82	1.01	7.88						
Mother's social background						3.976	3	1.325	0.649	0.421	
Working class	(1)	41	12.72	1.18	9.28						
Farmer family	(2)	14	12.68	1.77	13.96						x
Intellectual family	(3)	43	12.55	0.99	7.89						
Other	(4)	21	13.08	1.08	8.26						
Number of elder siblings						1.146	2	0.573	0.406	0.667	
None	(1)	60	12.63	1.19	9.42						x
One	(2)	39	12.84	1.17	9.11						
Two and more	(3)	20	12.75	1.21	9.49						
Number of children in the family						5.818	2	2.909	2.119	0.125	
One	(1)	17	13.25	1.04	7.85						x
Two	(2)	59	12.67	1.16	9.16						
Three and more	(3)	43	12.58	1.23	9.78						
Feeding after birth							117			0.930	
Breastfeeding	(1)	94	12.72	1.26	9.91						x
Artificial formula	(2)	25	12.70	1.40	11.02						

Table 1. The mean age at menarche… (cont.)

Factors		N	M	SD	V	SS	df	MS	/8F	p-value	Post-hoc Fisher's LSD Test
Family's financial status (earnings)						5.761	3	1.920	1.386	0.251	
Low	(1)	6	13.55	1.25	9.23						
Medium	(2)	11	12.92	1.12	8.67						x
Good	(3)	58	12.72	1.10	8.65						
Very good	(4)	44	12.56	1.28	10.19						
Family							117			0.917	
Two-parent	(1)	97	12.71	1.20	9.44						x
Single-parent	(2)	22	12.74	1.15	9.03						
BMI						11.15	2	5.58	4.20	0.017	
<M-1SD (under-weight)	(1)	10	13.66	1.71	12.52						1–2 (0.012)
+-1SD (normal weight)	(2)	93	12.68	1.12	8.83						1–3 (0.006)
>M+1SD (over-weight or obesity)	(3)	16	12.35	1.05	8.50						2–3 (0.289)

Urban/rural living environment is a factor that accelerates or decelerates maturation. The first to mature were girls living in big towns or cities (M=12.27), then those living in small towns (M=12.88), and finally girls living in rural areas (M=13.10).The differences between the girls from big towns and smaller towns and between the girls from big towns/cities and those from villages were statistically significant (Table 1).

To determine how parents' education affected their daughter's age at menarche, four types of parents' education were distinguished: primary, secondary vocational, secondary comprehensive, and higher. The earliest to enter puberty were the daughters of fathers with higher education (M=12.23) and secondary comprehensive education (M=12.50), whereas the latest were the daughters of fathers with primary and secondary vocational education (M=13.29, M=13.35). The differences between the age of menarche of the girls whose fathers possess primary and higher education, those whose fathers have secondary vocational and comprehensive education, and those with secondary vocational and higher education are statistically significant (Table 1).

Regarding mothers' education, a similar phenomenon was noticed: the first to mature were the girls whose mothers had a higher (M=12.32) and secondary comprehensive education (M=12.58). Apart from the differences between the age at menarche of the girls whose mothers completed primary and secondary

vocational education and those with secondary comprehensive and higher education, all others were statistically significant (Table 1).

With regard to fathers' occupation, the earliest age of menarche was found in the case of the daughters of fathers performing manual jobs (M=12.54). Next, there were the daughters of fathers performing white-collar jobs (M=12.95). The latest to begin puberty were the daughters of fathers who were old-age pensioners, who were on disability benefits, or who did not have regular jobs (M=13.02). The differences between the earliest and the latest girls (in terms of the father's occupation categories) with regard to maturity in this respect did not exceed 0.48 year and they were statistically insignificant. A similar situation could be observed with respect to the mother's occupation; the earliest age of menarche was found in the case of the daughters of mothers performing manual jobs (M=12.68). However, this factor did not significantly affect the age at menarche in the girls practising sports on a regular basis (Table 1).

Another factor was the girls' parents' social backgrounds. With regard to social background, the earliest age of menarche was observed in the girls whose fathers were farmers (M=12.42). Regarding the mother's background, the first to begin puberty were the daughters of mothers who came from intellectual families (M=12.55), while the daughters of mothers from 'other' backgrounds matured the latest (M=13.08). The difference of 0.53 year was statistically insignificant (Table 1).

The number of elder siblings did not significantly affect the age of menarche: the girls with no siblings were the first to have their periods (M=12.63), while the last were those with one elder sibling (M=12.84). The difference of 0.21 year was small and statistically insignificant (Table 1).

The total number of siblings in the family did not significantly affect age at menarche (Table 1). The earliest age of menarche was found in the girls who had two or more siblings (M=12.58), and the latest in the girls who were the only children in the family (M=13.25). Thus, the results show that the total number of children in the family was a weak operating factor. The difference of 0.67 year was statistically insignificant (p=0.052).

The data on the type of food, which the baby girls were provided with showed that this factor did not affect the age at menarche significantly. The girls who were breastfed entered puberty a little later than their peers who were fed with milk formula, the difference being statistically insignificant (Table 1). Therefore, this factor plays a negligible role in accelerating or delaying puberty. However, it should be noted that as many as 79% of the girls were breastfed by their mothers in their first year of life.

Regarding the financial status of the girls' families, the girls from well-off families were the first to mature (M=12.56), whereas those from the poorest families were the last (M=13.55). Although the difference of 0.99 years seems

large, it is insignificant (p=0.081) due to a small number (n=6) of the least well-off respondents (Table 1).

Family status was another factor that possibly affected age at menarche. The girls who had both parents had their first menstruation earlier (M=12.71) than those who came from single-parent families (M=12.74). The difference was 0.03 year and it was statistically insignificant (Table 1).

Considering the categorized BMI values, it can be noted that the youngest to mature girls were overweight or obese (mean age of menarche, M=12.35) and the latest were underweight girls (M=13.66). The difference in menarcheal age between normal-weight girls and overweight or obese girls was 0.33 years and was statistically insignificant, while the difference between age of menarche of normal weight girls and underweight girls was 0.98 years (statistically significant).

Spearman's correlation coefficient was used to assess the relation between the age of menarche and the selected social-background factors and BMI categories (Table 2).

Table 2. Spearman's rank correlation coefficients between the age of menarche and the selected variables

Factors	**Age of menarche**
Living environment	0.2893*
Mother's education	−0.4716*
Father's education	−0.3722*
Number of elder siblings	0.0903
Number of children in the family	−0.1099
Family's financial status (earnings)	−0.2378
BMI (1 – underweight, 2 – normal weight, 3 – overweight or obesity)	−0.3217*

* – significance at 0.05

Table 2 shows that age at menarche was significantly correlated with factors such as living environment, mother's education, father's education, and BMI. Living in larger communities has been linked to earlier menarche. The higher the parents' education level, the earlier the maturation of their daughters. The higher the BMI (the stouter the body), the earlier the maturation.

In addition, the correspondence analysis was used to categorize the age at menarche and the variables correlated with the age at menarche. The results of the analysis of correspondence for statistically significant variables correlated with the age of menarche (i.e., urban/rural living environment, parents' education, BMI categories) are shown in Figure 1.

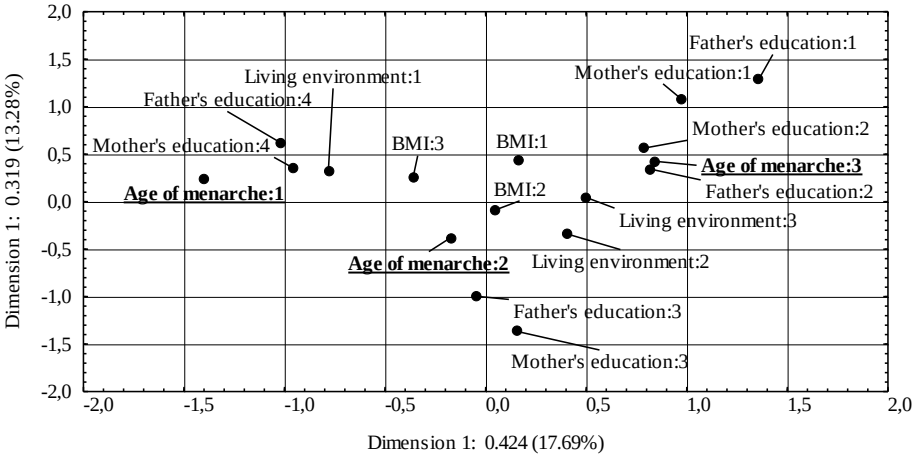

Figure 1. Multiple correspondence analysis of the Burt matrix for the selected variables

Figure 1 shows the results of the multiple correspondence analysis of variables that were significantly correlated with age at menarche. The horizontal axis representing dimension 1 has the largest share (17.69%) of inertia, while dimension 2 (vertical axis) equals 13.28%. The two dimensions constitute 30.97% of the inertia. To the left of the center representing category 1 there are the girls who matured the earliest (most often from cities of 100,000 or more inhabitants (1), who were overweight or obese (3) and had parents with higher education (4); around the center there are the girls with 'standard' maturation (2) – most often living in smaller towns of Lubusz Province (2), whose parents possessed secondary comprehensive education (3), whose body weight was within the normal range (2); to the right of the center there are the late-maturing girls (3) – most often living in villages (3), whose parents had primary (1) or secondary vocational (2) education.

Discussion

The age of menarche in girls practicing various sports occurs, as a rule, later than it does on average in the population [9, 31, 39, 50]. The mean menarcheal age of young female athletes in our study (12.72±1.18) was similar rather than higher to those presented in other articles on girls from Lubusz Province who were not involved in sports or doing sports only recreationally. For example, Asienkiewicz and Wandycz [2] showed that the mean age at menarche was 12.85 ± 1.01 years. Similarly, Tatarczuk et al. [51] reported 12.7–12.8 years and Tatarczuk et al. [53] reported 12.42 ± 1.18 years. Data from other Polish regions

are similar: 12.87 ± 1.26 years reported by Szwed and Kosińska [47]; and 12.63 ± 1.21 years found by Saczuk et al. [44].

Age at menarche was an anthropological parameter used in this study to illustrate the effect of socio-demographic factors on the maturation rate of young female athletes. These factors include social origin, urban/rural living environment, level of cultural development, traditions and customs, and nutrition. [32]. In countries with high living standards, social stratification is reflected in the maturation rates of children and adolescents. The effects of these factors on the age at menarche are well documented [8, 11, 50, 57, 58].

The question arises as to why girls living in towns mature earlier than their peers from rural areas. Favorable environmental and social conditions result in a fuller use of genetic possibilities, as manifested in this case by earlier menarche. The temporal differences in the average age of menarche of girls from different social groups are a good measure of the distance between the social strata. The differences are more acute when there are greater differences in the degree of urbanization, the practical use of civilization and hygienic achievements in everyday life, nutritional status, daily workload, parents' educational background, and awareness [3, 5, 28, 38, 49, 57].

The research conducted by the authors of this study confirms that the urban/rural environment significantly influences the rate of maturation in girls practicing sports. The lowest menarcheal age was observed among girls from towns with more than 100,000 inhabitants, while the highest was among those living in rural areas (as confirmed by the correspondence analysis, Figure 1) and by Spearman's rank correlation coefficients (Table 2). Our findings confirm the results of previous studies conducted by other researchers [8, 20, 21, 24, 30, 34, 36, 45, 52]. The effect of gradient on the age of menarche was confirmed.

The education of parents (father's, mother's, or both) may be another factor indirectly affecting the menarcheal age of girls. Some studies confirm the significant impact of this factor [1, 9, 12, 19, 36, 46, 59], whereas others attest to its lesser or even negligible significance [13, 20, 21, 37]. Another study of girls in Lubusz Province (general population without considering sports activities) reported a significantly lower age of menarche only if the father's education level was higher [52]. Our results, despite small differences in the mean age of menarche between girls from different categories of parents' education, show a specific trend that menarcheal age decreases with the increasing level of parents' education, both fathers' and mothers' as confirmed by the significant Spearman's rank correlation coefficients.

Earlier periods tend to occur in girls in a population with increased caloric intake, mainly of plant origin, and a higher incidence of overweight and obesity [17, 55]. Research by Frisch and Revelle [16] showed that menarche usually occurs after women reach the so-called critical weight. In our study, we decided to

analyze the influence of body composition by assessing only the BMI of the studied females. Underweight and overweight are other factors which influence the age of menarche: the lower the value of body mass index, the later the maturation. Girls with too much body weight (overweight/obesity) matured earlier than those with normal weight (non-significant difference) and underweight (statistically significant difference).The same relationship (between menarcheal age and BMI) has been confirmed by previous studies [1, 19, 20, 24, 25, 30, 42].

It is worth noting that the statistically significant factors affecting the age of menarche in school-aged female athletes are as follows: living environment, mother's and father's education, and BMI. The other factors that our study examined (father's and mother's occupation, father's and mother's social background, number of children in the family, number of elder siblings, feeding after birth, family's financial status, and family status) did not affect the age of menarche in girls practising sports.

The literature indicates that differences in the age of entering puberty between different groups and social environments are diminishing. It can be assumed that in conditions of economic unease, all life contrasts are sharper, and after reaching a certain level of affluence (e.g. in rich countries of Western Europe), social and class differences, although they still exist, affect the maturation of young people to a lesser extent [26, 50, 58].

At present, it is increasingly stressed that the acceleration of maturation caused by technological progress is a desirable effect, but it cannot be ruled out that proper biological development could occur at a slower pace [4]. Based on the results presented in this paper, it can be concluded that the female athletes included in our study matured at a similar age rather than later, in relation to girls who were not physically active, but their bodies were more susceptible to the influence of environmental and social factors and dependent on body slenderness. According to Tanner [48], there is no reason to think that earlier maturation is good, and there is some evidence to the contrary. Thus, the question arises as to what is the most desirable developmental path for the body. The unquestioned benefits of earlier maturation of girls include earlier puberty (high linear body gain), earlier maturation of the skeleton, and certain body proportions (especially the pelvis), as well as earlier readiness of the organism to produce offspring.

Limitations of the study

The problem with retrospective studies in general may be their inaccuracy, but this inconvenience applies to most studies that involve accessing the memories of the subjects. Another problem may be that the number of girls participating in the study was too small, which may have caused some of the differences in menarche age between the analyzed categories of social characteris-

tics, although large, to be statistically insignificant. Secondly, the insufficient number of girls did not allow for an additional comparison of menarche age between overweight and obese participants.

Conclusions

The average age of menarche among girls attending sports schools and regularly practising sports is not significantly different from the age of menarche in the general population living in Lubusz Province (western Poland). In the group of female athletes, the following variables had a significant impact on the lower age of menarche: the living environment (especially in girls from cities with more than 100,000 inhabitants) and higher education of parents (mother's and father's education). Underweight girls (as indicated by Body Mass Index) usually mature later than those with normal weight and those who are overweight or obese.

STATEMENT OF ETHICS

This study was conducted in accordance with the World Medical Association Declaration of Helsinki. The study protocol was reviewed and approved by the Bioethics Committee at the Regional Medical Council in Zielona Góra, Poland (registry number 3/63/2016). All participants provided written informed consent to participate in this study.

DECLARATION OF CONFLICTING INTERESTS

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